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January 26th, 1894 ... ...Steel Plate Portrait of Mr. Alexander Siemens (*President of the Institution of Electrical Engineers*).

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NOTES.

It is a subtle point which is raised by our correspondent "E. M. C.," namely, as to whether human beings possess an ether-sense. Prof. Poynting considers that the "agnostic in ethereal matters" may very well doubt the reality of the ether on the ground that he has no direct sensory evidence of its existence. Our correspondent thinks that the eye is a special sense organ capable of giving this direct evidence. From one point of view it may be maintained that we have no *direct* sensory evidence of anything; for all sensation arises from the energy state of the object perceived, and not from that object inherently. On the other hand, our other senses than sight indicate to us some centre of disturbance, as it were: sound telling us of the sounding body rather than of the air which bears the waves, scents telling of the vicinity of some perfumed object, and so on. So light, which *ex hypothesi* is waves borne on the ether, tells us rather of the source of light than of the ether which conveys its waves. It is a *petitio principii* to assert that the eye is an ether organ; for, at best, it only tells us of a light medium, which, so far as the eye alone is concerned, may be corpuscular on the lines of the Newtonian conception. It is not the sceptic, but the believer, who sees in the phenomenon of physical sight any evidence of the ether as a light-bearing medium.

Neither can the action of radiant heat on the skin be said to constitute an ether sense, except we first make the premiss that such radiation can only be propagated by the ether. Yet, while it is fallacious to suppose there is any sensory evidence of the ether, *per se*, we are equally in a difficulty when we learn that sight and skin-sensation are directly evidences of ordinary matter. When we see a glow lamp, it is true, we have clear evidence that the glow lamp is where we see it; but when we feel sunshine, or see starlight, we feel a radiation eight minutes old, and we see the image of a star as it existed perhaps hundreds of years ago. Both sun and star may cease to exist, yet still we should feel and see them. It cannot be argued, therefore, that sight gives us *direct* evidence either of the ether or of the presence of luminous or illuminated matter. Its evidence, more than that of any other sense, is indirect. In all such questions we must carefully distinguish between the *actual cause* of the sensation (which may be unknown) and the *logical value* of the sensation as a predicate of that cause. Sight may well be actually caused by ether; but it cannot be argued backwards that because there is sight there must be ether.

When, some weeks since, we penned an editorial note on a mathematical method of developing an absolutely constant current from two similar alternating currents, we had no thought of creating such an outburst of practical inventiveness as seems to have been stimulated by it. One contemporary takes us literally for a moment; but on second thought comes to the conclusion that to produce a current which should vary as the square of the sine of the phase-angle would require an infinite induction, because the direction of the current would always be positive. So it would—if there were no commutator; but the true curve of sine-squares might be obtained by means of a suitably fringed magnetic field and a properly adjusted commutator. There is no difficulty whatever in getting an electromotive force to follow the law of squared sines: the essential, and we believe insurmountable difficulty, in the practical use of the theorem, lies in the superposition of two such electromotive forces, in quadrature, without disastrous reaction of each on the circuit of the other. A writer in our Chicago contemporary, *Electricity*, takes up our editorial note and attempts a solution. He arrives at the amusing, if not novel result that, if we superpose a current of the form ($\tan x$) upon another current of the form ($-\tan x + a$) where a is a constant, we shall have an absolutely steady current of strength a. This profound truth dwindles into a vain platitude when we try to see how the current ($-\tan x + a$) is to be formed.

Meanwhile, a detailed account has been published of M. Pollak's device for obtaining steady currents from harmonic electromotive forces, in another and more practical fashion. He synchronises a commutator with the single alternating current with which he wishes to deal, distorts the curve of pressure so that it is much flatter at the top, then clips this curve into useful and useless portions. The useful parts he utilises by coupling them up with the storage battery; the useless portions he leaves to take care of themselves, by putting them on open circuit. It is true that to distort his alternating current into an effective shape, M. Pollak finds it necessary to filter it through a transformer, the core of which is designed to be very nearly saturated at ordinary loads. This is at best a very wasteful process, and may prove, in practice, a very troublesome one. Nevertheless, for the manipulation of small amounts of power, M. Pollak's system appears to give satisfactory and fairly efficient results. One drawback to M. Pollak's method is that it is impossible to measure the

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current thus produced. For charging a battery, for example, one of the most obvious uses to which it might be applied, nothing but a shunted voltameter would measure the charging current. We know of a private laboratory in London, supplied with alternating current. It is desired to charge batteries with about 2-H.P. continuous current. M. POLLAK's system would be useless for the reasons just given, and it appears that a gas engine and dynamo will be not only the most convenient, but the cheapest way of solving the problem.

WE hear an unofficial rumour that yet another loud-speaking telephone has been invented. 'Tis a consummation devoutly to be wished. And yet we cannot but have our doubts as to the practical success of this latest endeavour to increase the speaking power of the telephone. For, if rumour may be trusted, the inventor claims to have produced an instrument "which will talk loud enough for a person in any part of a large room to hear and understand what is said;" and further, that "the usual induction coil is discarded and the two instruments are directly connected in circuit with the line and battery." Now, quite apart from the possibility of any invention guaranteeing that we may "understand" what is said, it seems to us that it must be next to impossible to arrange a loud-speaking telephone on a primary circuit. It is, of course, of the utmost importance that the efficiency of the circuit shall be high; which it will be difficult to obtain if the high line-resistance is included in the instrument circuit. The whole *raison d'être* of the induction coil is to increase the speaking power of the apparatus, by excluding the line resistance from the circuit whose resistance is made to vary with the sound waves.

THEORETICALLY, and perhaps in practice also, there is no cause which operates to prevent very loud-speaking instruments being successfully invented. The energy of the sound given out by the receiver does not bear any necessary ratio to the energy of the sound put into the transmitter, and may be many times greater than the latter. For, with the use of microphonic transmitters, the operating energy is derived entirely from the source of electric power, such as the battery, and is merely governed by the sound waves. Theoretically, there is no limit to the variation of current in the circuit which may be effected by the feeblest sound waves; but practically, the arcings and sparkings, the hissings and fizzlings, which go on at the microphonic contacts limit the current which will transmit articulate speech to a very small value indeed. When a means shall have been discovered of making a microphonic contact which will modify very large currents without distortion, the problem of loud-speaking telephones will have been solved. The Gower-Bell and other transmitters with several microphones in parallel offer distinct advantages, but it is found that the principle cannot be carried far. There would be no difficulty in constructing a transmitter with several hundred microphones in parallel.

JUDGING from the kind of ammeters and voltmeters which find a ready sale in this country, many electrical engineers are very easily satisfied. Their excuse for supplying inferior cheap instruments is that, except for central-station purpos[es] no accuracy is needed, as their customers want light, o[r in] rare cases power, and do not want to conduct scientific exp[eri]ments. Another reason is that as they could not calibrate instruments themselves, except by comparison with any re[ally] good apparatus that they might happen to have, and th[eir] customers were still less likely to apply any check. On [the] other hand, with the exception of a genuine Weston voltm[eter] in good order, we know of no electrical measuring instrum[ent] that can compare with those of the first-rate English mak[ers]. Makers of high-class watches are reputed to be exceptio[nally] conscientious men, since defects in their goods cannot [be] recognised except by experts. But the rate-keeping of a w[atch] can be proved by the purchaser in a short time, with[out] any expensive apparatus, while the owner of an ammet[er is] generally at the mercy of the maker or agent who suppli[es it]. One tolerably safe rule has been to avoid instruments w[hich] contain much iron, especially in the moving parts. [The] reduction of the iron has led to delicate workmanship in p[ivots] and jewels. Lord KELVIN once proposed the rapid revolu[tion] of an iron core, and provided a handle on the instrume[nt by] which the residual magnetism might be ground out. H[e has] recently adopted the method of saturating the iron by a s[eparate] coil; and to-day we print a short article from Mr. VIGNOL[ES on] an ingenious method of compensation for hysteresis. [M.] ABAKANOWICZ appears to have hit on the same device, w[hich] consists of the use of a steel magnet magnetised b[y the] working current, and serving to demagnetise the iron whenever the working current is reduced or stopped. [It is] not quite clear how an exact neutralisation can th[us be] effected, but the results appear to be very satisfactory.

THERE is often a pomposity about the manner in wh[ich a] third-rate Vestry sets about the question of electric ligh[ting], as if it should say: I am Sir Oracle, and when I ope my [lips] let no dog bark! Until that Vestry "opes its lips" [and] settles the question, electricity is to be regarded as "i[n its] infancy" and quite a matter of theoretical speculation. [But] when it has spoken, then electricity blossoms out into "[the] light of the future," and becomes "reduced to the dead [level] of hard fact." So is it with Camberwell. The elect[ric] committee is now looked upon as the quasi-divine agent [for] reducing "theories to the dead level of facts," and [is] encouraged by the Chairman of the Vestry with the as[sur]ance that "the absence of any knowledge of the subject u[nder] consideration is no bar to efficient adjudication."

Cable Interruption:

	Date of Interru[ption]
Paramaribo-Cayenne	October 25, 18[93]

Award for Arc Light Carbons at Chicago.—In the de[part]ment of electricity at the Chicago Exhibition one additi[onal] award has been made to Great Britain, namely, to the Ge[neral] Electric Company, for arc light carbons.

Institution of Electrical Engineers.—The winter sessio[n of] the Institution of Electrical Engineers will commence [on] Thursday, November 9th, when Prof. George Forbes, F.[R.S.,] will read a Paper on "The Electrical Transmission of P[ower] from Niagara Falls."

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Telegraphic Communication with the Azores—The Eastern Telegraph Company (Limited) announce that telegraphic communication has been established between the Company's station at Lisbon and the islands of San Jorge, Pico and Terceira. Messages are accepted by the Company at the rate of 10d. per word.

Electric Car Catastrophe in America.—An electric car on the Oregon City Tramway line, containing thirty passengers, went through an open drawbridge in Madison-street last Wednesday and was plunged into Carpen River. So far as can be at present ascertained, twenty-five of the occupants of the vehicle were drowned. A heavy fog was hanging over the city at the time, and the open drawbridge could not be seen.

Brush Plant at Baltimore Burned.—The plant of the Brush Electric Company, at Baltimore, Md., caught fire during the night of October 13th, and was completely destroyed. The Company had the contract for city lighting, and operated the largest plant in Baltimore, having a capacity of over 1,500 arc and 12,000 incandescent lamps. The city will be in darkness, as there is no other company equipped to supply street lights. The loss to the Brush Electric Light Company is estimated at $200,000.

Trade Glow Lamps.—Lamp bulbs of curious and fantastic form are in use in some parts of the United States. Saloons are said to be lighted with clear glass lamps having the shape and size of a beer bottle, and with a paper label stuck on their outer surfaces. Globes having the shapes of cigars, cakes of soap, pickle bottles, &c., are to be found in the shop windows to which they are especially suited. Doubtless in time we shall see, and see by, luminous legs of mutton, glowing geese, and scintillating sausages suspended outside shop windows.

Railway Rates.—The London Chamber of Commerce is constantly being asked by members for advice in regard to paying their accounts with the Railway Companies on the basis of 5 per cent. increase. They have always been advised to pay "on account" only (and not including the 5 per cent.) pending the issue of the report of the Select Committee on Railway Rates which sat during last session. This report may be expected some time this month, and until its tenour is made known the course above referred to is the best that can be recommended.

Electric Light for Lighthouses.—We understand that the Harbour Department of the Board of Trade has decided not to accept the offer of Mr. John R. Wigham, of Dublin, to set at rest, at his own expense, the controversy regarding the relative merits of electricity and other illuminants in lighthouses. It will be remembered that at the recent meeting of the International Maritime Congress, some account of which appeared in *The Electrician*, September 1st, an offer was made by Mr. Wigham to conduct a series of experiments on lighthouse illuminants at his own expense.

The Harness Case.—The *Pall Mall Gazette* states that Messrs. Lewis and Lewis have, on behalf of the proprietor of that paper, accepted service of a writ issued by Mr. C. B. Harness, the late Managing Director of the Medical Battery Company, for libel. Messrs. Lewis, in reply, have informed the plaintiff's solicitors that "our instructions are to give you every facility to bring this case on for trial as early as possible, and to add that in the event of these proceedings being delayed we shall take such steps on behalf of the defendants as the law permits to compel the plaintiffs to proceed to trial."

Electricity in the French Navy.—A remarkable feature of the "Jauréguiberry," the new ironclad which was launched on October 27th from the yard of the Forges et Chantiers de la Méditerranée at La Seyne, near Toulon, will be the extensive use of electricity as a motive power. It will move the turrets, raise the ammunition, and do much other work which in the majority of modern ironclads is done by steam or by pneumatic or hydraulic power. It will also, of course, light the vessel. The ship will contain 550 incandescent lights, and there will be six powerful Mangin search lights.

Opening of a New Technical College.—Hymers College, the new technical college for Hull, was opened by the Lord Chancellor last Saturday. The building consists of a spacious main hall, capable of holding 800 people, and around it are arranged 16 class-rooms and laboratories. The suite of rooms includes chemical and technical laboratories. The estate, comprising the buildings and 20 acres of ground, is the gift of Robert Hymers, Esq., to the town of Hull. The inaugural proceedings included an exhibition of electrical apparatus, and the ubiquitous demonstrations in electric cookery.

Obituary.—Prof. Franz Grashof, the well-known authority in modern engineering science, died at Karlsruhe on October 26th. He was born at Düsseldorf in 1826, and had just completed his 67th year. As a young man he made a long voyage, extending over nearly two years, in a trading ship, to Indian and Australian waters, devoting himself to scientific pursuit. Subsequently rising into fame as an engineer, Grashof was in 1856 elected Director of the Association of German Engineers, and held the post up to the time of his death. Prof. Grashof was the author of a number of text-books on engineering.

Electric Locks.—A system of electrically-controlled locks has been introduced into a Female House of Detention at Baltimore, which it might be found satisfactory to place in every prison and institution where persons are forcibly detained. The women are locked in their cells at night, and, without some such system as that in use, would run the risk of death in the event of a fire breaking out. But all the locks are controlled by an electric switch in the matron's room; and the movement of this switch to the proper contact will release every door in the building, and ring several alarum bells.

Lightning—A New Danger.—Our readers may be interested to learn that Prof. Lodge has commented on the so-called "new danger" from lightning, to which we referred in an editorial note on October 13th, in the following communication to a contemporary :—

> "The note regarding indirect fire from lightning is interesting. It would be difficult to vouch for the occurrence in any particular instance, but I am already convinced that such resonant sparks occur and do cause fires. There is an instance in the Hotel de Ville, Brussels. Gas leaks act as the usual tinder. One would not expect a fringe to catch fire quickly enough."

A Multiple Filament Lamp.—A multiple filament lamp, which has been used for some time in Germany, contains a number of filaments united in common at the upper part; each half can, therefore, be used with any of the others, thus enabling all but one-half of a filament to be used up or broken before the lamp must be renewed; the extra expense is said to be much less than the equivalent in the new lamps. Furthermore, several filaments can be used at once, thus increasing the candle-power. The blackening of the lamp bulb must, however, limit the length of time during which a lamp of this kind might be used, and would probably render it more economical to get a new lamp rather than to continue to use the old one.

Gilchrist Lectures.—Courses of Gilchrist science lectures are at the present time being given in various parts of the country. On Thursday, October 27th, Dr. J. A. Fleming gave the third lecture of the course being delivered at the great Assembly Hall, Mile End-road, E., on "Magnets and Electric Currents." The immense building, which holds 5,000 persons, was completely filled with an audience consisting almost entirely of artisans, who followed with great interest numerous experimental illustrations, chiefly shown with the vertical and horizontal optical lantern. The Ven. Archdeacon Farrar presided. The same lecture was given on the following night to a large audience at Bournemouth

Accident in a Brooklyn Power Station.—One of the big fly-wheels used in the power house of the Atlantic Avenue Railroad at Brooklyn flew to pieces in the evening of October 11th, while revolving at great speed. The bursting of the wheel nearly demolished the power house, partly wrecked a house several blocks distant, broke in doors and windows in other houses, and, besides this, injured three persons. The wheel was 18ft. in diameter, carried a 14in. belt, and weighed about 20 tons. The electric machinery in the power house was, of course, instantly stopped, and all the cars on the Atlantic Avenue lines came to a sudden standstill. The blockade lasted a couple of hours, when traffic was resumed through aid furnished by the wires of the City Railroad Company,

Personal.—His Majesty the King of Portugal has bestowed the following honours in connection with the establishment of

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telegraphic communication between Lisbon and the Azores:—Sir John Pender, G.C.M.G., M.P., to be Grand Cross of the Military Order of Our Lord Jesus Christ (His Majesty having offered alternatively to create Sir John a Baron of the Portuguese Kingdom); Sir George Elliot, Bart., to be Grand Cross of the Military Order of Our Lady of the Conception of Villa Viçosa; Admiral Sir George Richards, to be Commander of the Military Order of S. Bento de Aviz; M. Jules Despecher, Mr. Thomas Fuller, Mr. John Denison Pender, and Mr. William Shuter, to be Commanders of the Military Order of Our Lady of the Conception of Villa Viçosa; Mr. Francis S. Harwood, to be Commander of the Military Order of Our Lord Jesus Christ; and Mr. E. V. Wyse and Mr. G. D. Stacey, to be Chevaliers of the Military Order of Our Lord Jesus Christ.

The Official Telegraphic Vocabulary.—The International Telegraphic Bureau at Berne is completing the great work, on which it has been engaged for three years, of the compilation of an official vocabulary for use with code telegrams. It was decided at the Telegraph Conference held in Paris in 1890 that this vocabulary should be undertaken at the cost of the States of the Union, and that the International Bureau should undertake the work, upon which English, Spanish, Dutch, Italian, and Swiss *employés* have been engaged. It will include at least 240,000 words, in selecting which the best vocabularies already in use (including the "Telegraph Convention Codes") have been utilised. The words are drawn from eight languages—English, German, French, Italian, Spanish, Latin, Portuguese, and Dutch. It is thought that the work of compilation will be completed in March next, and that towards the end of 1894 the Vocabulary will be on sale. Three years will be allowed for the general adoption of the vocabulary by the European States, and it is probable that the International Telegraph Congress, which will meet at Buda-Pesth in 1896, will make its use obligatory in all the States of the Union. This Vocabulary should not be confused with a code of prearranged sentences. It is simply a very full collection of words to be used in compiling code sentences. All words which, owing either to their orthography or similarity in telegraphic signals, are liable to error in transmission, as well as those exceeding ten letters, have been eliminated. The numeration of the words is in two sections, the thousands appearing at the top of each page, and the hundreds, ten, and units before each word. After each series of ten words are two words without numbers, which have been introduced to permit the replacing in future editions of numbered words which practice may prove to be inadmissible without necessitating the alteration of the consecutive numbering.

Taunton.—Dr. Fleming has forwarded to the Electric Lighting Committee of the Taunton Corporation his report on his improvements and additions to the electric lighting station. The report is divided into four parts. (1) The additions to the boiler plants; (2) the additions to the dynamo plant; (3) various small improvements required in the station, and especially the alteration of the steam piping; (4) the laying of the mains underground. He reports that the two Babcock boilers now in use at the station are, as far as he can learn, in fair condition. Practically the whole boiler power in the station is under use at the time of heaviest load, and there is no other reserve boiler power in case of one of the boilers breaking down; nor is there any possibility of extending the lighting without overloading the boilers. He therefore recommends the Committee to put down an additional boiler equal to 100 H.P., and this boiler should be devoted entirely to the arc lighting station. He recommends the acceptance of the tenders of Davey, Paxman and Co. for a steel economic steam boiler at the cost of £385, together with £50 for setting it. The next point on which Dr. Fleming lays stress is that it is absolutely necessary to put in at once a small alternator to take the load at times when it is very far below the full capacity of the two present alternators. He also recommends that to drive this machine an engine capable of undertaking about 40 H.P. will be required. Under these conditions he expects to produce a marked economy in the coal. He thinks that the present Willans engine requires overhauling, as does also the Ruston and Proctor engine. Lastly, he deals with a very important question of the supply of the current by underground conductors, and says it will be necessary for the Committee at once to commence putting some c the lines underground, but it is necessary to do this on systematic plan. He proposes to get rid of the small hous transformers, or rather to keep them for what may be calle the "pioneer" work, and to supply the central portion of th town from one common set of transformers which are to b placed in sub-stations.

Science in Public Schools.—The new science building whic has been erected by the governors of the Leys Schoo Cambridge, was opened on Saturday, October 28th, by Lo Kelvin. The building, which has cost a little over £4,00 contains four laboratories on the ground floor, chambers in tl basement for electrical work, three lecture rooms upstairs, tl largest of which has been named the Kelvin room, and vario other rooms for scientific work. The style follows out tl permanent plan of the north block of the school, and the obje of the governors in establishing a science department has bee to enable the boys to go into the University thorough prepared to enter upon a scientific course of education, a well grounded in practical work. At the luncheon, which w held in the school hall, and over which Dr. Moulton, the he master, presided, there was a large number of heads colleges, and scientific and other guests present. Dr. Moult said it was through the powerful and attractive influence the University that the Leys School was drawn to Cambridg Lord Kelvin spoke of the advance made in science teachi since he joined the University 52 years ago as a member Peterhouse. Their fondest anticipations at that time as what might be done never came up to that which had be realised. In those days they had nothing but mathemati and classics in Cambridge, and the undergraduates who to advantage of the teaching of great men in any other branch of instruction were exceedingly rare. Progress, however, h been made since then in the teaching of science in the ancie public schools. He hoped that all the glories of the old publ schools would not in any way be diminished, and that t splendid results attained in classics would not be made le but rather enhanced, by the introduction of other branches instruction. He begged, however, that classics should not l made so very hard and exhausting, and should not be allow to take up the whole of the time at school as they had done the past. It was possible to send out boys from their publ schools showing the best results of a classical education, a at the same time having a good deal of knowledge of math matics and experimental science. The public schools we showing strong and praiseworthy determination to meet matte in that respect. Many of them now had physical and chemic laboratories; but he doubted whether any of them had bett arrangements than those which had been established at the Ley School. The school might be held up as an example to all th ancient public schools which had not already got something a good. He should like to make it known that for a thorough going classical scholar science was a recreation. While losin nothing of the thoroughness of his classical work he migh have his mind opened and refreshed by turning to something else that would be his possession as long as he lived. On the other hand, he did not wish to see science students go out int the world without a fair knowledge of classics; but here there was a difficulty, because if the knowledge was to include verse and prose, Greek and Latin, it was beyond the possibilities o human nature. He did think, however, that classics an literary studies and history were quite necessary for every science student. There was now too much specialising. The object of a public school or University was not to allow a young person entirely to choose that which he liked best. If a boy was very fond of mathematics, for instance, a certain amount of compulsion should be put upon him to learn other things as well which he would not otherwise learn. After referring to the great services which the University had rendered to science, he remarked that it was not imagined 20 years ago that a public school would be equipped as the Leys School now was, and that practical training would be given in the natural sciences in order that pupils going up to the University might be properly prepared for University work. Such a change was comparable with the great revival of learning 300 years ago

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ELECTROMAGNETIC THEORY.—LVII.

BY OLIVER HEAVISIDE.

(Continued from page 664, Vol. XXXI.)

§ 217. Let us now ask what is the evidence in favour of the beneficial action of self-induction. There was plenty in 1887; it is overwhelming now. But there are two sorts of evidence, the theoretical and the experiential. The two are not fundamentally different, however; only the former is more indirect than the latter. We have certain electrical laws established, mainly by laboratory work followed by mathematical investigation, and there is no reason whatever to suppose that they do not hold good out of doors as well as inside. The important thing is to correctly recognise the prevailing conditions and determine their results. Now, if you can be pretty sure that you have done this, and have confidence in your investigations, then you may consider that you prove a thing, even though there may be no direct evidence. Discoveries are frequently made in this way. "A foundation of experimental fact there must be; but upon this a great structure of theoretical deduction can be based, all rigidly connected together by pure reasoning, and all necessarily as true as the premises, provided no mistake is made. To guard against the possibility of mistake and oversight, especially oversight, all conclusions must sooner or later be brought to the test of experiment; and if disagreeing therewith, the theory itself must be re-examined, and the flaw discovered, or else the theory must be abandoned." (Oliver Lodge.) But to convince other people is quite another matter. They may not be competent to understand the evidence. Or they may be fully competent, but not have sufficient acquaintance with the subject; or not have time to examine it; or not have the energy; or have no interest in it. Then, as Elijah said to the priests of Baal, you must "Call him louder!"

Now, the foundation of fact is the experimental facts of electricity and the laws deduced therefrom, though these laws are sometimes more comprehensive than the facts upon which they are based. But there was, in 1887, a certain amount of direct evidence as well, quite enough to make the theoretical conclusions practically certain, by the confirmation they afforded. Assuming the electrostatic theory to be true in telephony (for which, however, there was never any sufficient warrant) we can calculate its consequences. They indicate that the product RSl^2 of the total resistance and the total permittance limits the distance l through which telephony is possible. How big it may be is questionable, on account of the very complicated nature of the problem when the human is taken in as a part of the mechanism. We cannot say certainly beforehand how much distortion is permissible before the human will fail to recognise certain sounds as speech. But the electrostatic theory shows such very considerable distortion even when RSl^2 is as low as 5,000 or 7,000 ohms × microfarads, that it is scarcely credible that any sort of telephony could be practicable if it were much bigger, as 10,000 for example. Perhaps 5,000 might be taken as the practical limit for rough purposes. But experience showed that good telephony was got up to 10,000 and higher, in this country with circuits including underground cables, as well as in America, where long-distance telephony had already made a good beginning. Manifestly the electrostatic theory was erroneous by direct as well as indirect evidence. Now the inclusion of the influence of self-induction in the theory explained these results (and also the failure of iron wires and the success of copper) and pointed out how to improve upon them, viz., by directing us to lower R and increase L in order to increase the value of RSl^2 possible. So there was sufficient direct evidence then to satisfy anyone competent to judge who considered it fairly without being prejudiced by the law of the squares. Since that time, the amount of this direct evidence has been greatly multiplied, and RSl^2 has got up to 50,000, which may be about ten times as great as the probable value under purely electrostatic conditions. But there is nothing critical about 50,000. It might be 500,000 if the circuit were long enough. We may need to reduce R when we increase l, but not in proportion to the inverse square of l, or anything like it.

Any long circuit may be made approximately distortionless if the magnetic side of the phenomena can be made important, and without the inconvenience of the leakage needed to remove the distortion, which leakage, however, is essential when the magnetic side cannot be made important. The useful guide in considering telephony is the size of the quantity R/Ln, the ratio of the resistance to the reactance, the two terms appearing in $(R^2+L^2n^2)^{\frac{1}{2}}$, the impedance of unit length of circuit, apart from the permittance.

The term "reactance" was lately proposed in France, and seems to me to be a practical word. It may be generalised to signify the value of Ln, positive or negative, of any combination of coils and condensers, L being then the effective inductance. When L and the reactance are positive, the magnetic side prevails and the current lags; and when it is negative, the electric side prevails and the current leads.

At present, however, R and L are as before. Now the ratio R/Ln may be very large. If so, the influence of L is small, and we shall have something like the electrostatic theory, provided the range of n be such as to make the ratio always large. But this state of things is quite unsuitable for long-distance telephony. The most suitable state is when R/Ln is a proper fraction throughout the whole range of n; that is, when R is less than the smallest value of Ln. We shall then have approximately distortionless propagation of the type

$$f(x) = \epsilon^{-Rt/2L} f(x - vt),$$

as may be seen by examining the solution for simply periodic waves, and observing that when R/Ln is small we have nearly the same attenuation in a given distance (and also distortion) at all frequencies (not too low), so that the element of frequency tends to disappear altogether, and reduce the formula to the above type.

Practice shows, however, that this state of things is unnecessarily good for commercial telephony, which admits of a considerable amount of distortion. Then R/Ln is not less than 1 throughout the whole range of n, but is greater at the low frequencies and less at the higher. For example, if the lowest value of n be 625, and $L = 20$ (centim. per centim., usual units), the least value of Ln is 12,500. If also the resistance is 5 ohms per kilometre, then R is 50,000. The value of R/Ln is then 4 at the lowest frequency, and 2, 1, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ at the five successive octaves, the last being at $n = 20{,}000$. Here we have an excellent state of things from $n = 2{,}500$ up to 20,000, and only at the low frequencies does R prevail over Ln. If R be halved, or L be doubled (for it is indifferent which is done), then R/Ln is less than 1 from $n = 1{,}250$ upwards. Divide n by 2π to obtain the frequency. This 2π has nothing to do with the ridiculous 4π which the B.A. Committee want to consecrate. The significant point in calculations of this kind is the position of n in the scale of frequency which produces equality of R and Ln. When it is low we have good quality; when high, then relatively bad. Perhaps the American electricians may be able from their extended experience to give practical information on this and other points concerned in telephony, and construct an empirical formula of a sound character for determining the limiting distance roughly in terms of the electrical data, with given kinds of instruments for transmission and reception. It should be understood that the above remarks do not apply to short lines, at least in general. We may, indeed, so arrange matters that the above type is still preserved (with R/Ln less than 1) by practical annihilation of reflected waves, but otherwise serious modification may be needed. And with very short lines we may apply a purely magnetic theory, of course.

§ 218. Supposing, now, that practicians have come to discard the supposed limitations so persistently asserted by official electricians in England, and to open their eyes to the part played by self-induction, they will naturally recognise the wide possibilities that are suggested in future developments, and want to know whether such possibilities can be converted into actualities, and whether the conversion is practicable. For myself, I am not much concerned in this part of the question. It is for practicians to find out practical ways of doing things that theory proves to be possible, or not to find them if they should be impracticable. Nevertheless, since I am responsible

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for these views concerning the parts played by self-induction and leakage, I add a few remarks on the applicational side.

The ideal is the distortionless circuit, requiring both self-induction and leakage. If we utilise the present existent inductance only, then the needed leakage may be too great by far in many cases. On the other hand, if the existent inductance is big enough to make R/Ln small, in the sense described in § 217, we do not want the leakage particularly, or not at all practically, it may be. It is clear, then, that we should aim at making L/R, the magnetic time-constant, as big as possible.

Now, here is one way of doing it. If, a few years ago, an old practitioner was asked to put up a long-distance telephone circuit, he, being under the belief that R should be high, or at least that it need not be small, and that L should be as small as possible, in order to prevent the deleterious action of self-induction, would probably carry out his principles by putting up a circuit, several hundred miles long, consisting of a pair of fine wires, put quite close together. Or, if he was free from the error as regards R, he would use larger wires. But still close together, for that makes L the smallest. Also, he would not consider this to be bad as regards S, the permittance, being under the belief that the permittance of the circuit of two wires was just one half that of either with respect to the earth, so that their proximity did no harm in increasing condenser action, whilst it destroyed the deleterious self-induction. Now, such a circuit might do very well for local telephony, but for the purpose required there could not be a worse arrangement. The supposed case is not an extravagant one, since it involves the carrying out of official views thoroughly. The cure would be quite easy. Increase the inductance by separating the wires as widely as possible or convenient. If necessary, reduce R as well. The permittance will also be reduced in about the same ratio as the inductance is increased. By this simple process L may be largely multiplied, say from 2 to 20 (cm. per cm.), a tenfold magnification, without separating the wires so much as to require a double line of poles. This way of doing it is the secret of the success of the long-distance telephony which arose in America when iron was discarded. L is made important, and R is kept low. But although L increases very fast on initial separation of wires, it does not continue to increase fast on further separation, so that practical limitations are soon set to the process. The above example shows how a very bad line may be turned into a very good one by increasing the inductance.

Another way is suggested, but only to be immediately rejected. It is, nevertheless, instructive to study failures. We can increase L to any extent by using finer and finer wires. This would be admirable if it were all. But, unfortunately, this process alters R, and faster still; so that R/L increases instead of diminishing. Consider, for simplicity, merely a wire with a concentric tube for return. Then R/L is nearly proportional to RS. Now Lord Kelvin gave a formula long ago, showing that this quantity was made a minimum when the radii of the tube and wire bore a certain ratio. Then L/R is a maximum, approximately, and on decreasing the radius of the wire it falls off, ultimately very rapidly, which is the reverse of what is wanted.

A third way must also be immediately rejected. By using iron wires we can increase L largely with steady currents. But then the skin effect, or imperfect penetration, becomes important with telephonic currents in iron wires. It does two things, both harmful. It lowers L and increases R. So we do not get the large increase of L suggested at first, but only a comparatively small one with currents of great frequency, and we do get a lot of extra resistance that should particularly be avoided. Iron wires are failures for long-distance telephony, as was found long ago.

The case of copper-coated iron or steel wires is doubtful. Such wires were used in America, and it was said that they were successful for long-distance telephony. But here, evidently, the copper is very important in giving conductance. As regards the interior iron core, it must be considered very questionable whether it can be so good as an amount of copper of the same resistance (steady). It is not well placed for increasing the inductance, and the imperfect penetration will operate injuriously.

If we put the iron outside the copper the iron will be better situated for increasing L for steady currents (which is no good), but will act injuriously with rapidly oscillating currents, a[nd] partly prevent the utilisation of the conductance of the copp[er] if it be thick enough to make the increased L important.

The above considerations show that if iron be introduced [to] increase the inductance it should not be in the main circu[it] but external to it. There are, then, two principal ways su[g]gested. First, to load the dielectric itself with finely-divid[ed] iron, and plenty of it. This is very attractive from t[he] theoretical point of view, as it results in the production o[f a] strongly magnetic insulator, which is practically homogene[ous] in bulk, being, therefore, a sort of non-conducting iron of l[ow] permeability. In this way L, as compared with the same wi[th]out the iron, may be multiplied greatly. There is a partia[l] counteractive influence, however, due to increased permittan[ce]. This plan is interesting, in view of the wave theory. It is l[ike] multiplying the μ in ether, and lowering the speed of p[ro]pagation, but at the same time allowing waves to keep [up] against the resistance of wires they may be running along. [But] as regards the practicability of this plan I say nothing, exc[ept] that I have often smiled at this ironic insulator (in more t[han] one sense ironic), and the idea of telephoning through a c[able] resembling a poker with a copper wire run through the mid[dle].

The other way is to put the divided iron outside the work[ing] dielectric. Then it had better not be divided into partic[les], but, in the way well known to dynamo and transformer peo[ple], cut up so as to facilitate the flux of induction, whilst be[ing] electrically non-conducting transversely thereto.

Now it may be said that submarine cables of the present ty[pe], having cores surrounded by a large quantity of iron, have la[rge] inductance already. But it does not follow. If the iron wa[s] a solid tube, then undoubtedly L would be much magni[fied] with steady currents. But it is not a solid tube, as it cons[ists] of spirally laid separate stout iron wires. The magnetic c[on]tinuity is interrupted, and the permeance is much reduced. [As] Prof. Hughes pointed out (equivalently) some years ago. [And] besides that, when the current is not steady, we do not uti[lise] the iron even in the above imperfect manner. This is [par]ticularly the case with telephonic currents, when imper[fect] penetration will still further reduce the effective inducta[nce]. So the increased L due to the sheath must be far less than [the] large quantity of iron might suggest. Again, there is [the] increased resistance due to the sheath not being prop[erly] divided to prevent it. The case is therefore a considera[bly] mixed one. Whilst we can say with confidence that with [the] very slow signalling which obtains through an Atlantic ca[ble] the sheath cannot make much difference, it is not easy [to] decide whether its action is beneficial with telephonic current[s] [to] any great extent, though it would be if there were no increa[sed] resistance. It is not even easy to say what is the L of a s[ub]marine cable under the circumstances. A least value is rea[dily] obtained, but the magnitude of the increase due to the iron [and] the outside return current is rather speculative. It may [be] well-deserving of attention to change the type of the i[ron] sheathing, so as to increase L and keep down R. Remem[ber] here, that although there is plenty of evidence of the benefi[cial] (and very important) influence of this principle when it [is] carried out in a direct and natural manner, there is, so far a[s I] am aware, no experimental evidence yet published of the eq[ui]valent success of indirect ways involving the use of iron.

Another indirect way is this. Instead of trying to get la[rge] uniformly spread inductance, try to get a large average ind[uc]tance. Or, combine the two, and have large distribu[ted] inductance together with inductance in isolated lumps. T[his] means the insertion of inductance coils at intervals in [the] main circuit. That is to say, just as the effect of unif[orm] leakage may be imitated by leakage concentrated at disti[nct] points, so we should try to imitate the inertial effect of unif[orm] inductance by concentrating the inductance at distinct poi[nts]. The more points the better, of course. Say m coils in [a] length l, or $2m$ coils of the same total inductance, [and] therefore each of half the inductance; or mn coils each [of] one n^{th} the inductance of the first. The electrical diffic[ulty] here is that inductance coils have resistance as well, and if [it] be too great the remedy is worse than the disease. But it wo[uld] seem to be sufficient if the effect of the extra resistance [be] of minor importance compared with the effect of the increa[sed]

inductance. This means using coils of low resistance and the largest possible time-constants. For suppose 4 ohms per kilom. is the natural resistance, and there be one coil per kilom. having a resistance of 1 ohm. This will raise the average resistance to 5 ohms per kilom.; and if the time-constant be big enough, the extra inductance may far more than nullify the resistance evil. The same reasoning applies to coils at greater intervals, only of course in a more imperfect manner. To get large inductance with small resistance, or, more generally, to make coils having large time-constants, requires the use of plenty of copper to get the conductance, and plenty of iron to get the inductance, employing a properly closed magnetic circuit properly divided to prevent extra resistance and cancellation of the increased inductance. This plan does not belong to the category of those mentioned before, which a moment's consideration showed to be worse than useless. It is a straightforward way of increasing L largely without too much increase of resistance, and may be worth working out and development. But I should add that there is, so far, no direct evidence of the beneficial action of inductance brought in in this way.

The combination with leaks does not need any particular mention in detail after what has been already said relating to the distortionless circuit, which is the theoretical ideal, any approach to which is desirable if it be done without too much loss; bearing in mind, too, that we should increase L first in preference to putting on leaks first. I have confined myself so far entirely to my theory of 1886-87 and results thereof. Inductive shunts involve some other considerations, and a modified theory.

(To be continued.)

PRIMARY BATTERIES IN THEORY AND PRACTICE.*

BY W. R. COOPER, M.A.

PART II.

(Concluded from page 695, Vol. XXXI.)

Electric Lighting.

The production of light by primary batteries has been a favourite subject of many inventors, but, like the discovery of the philosopher's stone, has always eluded success. The fact, however, that it has not been accomplished is no ground for saying that it is impossible. Our present method of obtaining light is no doubt very defective. It is useless to speak of the high efficiency of the dynamo when the very low efficiency of the steam engine enters into the question. A double transformation of energy is involved with very heavy loss in the first; whereas in the primary battery we have direct transformation with very high efficiency. But in the one case we are consuming coal, and in the other zinc, costing about thirty times as much. Under these circumstances the two systems cannot very well compete. Two courses suggest themselves: either the working substances must be cheaper, or the by-products must be utilised.

A battery for electric lighting should fulfil several conditions. The current should be constant, the E.M.F. high and constant, and the internal resistance small. It should be cheap, small, and easily handled, and there should be no waste or deterioration on open circuit. All these conditions are somewhat difficult to comply with in the same cell.

In looking over the past attempts, one cannot fail to be struck with the small cost of production which is given in many cases, as shown in the following table:—

Battery.	*Cost as stated.*
Ross	= gas at 3s. 6d.
Regent	= gas at 6s.
Upward	= gas at 7s.
Weymersch..................	0·75d. per 30-watt lamp-hour.
Renard	0·2d. „ c.p. hour.
O'Keenan	0·5d. „ 12-c.p. lamp-hour.
Holmes and Burke......	0·5d. „ 10-c.p. „ „
Newton	0·16d. „ „ „ „
D'Humy	0·25d. „ „ „ „

As it is hard to obtain information as to the cause of failure, it can only be concluded that the above figures did not generally include all the items of expense. These attempts were chiefly made in the years 1886—1888.

Among those that promised to be particularly successful, mention may be made of the Lalande battery. It consisted of an iron vessel, A, containing KOH solution and zinc plates, with wire gauze, G, containing copper oxide, between these and the iron vessel (*see* Fig. 21). These were used to charge a secondary battery. To supply 10 lamps of 10 c.p. for five hours per day, two sets of six cells were required, and they had to be completely refilled every fortnight. This battery was reported on very favourably, and it was estimated that the Zn could be recovered as sulphide of zinc white paint, giving a net profit of 9s. 1d. on each battery charge.

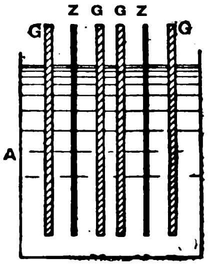

FIG. 21.—Lalande Cell. A, Iron Vessel; Z, Zinc Plates; G, Iron Gauze containing CuO.

A distinct departure was made in the Upward battery, in which gaseous chlorine was one of the active agents. The cells consisted of an outer vessel containing carbon rods packed in crushed granular carbon, and an inner porous pot containing the zinc rod (*see* Fig. 22). A little water was added occasionally, and chlorine was passed into the porous pot. Zinc chloride was formed; and, being very deliquescent, it passed to the carbon, maintaining it moist, the surplus being drained off from the outer vessel. All the arrangements connected with this battery were very ingenious, but it was not a success from a commercial point of view.

FIG. 22.—Upward Cell.

Maquay Primary Battery.

Many will have noticed at the late Electrical Exhibition a stand which was devoted to electric lighting by the Maquay primary battery. Upon applying to the Maquay Electric Light Company they kindly furnished me with the following particulars:—

"The Maquay battery is the outcome of many years' work on the inventor's part, to find a primary battery sufficiently compact to be used for lighting purposes.

"It was the inventor's fond hope that this battery could be used on a large scale, but the cost of the materials for consumption has prohibited its being used for installations, and it is now chiefly used for miners', divers', cycle, bedroom, carriage, and portable hand-lamps, where an excessive candle-power is not required.

"The inventor patented a most ingenious method of automatically feeding the large batteries, so as to keep the solution at a constant density, and also an arrangement to lift the zincs out of the solution and cut off the feed automatically when the last lamp was turned out.

"As now made, the zincs and carbons are attached to a board which can be raised or lowered about an inch, and the board is

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held in position (when raised) by a clip, which prevents the battery wasting when the light is not required. The zincs are very small, and are arranged to just last out the solution, so that new zincs must be attached every time the battery is recharged. They have a small hole in them that passes over a knob on the zinc holder, and a screw comes down to clamp them; the zinc holder is provided with spring-clips to attach it to the battery, so that the operation of changing the zincs is as simple as it can well be.

"The zincs themselves are part of the patent, and they are painted on one side with a special paint that scales off at a temperature of 65°F., so that when the solution has been reduced to about half its strength, a double surface of zinc is exposed to its action.

"The battery is usually arranged to give 0·5 ampere current for eight hours. It is advisable not to draw more than four amperes from it, and it can be arranged to run for any specified time up to twenty hours. . . . The elements are zinc and carbon in a modification of the ordinary bi-chromate solution. It gives two volts per cell on open circuit and 1·4 volts per cell through the resistance of a lamp, and the polarisation is inappreciable.

"The cost of re-charging this battery is 1d. per cell per eight hours or 1s. 3d. per candle-power hour, or £1. 9s. 2d. per Board of Trade unit."

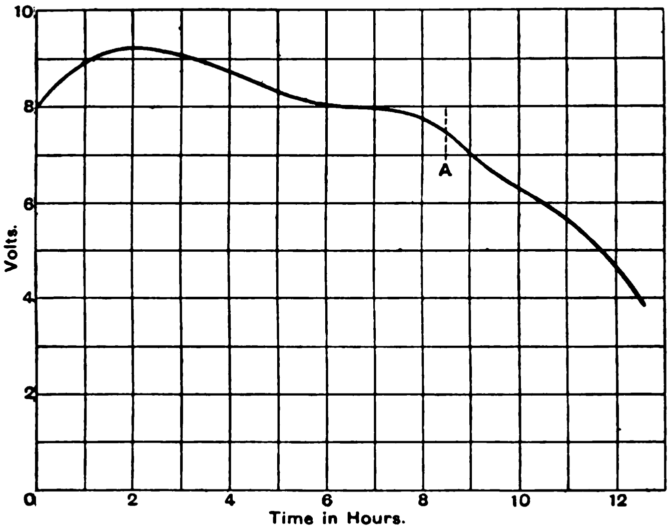

FIG. 23.—Curve of Discharge of a Six-Cell 8½ hour Maquay Battery, lighting an 8-volt Lamp, normally Discharged to the Point A.

The Company have also forwarded me a curve of discharge of a six-cell 8½ hour battery, used for an eight-volt lamp (*see* Fig. 23). There appears to be a variation of about 1½ volts in the 8½ hours, but I am informed that the battery will run without difficulty for another four hours, and that the light in the present case was still bright after 12 hours' discharge.

By-Products.

Although the utilisation of by-products presents an enticing appearance, it is hard to accomplish. It is practically impossible on a small scale, and even at the General Post Office, where there are thousands of cells, Mr. Preece never attempts it. It seems only commercially possible on a large scale by combining a central station with a chemical works. Success would appear to be more easily attained by considering electricity as a by-product. If some of the chemical operations in manufacture could be so conducted that the energy is transferred, instead of being converted locally into heat, then electricity would be obtained simply as a by-product. This may also be done by other means. For example, the utilisation of waste heat presents a problem of considerable interest, and, in connection with this subject, it may not be altogether out of place, in concluding this Paper, to allude to the generation of electricity by heat.

If a circuit consist of two dissimilar metals, and one of the junctions is at a higher temperature than the other, there is a resultant E.M.F. This, in general, increases as the differen of temperature is increased. The E.M.F. per degree is kno as the thermo-electric power of the couple. Thus the thern electric power of bismuth and antimony is about 100 microvo per degree centigrade.

Reference was recently made in *The Electrician* to t Gülcher thermo-electric battery employed at Freiburg in t chemical laboratory. It is employed to charge eight sma accumulators, the heat being obtained from ordinary gas, a it is no doubt very convenient when power is not availabl It consists of sixty-six elements: its mean voltage is 4·1 volt and internal resistance 0·68 ohm.

The utilisation of waste energy is attempted by the Gira thermo-electric stove, being introduced by Messrs. Rensha and Co. It consists of a slow combustion stove for domest heating, and is surrounded by 850 elements, composed copper and a brittle alloy, consisting chiefly of antimony a zinc with Cd, Cu, Sn, and Si. These elements are formed in rings, and are placed round the iron tube of the stove, bei separated from it by asbestos and sodium silicate. Since he is required from the stove, the conditions are somewhat anta nistic to a good effect. The hot junctions are at a temperatu of 380deg. to 420deg. centigrade, and the outer junctions about 120deg. The E.M.F. is about 40 volts; the inter resistance diminishes with rise of temperature, but stands the somewhat high figure of 11 ohms. It may be used charge eight accumulator cells, and will light five or six lan of 8 c.p. by that means for five hours. The inventor hopes be able to apply the principle to the utilisation of waste h which must so frequently occur.

In conclusion, my thanks are due to several gentlemen a electrical firms for the ready manner in which they h supplied me with information, and especially to Mr. Aylr and the Maquay Electric Light Company, who have kin sent round a variety of cells to supplement the informat which I have attempted to bring before you.

THE EDUCATION OF ENGINEERS.*

We believe that the present system, or want of system, of tr ing engineers is very defective. We find, on the one hand, utmost reluctance manifested by civil engineers in practice to pupils, articled or otherwise, at any price. There is incred difficulty encountered in placing a youth in any shop to le mechanical engineering. It can only be done by the aid of "l *and* money;" that is to say, interest in some shape or othe necessary. There are two reasons for this. One is that n heads of firms dislike to take apprentices, and that those fi which will take them have ten times as many applications as th are vacancies. The result is that young men bent on being e neers are driven to the colleges, which are entirely incapabl turning out either mechanical or civil engineers, although they when well managed, perfectly competent to give a prelimin training, which may be useful in after life. But the techn college might be made much more useful than it is were it wo while, which we doubt. Let us compare the training gi to a young man who wishes to enter the medical pro sion, with that given in a college to a would-be engineer. former must spend five years in learning his profession bef he can obtain his diploma. There are various ways in which training is effected; but they differ more in matters of detail t in principle. Before a youth can get into one of the great Lon hospitals as a student, he must have passed an examinatio general knowledge, such, for example, as the matricula examination at London University. From the moment he en the hospital until he leaves it, his course of training is of most practical character. Theory finds no place in it until comes to study physiology. The whole duty of everyone in hospital is to keep patients alive as long as possible, to cure th and to alleviate suffering. Every day, and all day long, student is taught how this is to be done. Who does the teachi Who deliver the lectures? Who perform the operations? fessors, men who have nothing else to do but teach, and who paid for teaching? Absolutely nothing of the sort. There are professors of anatomy, or medicine, or anything else of the k on the regular staff of London hospitals. The whole of teaching is done by men practising their profession, and it is al

* Abstract from *The Engineer*.

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entirely done without fee or pecuniary remuneration of any kind. These men are all practical surgeons, practical physicians, of the highest eminence. It will be seen at a glance how infinitely superior must be their teaching and their example to that of any professor, however able or clever. Let us suppose that it was possible for 20 or 30 young men to be taken as pupils by some great firm of mechanical engineers, and that the heads of this firm delivered from time to time lectures on every conceivable aspect of engineering. Let the shop training be elaborate, careful, and continuous. At the end of the first twelve months let the pupil go up and pass a preliminary examination, the questions being prepared, as the result of long experience, in such a way that they will most fully test the elementary information which has been acquired during a year by the pupil; and if he fails to satisfy an independent Board of Examiners, all practical engineers, let him be sent back to the shops for three, six, or even twelve months. Let him, if he passes, go on for another year, and then pass an examination in some one special department of engineering. Then, at the end of another year, pass a third examination, in some other special department. Then, at the end of five years, pass two distinct examinations before two separate bodies before he is allowed to practise his profession. Such a training would be strictly analogous to that which the medical student undergoes, and it is, we know, believed by very many people that the college training of a young engineer is almost precisely the same. This is simply a delusion, and the difference is this: The hospital is the strict analogue of the workshops. The wards and the operating theatre are the shops in which the surgeons, the physicians, the nurses, and the pupils work. No science college possesses any facilities of the kind, and it is worth notice that Durham and other universities which confer medical degrees, are obliged to send their students up to the London hospitals in order to give them the practical training which cannot be had in a college.

Such a training cannot be had by the young engineer. It is unattainable. It may be added that it is largely held that it is unnecessary. There is much more force in the arguments urged on this side than the technical educator will admit. The great defect of all science education in the present day is that a great deal too much is attempted. A dozen different men are authorities on a dozen different subjects and on nothing else. Each insists that his own speciality shall be taught. There is no discrimination, no regard for the fact that life is short. It is the age for the dissemination of useless knowledge. Are we justified in hoping that in the teaching of engineers, at all events, it may not be forgotten that one man trained in the field or the shop is worth two trained within the walls of a college?

CITY AND GUILDS OF LONDON INSTITUTE.

The annual report of the Examinations Department of the City and Guilds of London Institute, signed by Mr. G. Matthey, Chairman of the Committee, and Sir Philip Magnus, Superintendent of Examinations, which has just been issued, shows a considerable development in the work undertaken by the Institute. The increased facilities now afforded for instruction in technology, as distinguished from pure science, cannot be better shown than by the fact that the number of students in the classes affiliated to the Institute has increased from 2,500 in 1881 to 22,621 in 1893, whilst the number of candidates for the examinations has increased from [illegible] to 10,254 during the same period. The report is of especial interest at the present time, as indicating the new methods adopted by the Institute for the further encouragement of technical education. From 1889 till the present year the City Guilds have made payments to local classes on the results of their examinations after the manner of the Science and Art Department, and for many years these payments formed the only external help which these classes received. But after the passing of the Local Taxation Act which placed ample funds at the disposal of county councils, the Institute withdrew its grants from classes outside the metropolitan area, whilst continuing to register the classes and to examine the students. It appears from the report that, notwithstanding the withdrawal of grants on results, there is no diminution, as might have been expected, but an actual increase in the number of candidates. The improvements introduced this year into the mode of conducting the examinations include a closer adaptation of the syllabuses to the requirements of different localities, the division of subjects into sections following more nearly the principal branches of each trade, and the addition of further practical tests. The Institute has further arranged to forward special reports to local centres on the work done in separate classes examined by the Institute. The report gives full details of the number of classes and of students in attendance at the different centres of instruction throughout the country, and contains a complete list of the London institutions in which technical classes are now held, including those at the Regent-street Polytechnic, the Goldsmiths' Institute, the People's Palace, and the Borough-road Polytechnic. The Institute's registered classes are now found in all the principal towns of Great Britain and Ireland, a list of which is given in Table V. of the report, and examinations were this year held in India, New South Wales, and New Zealand, the number of centres of instruction and examination having increased from 265 in 1892 to 388 in 1893. The work of the department is carried on by 77 acting and 41 consultative examiners, all of whom are experts in their several trades. The examinations embrace all the principal industries of the country, and range from electric lighting and alkali manufacture to plumbers' work and dressmaking.

The Institute is doing important work in endeavouring to raise the standard of teaching in the various trade subjects in which examinations are held. In order that a class may be registered by the Institute, it must be managed by a responsible committee, which is required to submit to the Institute for its approval the qualifications of the teachers employed; and the report states that in many instances "the refusal of the Institute to recognise a teacher has led to the appointment of a more competent instructor." The extracts published from the reports of the examiners show that there has been a general improvement this year in the work sent up for examination. The percentage of failures in some subjects is still very large, but there is a satisfactory increase in the proportion of candidates who have passed the higher grades of the examination.

The practical tests which the candidates are required to pass are carefully arranged with the view to the special branch of the trade in which they are severally engaged, and, owing to the numerous sections into which trades are now divided, the organisation of these practical tests is attended with considerable difficulty. Thus, in boot and shoe manufacture, a candidate may select any one of ten branches of the trade, in each of which separate tests are given, and in mechanical engineering a candidate may elect to be examined in the honours grade as a fitter, a turner, a patternmaker, or a draughtsman. The practical tests are always held in connection with the written examination, and in many subjects form a necessary part of the qualification for a certificate. In addition to its other work, the Institute awards certificates to teachers of public elementary schools who have regularly attended a course of instruction in manual training and have passed the required examinations. The number of teachers who came up for examination this year was 1,141, as compared with 615 in 1892. The percentage of failures has fallen from 42·6 to 33·5. The Institute continues to restrict its examinations in manual training to certificated teachers, and regards the education which such teachers receive in their ordinary normal course as a part of the necessary preparation for giving instruction in this subject. Next year examinations will be held under similar conditions in metal work, with the view of certifying teachers as competent to give instruction in this branch of manual training to pupils of higher grade schools. The report, of which we have given a short summary, affords abundant evidence that the City Guilds, through this department of their operations, are doing a very useful educational work, in the benefits of which every technical school, not only in London, but throughout the country, is enabled to participate. In the appendix to the report are given the names and places of education of the candidates who have taken the prizes offered by the Institute. These consist of money prizes to the amount of £352 given by 16 of the Livery Companies and of 85 silver and 133 bronze medals. A scheme for the inspection of technical classes by educational and trade experts has recently been issued by the Institute, some particulars of which are given in pages of the report.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

MONDAY, November 6th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

THURSDAY, November 9th.

INSTITUTION OF ELECTRICAL ENGINEERS

8 p.m. "The Electrical Transmission of Power from Niagara," by Prof. George Forbes, F.R.S.

FRIDAY, November 10th.

PHYSICAL SOCIETY.

5 p.m. (1) "On the Separation of Three Liquids by Fractional Distillation," by Prof. S. Young, F.R.S., Prof. Barrett, and Mr. Thomas. (2) "On the Critical Constants of various Ethers," by Prof. S. Young, F.R.S. (3) "An Instrument for Drawing Conic Sections," by J. Gillet, B.A.

THE JUNIOR ENGINEERING SOCIETY.

8 p.m. Mr. John Wolfe Barry, M.Inst.C.E., will deliver the Presidential Address at the Westminster Palace Hotel.

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(The Oldest Electrical Journal.)

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SPECIAL NOTICE.

With the next issue of "THE ELECTRICIAN" (10th November) will be published (Gratis to Subscribers) a fine STEEL-PLATE PORTRAIT of Mr. JOSEPH WILSON SWAN.

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THE PUBLICATION OF PHYSICAL RESEARCH.

The correspondence which was started in *Nature* on the "Publication of Physical Papers," by Mr. J. SWINBURNE, has attracted a good deal of attention, and may be said to have culminated in the discussion which followed the Paper of Mr. BASSET at the British Association. By far the most important feature of this discussion was the official announcement by Lord RAYLEIGH that the Royal Society had appointed a committee to consider the matter. Under these circumstances further discussion of the whole question is unnecessary until some decision has been arrived at by this committee, but there are several minor points, to some of which Mr. E. E. FOURNIER alludes in his letter to us this week, which are worthy of further consideration. Although a general opinion seems to have been expressed that a simple translation of *Wiedemann's Beiblätter* would not meet the case, Mr. FOURNIER discusses this proposal, but admits that the cost might not fall short of the starting of an English periodical. The only existing publications of the kind are the *Philosophical Magazine* and the *Proceedings* of the Physical Society; and some difference has naturally arisen as to the possible modification of these publications, in order to meet the loudly-expressed want. In suggesting a new periodical it must be remembered that the want is more keenly felt in those branches of physics which have little or no commercial side. This means that few advertisements could be expected other than of scientific instruments, new scientific books, and cocoa. And without copious advertisement pages, or else a heavy subsidy, it would be impossible to make such a periodical pay for the mere cost of production. It was pointed out by Mr. SWINBURNE at the

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British Association that scientific literature is mainly supported by amateurs. It is doubtful if a sufficiently large circulation among these amateurs could be found for a journal of the kind advocated. Extensive circulation is essential if the paper is to attract advertisements. There seems to be a reluctance on the part of English journals, whether daily, weekly or monthly, to admit that, with but few abnormal exceptions, they are dependent upon advertisements for their existence. When M. ZOLA recently called attention to this fact, it was shyly alluded to in the press, but as a matter on which no comment should be made. A glance at the railway bookstalls shows the vast mass of rubbish which appears to have been brought into existence by the compulsory instruction of the masses in reading and other accomplishments. Having learned to read, they must have something to read, but being uneducated, and having no time to be thoughtful, they are content to take whatever trash is offered. And yet a weekly or monthly journal of physics must await the support of the Royal Society!

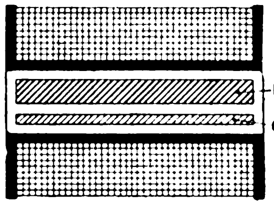
Electrical science is the only branch of physics which has a distinct commercial side, and consequently we are enabled to notice some of the leading work in pure electrical physics. We endeavour to keep our readers informed of most of the important researches in this science, but we are well aware that our record is by no means complete. Some idea of what a thorough record would be, may be gleaned from the careful digest of electrical journals in the *Electrical World* of New York. From this should be eliminated, for the purpose under consideration, all the engineering and industrial applications; but of electrical science alone a large quantity would remain. Lord RAYLEIGH has alluded to the difficulty of censorship. This function, the thankless task of every editor, is discharged with but little difficulty by scientific societies who refer their Papers to members of Council. The anonymity of their decisions is of course convenient, but the duty is not always pleasant. If the commercial element were really eliminated, censorship would be confined to the exclusion of communications to which the authors attached an undue importance, which contained some palpable errors, or which turned out to be old. It is really to avoid this last contingency that the want of some means of publication is so keenly felt, but will not the news often come too late? Would such a journal have prevented the independent construction of magnetic curve-tracers by Prof. EWING and by Mr. SEARLE, working within a few yards of each other at Cambridge, each ignorant of the other's aim; aims which by-the-bye differed considerably, and do not happen to clash.

We do not, as we have already stated, attempt to make in the columns of *The Electrician* a complete *resumé* of electrical physics. The great activity in this branch, due not so much to utilitarian applications as to the purely scientific work of HERTZ and many others, would result in a considerable preponderance of electrical matter in any such record. The scientific news agency which Mr. FOURNIER finally suggests has been tried, but we do not know with what encouragement or success; the samples we have seen were extremely feeble. Such methods of disseminating information appear to be best suited for the supply of press-cuttings on special subjects to subscribers; but for the present purpose each subscriber would probably want news of all the branches, and the cost would be considerably greater than that of a special journal. We are inclined to think that the Physical Society might do for its physics what the Chemical Society has done for chemistry, but still leaving communications on researches of the highest character to the Royal Society, whose action in this matter will be awaited with interest.

COMPENSATION FOR HYSTERESIS.

BY E. B. VIGNOLES.

One of the most serious drawbacks to the use of a magnetic measuring instrument containing iron, in the hands of an unskilled or careless observer, is the liability to errors due to hysteresis; and the attention of inventors has long been directed to the problem of avoiding them. Broadly speaking, the kind of error that takes place in an instrument in which the iron circuit is of nearly the same length as the coil, is about 1 per cent. on reversal at the upper part of the scale, increasing gradually to 5 or even 10 per cent. at $\frac{1}{10}$th of the maximum reading. If an attempt is made to increase the forces working an instrument by making the magnetic circuit more complete, the effort is frustrated by the enormous increase in the hysteresis error. This effect may be produced in two ways: the first is due to the coercive force of the magnetic circuit, and this is the generally observed source of error; but wherever a movement of the working part is accompanied by a movement of a bundle of induction in an iron block or sheet there is an additional local effect due to the reluctance of the iron to accept this change of position of the induction. Were it not for this, a powerful ohmmeter might be made by arranging the pressure and current coils on magnets at right angles to one another, and whose pole-pieces embraced a soft iron needle having a wide end. When the two magnets are equally strong the needle should take a mean position, but such an arrangement has such terrible "local" hysteresis, that it is completely useless. To keep this in mind when designing new instruments may spare the inventor many a useless experiment. The reasoning applies chiefly to powerfully magnetised iron, but is true also to a certain extent of every instrument where the position of the maximum induction in the iron varies.



It is not by any means necessary to eliminate this error, even if the instrument is for use as a standard, but the precautions which have to be taken to ensure accuracy are briefly as follows: the instrument must always be used with the current flowing through it in the same direction, or if this is impossible the full current must be sent through it in the direction in which it is required to be used before any readings are taken; secondly, the current must always be broken just before any reading is taken, in order to ensure that the magnetisation curve of the iron is always starting from the same point, and if these conditions are strictly fulfilled the reading of an iron instrument is absolutely reliable, and it may be used as a standard with very great convenience; the author has had such an instrument under observation for some years, and has never been able to detect the smallest variation at one sixth of the maximum reading.

In order to ensure the least possible hysteresis error the length of the iron in the direction of the induction must be made as small as possible, so as to diminish the coercive force, or, in the old-fashioned parlance, to increase the demagnetising effect of the ends, as has been done in the latest Hartmann and Braun design, which is not otherwise noteworthy.

But it is, perhaps, not generally known that by an ingenious device due to Mr. Evershed originally, I believe, and for which a provisional specification was filed some years ago, the effects of hysteresis can be almost entirely eliminated, and can easily be rendered so small as to be practically negligible. A similar principle appears to have been recently invented by M. Abdank Abakanowicz, whose methods are described in *La Lumière Electrique* and other papers. The simplest form of the Evershed method is illustrated by the adjoined sketch, which represents a section of a coil magnetising the iron cores I and C. Suppose the current tends to make the left side north, and suppose that C is made of hard steel, and has, therefore, a much greater

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coercive force than the soft iron I. When the current is cut off the core C remains more intensely magnetised than I, and the return path for its induction is partly through I, which is thus demagnetised, and may be reversed. By suitably proportioning the parts the effect outside the core may be entirely obliterated.

Modifications of the method easily suggest themselves. The core C may be outside the coil, and separately magnetised, although this is generally more cumbersome; but it is needless to go into details, as the principle is so very simple; but one of M. Abakanowicz's examples is worth alluding to. He makes a wattmeter whose field is produced by two electromagnets, the main core producing a large field in one direction, and a small and very coercive core producing a small reverse field. The "residual magnetism" of the two may be easily made equal, while when the current is on, the main field is largely in excess of that of the compensator.

The condition for perfect compensation is that the two curves of magnetisation shall be similar, but on different scales; but the author has found that this condition is exceedingly difficult to obtain. It is possible that for standard instruments the method may be of value, but the author believes that Mr. Evershed has not kept up his patent. It is probable that compensation would never be so perfect as to obviate entirely the necessity for the precautions above described. It seems desirable, however, that, in view of the publication of M. Abdank Abakanowicz, the results of our earlier work should be put on record in these pages.

THE POLLAK SYSTEM OF CHARGING SECONDARY BATTERIES FROM ALTERNATORS.*

The essential feature of M. Pollak's apparatus for transforming alternating currents into uni-directional currents is a commutator placed on an extension of the spindle of a synchronising motor, which is driven by an alternate current of the same phase as the one which is to be redressed. The commutator is composed of as many segments as there are poles on the motor. If, for example, this latter has eight poles, there will be eight strips on the commutator, as is shown in Fig. 1. These strips do not, however, fill the periphery of

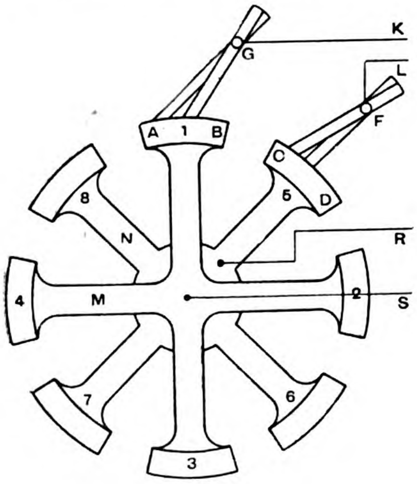

Fig. 1.

the commutator, for there is a considerable gap between the adjacent strips. The segments 1, 2, 3 and 4 are coupled together in parallel on a ring M, which is keyed to the spindle, and are connected to one wire, S, of the alternate-current circuit. The other wire, R, of that circuit is connected to the ring N, keyed similarly to the spindle, and the segments of which, 5, 6, 7, and 8, alternate with those on the ring M. Two brushes, F and G, which make contact with two adjacent strips, as at 1 and 5, are coupled to the wires K and L, which lead to the circuit in which the current is to be used. The result of this arrangement is that four of the segments are connected to the positive terminal of the circuit, and the remaining four segments to the negative terminal; while this polarity is reversed in every eighth part of a revolution. If, at any one instant, the strips 1, 2, 3, 4 are positive, then, when the motor and the commutator have turned one-eighth of a revolution, the strips 5, 6, 7, 8 will be positive; but at this instant the brush G, which in the first instance pressed against the strip 1, will now press against the strip 5. The polarity of the brush G will therefore never change, and the same may be said for the brush F. In consequence of this, the brushes F and G will collect currents always in the same sense.

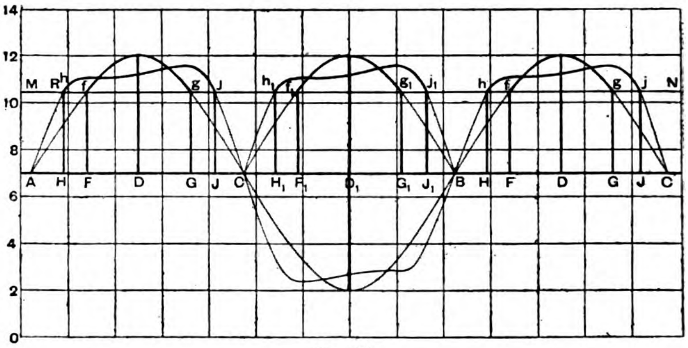

Fig. 2.

If the alternating electromotive force in R, S, is assumed to be sinusoidal, or a simple harmonic, the pressure collected at the brushes will have the general form of a succession of rectified sine curves; A, f, g, C, in Fig. 2 becoming succeeded by C, f_1, g_1, B, and so on. But when it is required to charge accumulators, it is impossible to utilise this redressed electromotive force during its entire extent, because the charging pressure E should always be greater than the counter-electromotive force of the cells E′. If we represent this latter by the straight line M, N, the portions f, g, and f_1, g_1, are alone utilisable. It is therefore essential that the current taken off by the brushes shall not commence before F, F_1, and that it

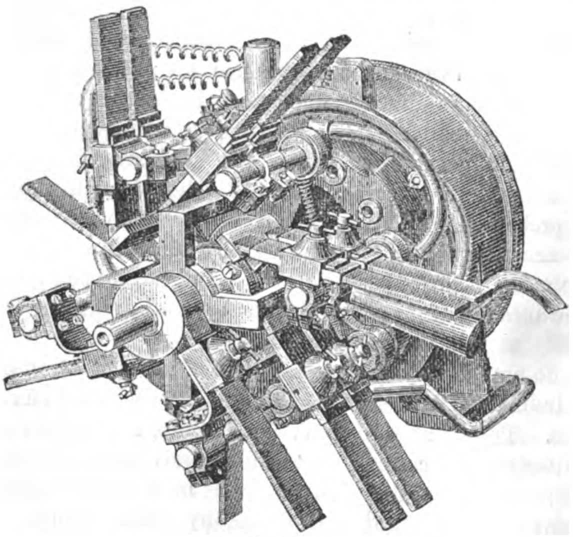

Fig. 3

shall not be continued beyond G, G_1. At these points the opposing electromotive forces in the circuit are equal, so that contact at the brushes is made and broken without sparking. Further, if the contact of the brushes is maintained during a shorter period than F G or F_1 G_1, the energy passed will be less than the area F f g G or F_1 f_1 g_1 G_1, and as a consequence the rate of charging will be less rapid. The duration of the rupture of the charging circuit, G C F_1 or G_1 B F, can be regulated by shifting the two brushes relatively to one another. If we suppose the brushes to consist of mere strips, a and c, it will be easy to see that if they are one-eighth of a turn apart, the length of the segments, such as 1 or 5, will

* From *La Lumière Électrique.*

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represent the duration of the closure of the circuit F G_1, while the period of rupture will be determined by the distance which separates two adjacent strips on the commutator. The period of rupture can easily be regulated, however, to suit any value of the counter-electromotive force, by shifting one of the brushes forward or backward.

If the electromotive force is represented by a sine curve, the two portions of the period of rupture, G C and C F_1, will be equal. But it will often happen that the curve of voltage is not symmetrical, such as in A $h j$ C, or C $h_1 j_1$ B, where the ordinates are not equal. But it is still possible to effect an exact adjustment, by means of two strips on each brush. Each brush is, in fact, constructed of two brushes, *a* and *b*, and *c* and *d* (Fig. 1), each pair mounted on the same metal holder and therefore in electrical connection, but capable of relative adjustment of their positions. The similar brushes, as *b* and *d*, are manipulated by the same brush rocker and lever.

What is true of one pair of segments, 1 and 5, is applicable to every other pair of contacts which can be made on the commutator. The current, therefore, may be collected all round the commutator by means of four pairs of brushes, arranged so as to develop an effective electromotive force, E_{eff}, equal to E′. For example, for a battery of 35 cells, giving an opposing pressure of 70 volts, it will be necessary to have an effective pressure E_{eff} equal to 70 volts, which will correspond to a maximum pressure of 100 volts. Adopting this rule, and still supposing a simple harmonic current, we find that in Fig. 2 the period of closed circuit, F G, will be equal to the period of rupture of the circuit; these two periods being severally equal to one-fourth of the harmonic period of the current. The energy expended on the battery in one half-period will be represented by the area F $f g$ G which approximately equals three-quarters of the total area, A $f g$ C. Hence the commutator may be said to have 75 per cent. efficiency.

The energy which is not taken up by the commutator, *i.e.*, the part of the curve A f F and G g C, is simply available energy which, however, is not wasted, because during this portion the circuit is open. Theoretically, then, the commutation is no source of loss, but practically we must deduct from the energy supplied that amount of energy which is required to work the synchronising motor and commutator. This actual loss amounts to only 100 watts in a commutating apparatus capable of transforming eight kilowatts, which represents a loss of less than 2 per cent.

With a true sine function the maximum electromotive force will very much exceed the steady counter-electromotive force of the battery, and it would be found that the accumulators would be subjected to a current of greatly varying strength. M. Pollak has got over this difficulty by replacing the sine form of electromotive force curve by a curve shown by A $h j$ C, which he obtains by passing the alternating current through a transformer in which the magnetic induction is such that the iron is brought very nearly up to saturation. The line of counter-electromotive force, M N, will cut this curve in the points h, j, h_1, j_1, nearer to the points of reversal than where the curve is sinusoidal. In consequence of this the duration of the closed circuit condition, H J, will be longer, and the duration of the open circuit condition will be less than in the previous case. It will be seen in Fig. 2 that the area H $h j$ J, which represents the stored energy is very perceptibly greater than the former area F $f g$ G, corresponding to a similar quantity. That is to say, the charging is carried on more rapidly, and at the same time with greater regularity. In fact, the pressure, instead of varying from 70 to 100 volts, is kept at about 85 volts during the whole period of closed circuit, which is much less injurious to the plates in the storage cells.

After the foregoing theoretical considerations it will be easy to understand the practical working of the Pollak commutator, which is shown in Fig. 3. The commutator itself is mounted on an extension of the spindle of a little synchronising motor, having 8 poles, and running directly on the circuit of an alternator. This motor is drum-shaped, 30cm. long and 20cm. in diameter, carrying on an extension of its spindle two vertical brass discs, each composed of four arms surmounted by contact plates or teeth, slightly rounded. The two discs are insulated, and their teeth are interpenetrated or sandwiched so as to form a circular ring of eight segments. The eight brushes for collecting the rectified current are each composed of two strips of copper, mounted side by side on the same brush holder. The eight inside strips, which are insulated from one another, are connected together by springs which are mounted on a ring, which is provided with a handle for regulating the distance between the interior and exterior strips of the same brush. The brush-holders are alternately connected in parallel, forming two series of brush-holders, which are connected severally to the two terminals of the charging circuit. The four brush-holders forming one series are attached to the frame of the machine; the other four are mounted on a movable ring, which can be shifted round by means of a handle.

A Siemens alternator was run at half speed, giving 60 volts, and was connected through a switch to the terminals of a little Ganz motor, on which was mounted the rectifying commutator. When the motor had attained a speed of 300 revolutions per minute, the switch in the circuit of the commutator was closed, and a current passed to the commutator. This current was derived from a small 2 kilowatt Ganz transformer, the primary circuit of which was fed from the Siemens alternator. A voltmeter and an ammeter were placed on the primary circuit of the transformer, the coefficient of transformation of which was equal to unity. The rectified current was employed in charging a battery of 24 cells coupled in series, and having a capacity of 500 ampere hours. A reversing switch, capable of reversing the battery connections, was placed in the circuit together with a pole indicator, this last consisting of two glow lamps. If the contact of the reversing switch left the lamps in darkness, the poles of the commutator were in opposition to those of the battery. On the other hand, on reversing this switch, the lamps glowed, indicating the current in the battery. The position of the brushes to obtain the minimum of sparking would be regulated at this moment. It was easy to render the sparking imperceptible with a current of 30 amperes passing through the commutator. This shows that the Pollak commutator is not merely a laboratory instrument, but a practical apparatus for industrial uses.

In the primary circuit of the transformer the voltmeter indicated 62 volts, and the ammeter 50 amperes. The voltmeter in the charging circuit read 60 volts, and the ammeter of this circuit 40 amperes. The synchronising motor absorbed 100 watts.

THE ARTIFICIAL LIGHTING OF WORKSHOPS.*

BY BENJAMIN A. DOBSON.

(Concluded from page 703, Vol. XXXI.)

Fire Insurance.—With the object of avoiding any difficulty in the future it would seem advisable, before proceeding with the further development of the plan of inverted arc lighting, to consult the insurance companies in each individual instance. The old style of insurance, where heavy risks were taken by one or two companies only, has now been altered, so that in large works such as those here considered, where the amount of insurance may be near £300,000, the risks are divided among a large number of different companies, who in their turn sub-insure their risks in other companies not primarily engaged. There is a tacit understanding between the companies that one surveyor may act for the whole of them in any one particular case, thus judiciously securing uniformity of action. But it unfortunately happened that the four lamps in question, which had been tried for some months at the works of the writer's firm, were lent by them, along with a dynamo and driving power, for the purpose of ascertaining how a certain cotton mill, which had the disadvantage that one corner of the bottom room was darkened by buildings outside, could be lighted so as to replace the missing daylight. The four lamps were placed in position and tested. The result was far beyond expectation. It was found that the cleanliness of the work, which is an essential requirement in cotton spinning, could be supervised to a degree hitherto unattainable by artificial light. The owners of the mill were then anxious to adopt this kind of lamp immediately; but they met with an absolute refusal from the insurance companies to allow any open arc lamp to work in a cotton mill. This led to the question of its further use in the ironworks of the writer's firm, and at first a blank refusal was received, without any reason being given; but correspondence of some months resulted in permission being at

* Abstract of Paper read before the Institution of Mechanical Engineers, on Wednesday, Oct. 25, 1893.

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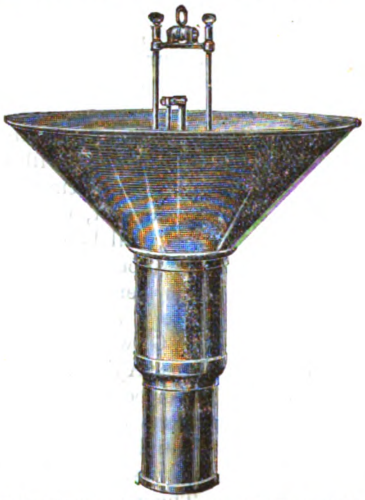
length granted to continue its employment under certain rigid conditions. These indeed were reasonable as regards the conducting area of the wires, the voltage, safety fuses, and other necessary precautions.

In order to see whether there could be any valid objection to its use in cotton mills, the author made a fairly complete series of experiments. The danger in cotton mills is supposed to be that the finest fibres or filaments are liable in the process of spinning to escape in a certain proportion, under the action of the draught caused by the moving parts; and being of much the same specific gravity as the air, they are easily carried by upward draught. When they reach any ironwork, either columns, beams, shafting, or gas pipes, they have a tendency, owing to the latent electricity always developed in textile fabrics, to attach themselves radially to the electric or magnetic centre; and as the carding-room air in a cotton mill is always more or less charged with these floating filaments, the insurance companies feared the result of combustion by contact with the open arc would be that the fire would be conducted to a dangerous quarter by the loose filaments adhering to wires, &c. This fear is found to be absolutely groundless. Repeated and extended experiments have in every case failed to show any indication of danger from such a cause. The fallacy of the insurance companies' objection is rendered apparent by the fact that at the present time they allow open gas-jets in all cotton mills. If there were any danger in an open arc lamp, there would surely be more in open gas-jets, which, of course, are more numerous than arc lamps would be. Furthermore, the arc lamps have to be lowered every eight hours of work for the purpose of changing the carbons. The gas jets are turned off when not required, and lighted again when wanted; this may occur two or three times a day. But every time the electric lamp is lowered it is thoroughly well cleaned, which is especially easy, as it consists simply in wiping the wire and the inside of an enamelled reflector. To prove that the arc-lamps cannot convey fire by contact with the cotton fibre, the author has let fall in the inverted reflector quantities of what is termed cotton-fly, being the lightest and most inflammable part of cotton fibre; and as soon as the level of the arc was reached and the top fibres were ignited, the fire spread rapidly round the cone of the reflector, and burnt downwards towards the bottom. When keeping the eye level with the top of the reflector, it was impossible to see anything escape over this level except the black tinder resulting from the combustion of the fibre or fly. With the true cotton itself, smouldering particles might be seen to the extent of from 4in. to 6in. above this level; but it was proved that these smouldering embers had no heat beyond that necessary to give them their colour, for they were not even capable of exploding gunpowder.

For the purpose of further elucidating the question of fire risk, the author visited a mill in Belgium, not far from Ghent, where very coarse numbers were spun, the cotton being of short fibre; and the amount of evaporation, as it is termed, of fly from the lower filaments was particularly great, the cotton used being of the poorest quality. Directly over the carding engines was an arc-lamp of more than 1,200 c.p.; and during four hours spent in watching and noting the effect of the lamp upon the fly, on not one single occasion was the slightest spark visible outside the reflector. Sometimes when the fly was unusually thick in the air, owing to a carding engine being brushed out, a slight corruscation could be perceived near the centre of the reflector, like the twinkling of a star; but this would only occur once now and then. Undoubtedly a certain amount of fly was consumed, because when the lamp was lowered for examination a residue was found in the bottom of the cone, composed of the very lightest tinder of cotton, but utterly uninflammable under any circumstances. In this country the insurance companies declined to countenance any experiment, on the ground that mill owners had been satisfied up to that time with the ordinary gas-light and with their insurance regulations, and therefore they could see no good reason for a revolution of ideas. Furthermore, the definite allegation was made that on two occasions fires had been caused in cotton mills abroad which were lighted with arc-lamps. Feeling the importance of ascertaining what amount of truth there was in this statement, the author wrote to the proprietor, manager, and others interested in each instance. In the first it transpired that not a cotton mill but a cotton store had been burnt, which was lighted not by arc-lamps but by glow-lamps only; and the theory to account for the conflagration was that of spontaneous combustion, which is by no means rare when cotton is stored in bulk. In the second instance, the lighting was not by the open arc-lamp inside an inverted conical reflector, but by an ordinary arc-lamp surrounded with a glass globe. There was an aperture in the bottom of the lamp; and owing to some disarrangement of the clockwork regulating the carbons, a portion of an incandescent carbon had been split off, and falling through the aperture upon a mass of cotton beneath had set it on fire. When cotton in a loose condition does get on fire it is much like a train of gunpowder; and this mill, which was kept in a condition far from clean, being covered with a thickness of fly steeped in oil over the floor, walls, and ceiling, became so suddenly a mass of flame that the workpeople had considerable difficulty in making their exit from the burning building.

Arc-Lamp.—The complete absence of danger from the arc-lamp used by the author will be more thoroughly appreciated from a description of its construction. It consists of two carbons of different diameters, the upper or negative carbon being solid, and the lower or positive carbon being annular and rather larger in diameter. Their areas are 0·200 sq. in. and 0·486 sq. in. respectively: which proportion ensures their both consuming at the same speed, thereby avoiding the necessity of any complicated clockwork arrangement to differentiate the speed of the feed. In this lamp, indeed, there is no clockwork, but the carbons are drawn together by a pulley, string, and counter-weight, their distance apart being regulated in the usual way by a magnetic brake. The pulley, weight, and brake are all contained in a cylindrical box attached to the underside of the cone of the reflector; and the only interruption to the light above is that occasioned by the thin arms forming the clip which holds the upper carbon. The crater carbon is here the lower one, in order that the larger number of rays produced may be thrown upwards. The cone reflector is 25in. wide at the top and 7in. at the bottom, the angle of the cone being 88deg. The interior surface is ordinary white enamel upon the sheet-iron exterior.



Pieper Inverted Arc Lamp of the Compagnie Internationale d'Electricité.

Each lamp is balanced by a counter-weight over pulleys, and the counter-weight hangs conveniently alongside either a wall or a pillar, so that it may not be in the way of traffic. Thus it is easy to lower the lamp for the purpose of renewing spent carbons, which has to be done about every eight hours, and requires not more than one minute per lamp.

Practical Results of Working.—The plan of inverted arc-lighting has now been in use in some portions of the writer's works for 12 and 13 hours a day during the last 12 months, and sometimes almost night and day; and the results of its working he has every reason to believe may be considered successful. The building, as already mentioned, consists of three storeys, each room 123ft. by 55ft.; the bottom room of all is surrounded to such an extent by other buildings that it was necessary to keep the gas burning the whole of the day. In this room the work consists of turning, fluting, polishing, and repairing what are known as fluted bottom-rollers for spinning machines. These rollers require to be finished with mathematical accuracy, and the majority of them have to be channelled or fluted to the closeness of from 16 to 19 flutes per inch, the shape of the flutes being of the greatest importance. In the room above are manufactured top rollers to work on the fluted rollers; these also have to be mathematically correct, and their surface finished to a high degree of accuracy. In the third room are manufactured what are known as flyers, having one hollow leg, through which the cotton must pass down in a slightly twisted condition. Owing to the affinity of cotton fibre for metal affected electrically, however little, it is evident that any roughness of the interior surface of the hollow leg must be prejudicial to the working; and it is, therefore, necessary that the smoothness of finish should be unquestionable. The attic or roof room is used for the storage of patterns, as previously mentioned. In the bottom room there are 51 machines, consisting of lathes and fluting machines and others, and employing 60 workmen. The second room contains 164 machines, employing 139 workmen; and in the third room there are 69 machines and 112 workmen. The only glow lamps used are those in the attic or pattern store, most of which are portable for the purpose of finding patterns on the various shelves; and also, strange though it may seem, two glow-lamps in the bottom room, for the examination and repair of slightly defective flutes. The latter lamps had to be applied because the reflected light from the arc-lamps gives no shadow; and in order to

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perceive the minute defects in the flute it is necessary to have a light that will give a prolonged shadow, for the purpose of exaggerating what is to be seen. The writer quite thought it would be possible to accomplish the same object by the use of a reflector; but the prejudices of the workpeople were too strong.

When first this mode of lighting the rooms was set going, and the gas turned off at the mains, there was much grumbling of the workmen, who protested it was impossible to perform their work by the new light. This difficulty, however, had been foreseen, and they were informed that as the light had been put in at a large expense for their comfort and health, they must, at least, give it a fair trial. Within six weeks of starting its regular working something occurred which prevented the requisite steam power from being furnished to the dynamo, and the gas had, therefore, to be turned on again, exactly as it had been in the former time. The result was a deputation to the manager on the part of the workmen to know what they were to do, as they could not see how to perform their work by gaslight; and on one or two occasions since then, when the light has failed through one cause or another, the workpeople have declined to work with the gas, stating that they preferred to wait until the electric light was on again, and that they could pull up the time lost.

Dynamo and Lamps.—The dynamo is of Belgian construction, and known as the four-pole dynamo. It runs at 600 revolutions per minute, and gives a voltage of 115. It is driven by a countershaft from the main engine driving the machinery in the building, and with 60 arc lamps and 66 incandescent lamps, it absorbs 70 horse-power. The lights are steady and free from flicker; if ever a lamp is seen to flicker it may be certainly concluded that it has not been thoroughly cleaned, and that the carbon slides are sticking in the magnetic brake.

Horwich Locomotive Works.—Four inverted arc lamps were tried by Mr. John A. F. Aspinall in one of the Lancashire and Yorkshire Railway work shops at Horwich, where however, owing to the great height at which they had to be fixed, they were not successful. They have since been placed in the large drawing-offices, and the light for drawing purposes is as perfect a light as can be. Failing on account of the height of the workshop to arrive at a satisfactory result with the solely reflected light, Mr. Aspinall has succeeded in lighting the main machine-shop with ordinary open arc lamps, each protruding through a white-washed disc formed of light boardings framed together. A curious combination is thereby produced of lighting by the reflected and the direct rays. It has not the whole of the advantages of the reflected light, because the eye has a tendency to glance upward towards the dazzling arcs, and shadows are projected. Nevertheless, the writer is convinced that by this combination of reflection a gain has been achieved of at least 25 per cent. over the ordinary direct arc-lighting without reflection; and all concerned are satisfied with the result.

Cost.—The question of cost of electric lighting, which after all is of the greatest importance, is somewhat difficult; and the writer is hardly in a position at present to give data sufficient to be of much practical value. Having regard to the number of workpeople who could be served with the light, the cost is less than that of gas, and of course the light is stronger and more general; so that in respect of candle-power it would be considerably cheaper than gas. In the three-storey building at the author's works there were 502 gas jets, each burning four cubic feet per hour. Gas costing 2s. 8d. per 1,000 cubic feet would, therefore, come to something like 5s. 4d. per hour for this consumption. In the 60 electric lamps the only consumption is that of the carbons, which are reckoned at one halfpenny per lamp per hour. This has subsequently been reduced considerably; but taking this basis the 60 lamps would together cost 2s. 6d. per hour for carbons. The 66 incandescent lamps which are included in the 70 horse-power absorbed by the dynamos would of course, add to this cost, as they are only 1,000-hour lamps. The greatest cost after the original installation is depreciation and horse-power. Taking the whole into consideration, it is probable that the cost of electric lighting would be more than that of gas; but as the light is so much more satisfactory, it may prove an economy in most cases to adopt it. Thus in the present instance the total candle-power of the 500 gas jets would be roughly 8,500; while the arc and incandescent lamps combined would have 73,000 c.p., much of which however is, of course, useless except for the general effect of the light.

Conclusion.—The light now described has proved in practice to fulfil the requirements enumerated at the beginning of this Paper as the necessary qualifications of a good artificial light, and for any class of manufacture for which it is applicable. For bleach and dye works, where it is necessary to distinguish minute differences in shades of colour, it must be invaluable, permitting this delicate work to be carried on in the dull winter days, which is now difficult if not impossible. If the insurance companies can be persuaded that not only is there no danger from this light, but that it is, perhaps, safer than any other mode of lighting, there seems every possibility that the use of the arc-lamp will undergo a rapid development

HEDGEHOG TRANSFORMER AND CONDENSERS.*

BY FREDERICK BEDELL, K. B. MILLER, AND G. F. WAGNER.

In this investigation a modification of the method of instantaneous contact was applied to the study of an open magnetic circuit transformer known as the "Hedgehog," experiments being made, first with the transformer under usual conditions, and then with condensers connected in parallel with the primary.

Apparatus and Method Employed.

For the complete analysis of alternating current phenomena, we should know not only the value of each changing quantity at every part of its period, but we should know the phase relations between the several varying quantities; that is, the relations between their respective zero and maximum values. To enable us to do this, the method of instantaneous contact has come into use, in which a revolving contact is made at a particular part of the period in such a way that we may ascertain the value at that particular instant of any of the varying quantities measured. The features introduced in the method as employed in the present investigation are two: first, the use of a revolving contact-maker in which the contact is made by a needle passing through a water-jet; and, second, the use of a condenser to displace the zero of an electrostatic potential instrument, so that readings are taken at the best portion of the scale.

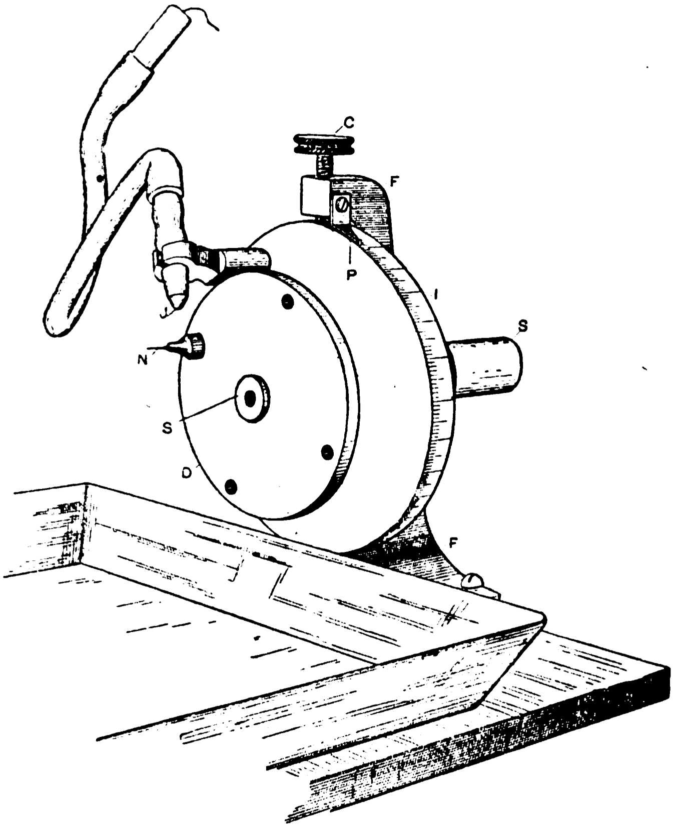

FIG. 1.—Bedall-Ryan Revolving Contact-Maker.

A general view of the revolving contact-maker is given in Fig. 1, and a detailed view in Fig. 2. The whole instrument is supported by a stationary frame, F. The shaft S is connected to the armature shaft of the dynamo by a coupling (not shown) on the end of the rod R, and carries the disc D, which revolves with it. The needle N projects from this disc and forms one of the electrodes of the contact. The other electrode is a fine water-jet (not shown) issuing from the nozzle J, well insulated by hard rubber from the rest of the instrument. This fine jet is maintained from a jar of water, several feet above, to which it is connected by a flexible rubber tube. Electrical connection is maintained with the water-jet by a wire W, which passes through this tube and is soldered to the nozzle J. Electrical connection with the needle-point electrode is obtained through the shaft and frame of the instrument. The needle cuts the water-jet once in every revolution of the armature of the dynamo, and makes a contact which is well defined and unvarying. The nozzle of the water-jet is carried upon an index disc I, which can be turned into any position by revolving it upon a projecting collar of the frame, which forms its bearing. The water-jet is held in any position by securing the index disc by

* Abstract of a Paper read before the American Institute of Electrical Engineers, New York.

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means of the set screw C in the top of the frame. Its position is indicated by the pointer P, upon the scale on the circumference of the index disc which is graduated in degrees.

The needle cuts the water-jet very near the nozzle, at a point where the jet is quite stiff, due to the head of water. The nozzle is radial, and the jet keeps the direction of the nozzle for some little distance before being materially deviated by gravity. A little salt was put in the water to increase the conductivity of the jet. Pure water would not work ; acidulated water corroded the nozzle, thus changing the jet.

It was after working for some time with various mechanical contact-makers that this water-jet was devised. It came up to our expectations in every respect, the contact being perfectly constant and reliable, and free from the changes always found in a mechanical device, due to the wearing away of the contacts. This constancy is particularly necessary in an instrument which is to be used in an extended investigation, during which any change would

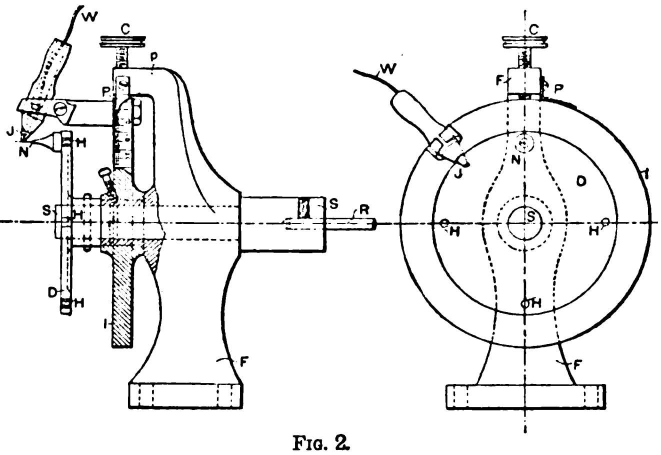

FIG. 2.

be fatal. By maintaining a fine, strong jet, for which a head of 5ft. or 6ft. is ample, and using a fine needle close to the nozzle, the instrument may be used with great precision, and needs but little attention, running every night for weeks with scarcely any interruption. Of course, the accuracy of the instrument is increased as the diameters of the discs are made greater.

For use in another investigation, in which it was desired to obtain measurements for several consecutive cycles, without interruption, the instrument was made so that the needle could be secured in the disc D, by screwing it into any of the four holes H, thus making it possible to have the contact made with the armature in any desired position, without moving the nozzle more than 45 degrees from the vertical.

This contact-maker was used with a Thomson multicellular voltmeter, as shown in Fig. 3. The difference of potential between *a* and *b* is to be measured. The condenser C_1 is kept charged to this potential to be measured, being connected through the contact-maker. The voltmeter used reads between 40 and 120 volts. Its zero was displaced by the condenser C_2, in series with it, which was

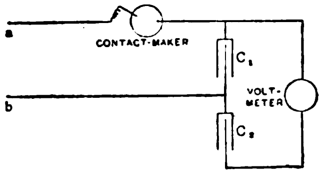

FIG. 3.

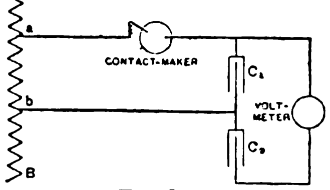

FIG. 4.

kept charged to about 80 volts ; that is, the voltmeter reading indicated the sum of the potentials of the two condensers C and C_2, so that a reading of 80 volts indicated that there was no difference of potential between the terminals of condenser C_1, or between *a* and *b* ; a reading of 85 volts indicated 5 volts difference of potential, and so on.

When a difference of potential beyond the range of the instrument was to be read, the apparatus was arranged as in Fig. 4 ; for instance, suppose it was desired to obtain the difference of potential between A and B. These points were connected by a non-inductive resistance, and the difference of potential was measured around a known portion, *a*, *b*, of this resistance, and the whole difference of potential between A and B calculated.

Measurement of current was obtained by the potential instrument in a similar way. A non-inductive resistance was inserted in the circuit, in which the current was to be measured, as in Fig. 4.

From the curve representing the instantaneous values of E.M.F. around these lamps, the square root of the mean square value of the E.M.F. was determined. The lamps were previously calibrated by a continuous current, and their resistance determined for any value of E.M.F. at their terminals. For an alternating current their resistance was ascertained from this calibration for the square root of the mean square value of the E.M.F. at their terminals, and this value of their resistance was used to obtain the instantaneous values of the current from the instantaneous values of E.M.F. in accordance with Ohm's law.

The multicellular voltmeter is ordinarily a slow instrument to read. Readings were quickened by a pneumatic damping arrangement devised by Prof. Ryan, consisting of two rubber tubes, each connected at one end to the same rubber bulb, their other ends terminating in fine glass tubes leading down through the glass cover of the voltmeter. By pumping air from the bulb through one or the other of these tubes, a draught could be produced against the needle, so as to oppose its motion and bring it quickly to rest.

The transformer upon which these experiments were made is a 60-light Hedgehog transformer, built on the general lines of an old-fashioned induction coil. A thin casting of gunmetal, cross-shaped in section, runs through its centre and supports the flanges of the spool. The four angles of this casting are filled with soft iron wires, running length-wise, thus forming a cylindrical core. These wires are considerably longer than the castings, and are spread out at their free ends, thus making a partial return for the magnetic lines. Half the secondary turns are first wound around this core, then all the primary, and finally the other half of the secondary. The primary consists of 1,426 turns of wire 0·072″ in diameter, arranged in twelve layers. It has a resistance of 2·748 ohms and weighs 29lb. The secondary consists of 73 turns of 19/0·058 cable, in two layers. Its resistance is 0·0149 ohms, and weight 12·6lb. The transformer is designed for a primary potential of 1,000 volts, with a frequency of 130.

This transformer was supplied with current from a Westinghouse alternator with a frequency of 133. The potential was kept constant at 1,154 volts by varying the exciting current. The primary E.M.F. was measured by measuring the fall of potential around a portion of a non-inductive resistance, which consisted of a series o 50-volt incandescent lamps arranged between the mains, as shown The secondary E.M.F. was similarly found by measuring the fall o potential around one of three lamps, placed in series across th secondary terminals. The primary current was found from the fa of potential around incandescent lamps, in the primary current The number of these lamps was so adjusted that the fall in potentia would be in the range of the voltmeter. The lamps were carefu ll calibrated for current at different pressures by means of a dire current, and curves drawn, from which the current could b determined for any pressure.

The secondary load consis ted of sixty 50-volt incandescent lamp mounted upon a frame in such a manner that any number of lamp could be turned on or off. It was planned to measure the secondar current by means of a calibration of these lamps, but it was foun on recalibrating them, at the end of the work, that their resistanc had increased considerably, so this method had to be abandone The secondary current was finally determined by constructing right triangle, the hypotenuse of which was equal to the primar current at no load. The third side, multipled by the ratio transformation, gave the secondary current.

To find the square root of the mean square value of the primar current, a curve was drawn, using the instantaneous values of th E.M.F. around the primary current lamps as ordinates, and second curve drawn, the ordinates of which were equal to th square of the corresponding ordinates of the first curve. Th mean ordinate of this second curve was found by a planimeter, ar its square root found. This represented the square root of th mean square of the difference of potential around the lamps. E reference to the calibration curve, the current could readily determined. Although somewhat laborious, the method proved be extremely accurate.

The square root of the mean square value of the seconda E.M.F. was measured directly by the multicellular voltmeter.

Five separate runs were made, first for no load, with the secon ary on open circuit, and then with loads of 15, 30, 45 and 60 fift volt incandescent lamps. With lamps of this resistance, the la run was quite beyond full load, inasmuch as the primary E.M. was 15 per cent. above that for which the transformer was intende The results of three of these runs are shown in Figs. 5 to 7.

At no load, the lag of the primary current is almost 90de which is greatly in excess of the lag shown by similar experime upon a transformer with a closed magnetic circuit. This diminishes rapidly as the load increases, as seen in the success curves, but it is always greater than for the corresponding load a closed magnetic circuit transformer. This is on account of t large magnetising current in the open-magnetic circuit transform the effect of this component of the total primary current being qu

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marked, even at full load. The secondary E.M.F. at no load is almost opposite in phase to the primary E.M.F.; that is, it is almost 180deg. behind it. As the load increases, a small but distinct increase in this lag is noticed, due largely to increased leakage.

The power supplied to the transformer was found by finding the products of corresponding instantaneous values of the primary E.M.F. and current. These products were positive or negative, according to whether the two factors were of the same or different sign. The products thus found were plotted as curves, showing the primary power (Fig. 8), positive values being plotted above the axis, and negative below. These areas were found by a planimeter, their algebraic sum taken, and the mean ordinate thus determined.

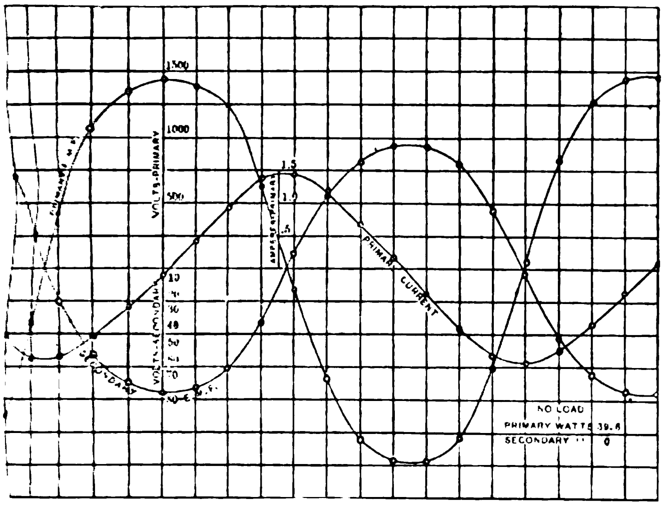

Fig. 5.

Although at no load the primary current is large, the fact that it lags so nearly 90deg. behind the primary E.M.F. causes the energy expended to be small. This was found to be a total of 39.6 watts. Of this the primary copper losses, $R_1 I_1^2$, amounted to 2.58 watts, leaving 37.02 for the core losses,—hysteresis and eddy currents. If we assume the loss in the core to vary as the 1·6 power of the E.M.F., this loss for the designed primary E.M.F. of 1,000 volts would be

$$\frac{1{,}000^{1.6}}{1{,}154^{1.6}} \times 37{\cdot}02 = 29{\cdot}4 \text{ watts}$$

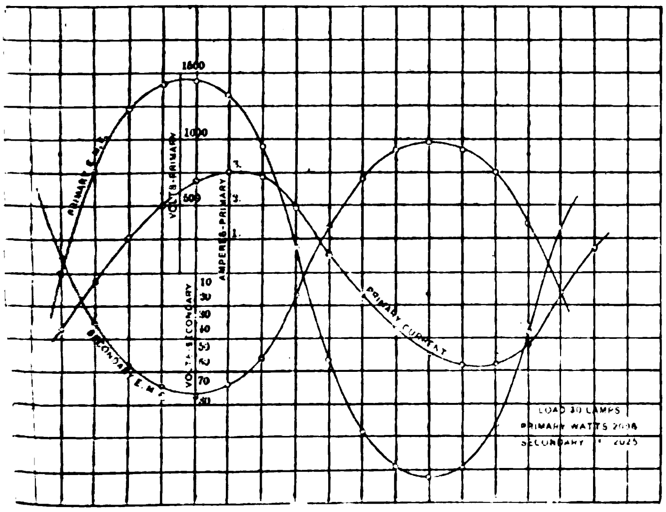

Fig. 6.

In any transformer, if the primary E.M.F. is a sine curve, the current curve would also be one, in case there were no hysteresis or eddy currents. In the no-load diagram of this transformer the primary current curve is not materially different from a sine-curve 90deg. behind the E.M.F.; while in the no-load diagrams of closed magnetic circuit transformers supplied from this same alternator, the curves for primary current depart widely from sine curves, and are much nearer the primary E.M.F. in phase. Thus the form and position of the current curve in the open magnetic circuit transformer show the hysteresis and eddy currents to be small, as compared with the transformer with closed magnetic circuit.

The efficiency of the transformer was found by taking the ratio of the secondary to primary power. The primary power was found from the watt curves in Fig. 8. The secondary power was found by deducting the primary and secondary copper losses, $R_1 I_1^2$ and $R_2 I_2^2$, and the core losses from the primary power thus found.

The curve for efficiency is given in Fig. 9, and is seen to rise very rapidly as the load increases, reaching 90 per cent. at about one-eighth of full load. From quarter load it is nearly constant, rising to 96·6 per cent. at two-thirds load. It remains practically constant until full load is reached, and then falls off slightly on over load. The all-day efficiency, calculated on a basis of five hours at full load out of 24, is 91·8 per cent.

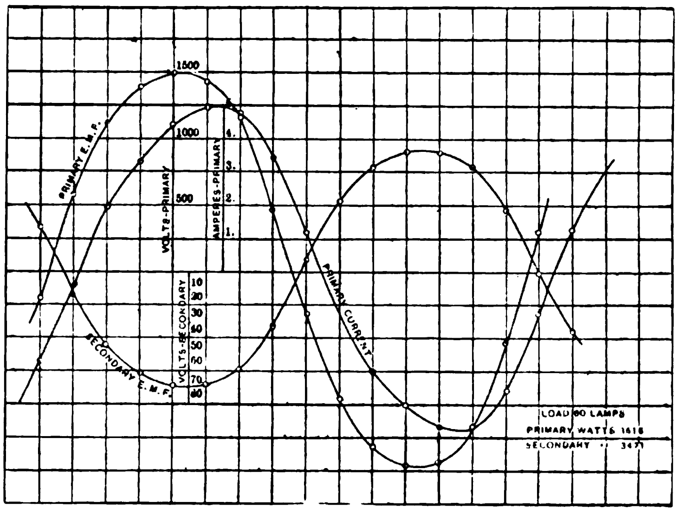

Fig. 7.

The regulation is seen by the curve in Fig. 9, showing the secondary E.M.F. for different loads. There is a fall of about 2·5 volts in the secondary, between no load and full load. This curve is drawn for a primary E.M.F. of 1,000 volts.

The primary current is shown by a curve in the same figure. Even at no load it is quite large, although representing very little energy expended. Clearly the disadvantage of such a current is that it increases the losses in the line and in the primary conductor. If this line current can be successfully reduced, one of the chief objections to the open-magnetic-circuit transformer will be removed. This can be done by the use of condensers.

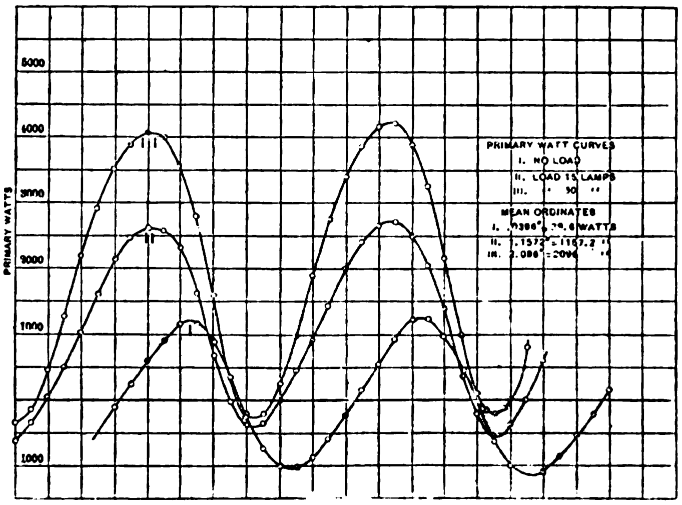

Fig. 8

Experiments were made with six condensers from the Stanley Laboratory, and were intended to be used commercially on a 500-volt circuit. The plates are of tinfoil, the useful part of which is of the following dimensions:—Length, 10½in.; width, 8in.; thickness, 0·0007in. The dielectric is of waxed paper, 0·0043in. thick. There are 65 sheets of tinfoil (total) in each slab, and two of these slabs are placed together in one tin case. The capacity of each condenser was about 1·5 microfarads. By arranging the condensers in various combinations, it was possible to obtain a number of different capacities, ranging from 0·25 to 2·25 microfarads, without

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subjecting any one condenser to more than 500 volts difference of potential. The proper capacity to be used in parallel with the primary is that which will bring the line current in phase with the E.M.F. When this result is brought about, the line current is a minimum. Predetermined by an analytical and graphical method, of Dr. Crehore and one of us, the proper capacity was found to be very close to one microfarad. Fortunately, the capacity required is almost constant for all loads of the transformer. The proper capacity for the condensers was ascertained by trial as follows :— The transformer was run on open circuit with the condensers arranged in various combinations, so as to obtain different capacities, and the fall of potential around the incandescent lamps in the line was measured by the multicellular voltmeter. Square root of mean square values were obtained by direct reading, no instantaneous values being taken. This fall of potential was ascertained for different capacities, and the results obtained were plotted in a curve. The minimum drop occurs when the current is a minimum and in phase with the E.M.F. This is seen to be obtained by a capacity of almost one microfarad, the same capacity as calculated. The six condensers were therefore used, three in series and two in parallel, giving a capacity of 1·02 microfarads.

Three runs were now made, one with the secondary circuit open, and the other two with loads of 15 and 45 lamps each. Readings were taken for determining the primary E.M.F., secondary E.M.F., primary current, and line current. By primary current we mean the current in the primary of the transformer, and by line current the current supplied to the condensers and transformer together.

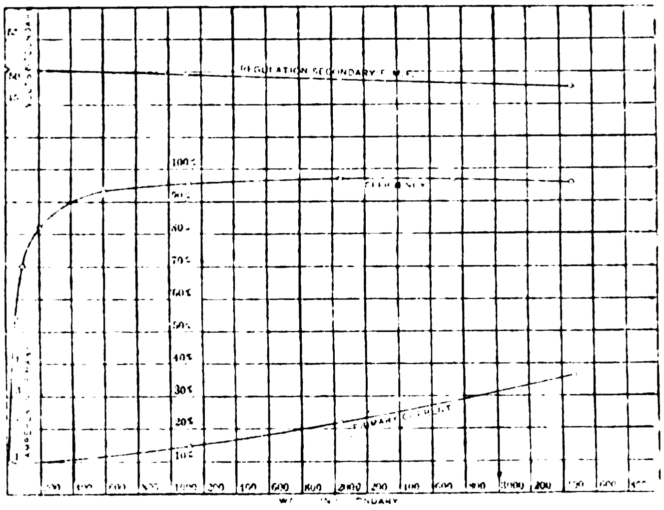

Fig. 9.

The results of these three runs are given in the following table, showing clearly the effect of the condenser in diminishing the line current, especially at no load :—

Lamps in secondary.	Primary current.	Line current.
0	0·95	0·187
15	1·24	0·867
45	3·07	2·73

At no load the line-current is seen to be less than one-fifth of the primary current, or the value it would have if the condensers were absent ; even under load the reduction is considerable.

The results of the three runs are shown in the Paper by curves. The character of the line-current curve is somewhat irregular. It is the algebraic sum (the arithmetical difference) of two almost equal and opposite currents, and is very small compared with either. If these two currents were exactly sinusoidal the resultant curve would be sinusoidal. As a matter of fact, although very nearly sinusoidal, they are not exactly so, and these variations have a marked effect upon their resultant, which is their arithmetical difference. The line-current curve has a marked depression, which brings the portion which would naturally be the crest over the axis : that is, for a brief interval in each half-period it has the opposite sign, and the current flows in a direction opposite to its flow during the other part of the same half period.

The experiments with the condensers demonstrate the practicability of their use to diminish the line-current in tranformer circuits, and points to their more extended use, as their manufacture is perfected and cheapened, not only in this, but also in other systems of alternating current distribution.

PHYSICAL SOCIETY.

At an ordinary meeting of this Society on October 27th, Prof. J. Perry, F.R.S., Vice-President, in the Chair.

Mr. E. C. Rimington read a Paper

"On the Behaviour of an Air-Core Transformer when the Frequency is below a certain Critical Value."

Taking the ordinary differential equations for two circuits having self and mutual induction, and assuming sinusoidal electromotive forces and constant co-efficients, the author shows that although the difference of phase between the primary potential difference and primary current is always diminished on closing the secondary circuit, yet under certain circumstances this closing increases the impedance of the primary. With constant potential difference this means that closing the secondary decreases the primary current, a phenomenon not usually observed. The critical conditions necessary for increased impedance are fully worked out in the Paper, as well as those under which this increase becomes a maximum. In the case of two identical coils with no magnetic leakage, the critical value of a ($a = \frac{p\,L}{r_1}$, where $p = 2\pi$ times the frequency, L the inductance of the primary, and r_1 its resistance) is $\sqrt{2}$, whilst that to give maximum impedance is $\frac{1}{\sqrt{2}}$. The maximum increase possible is 15½ per cent. The corresponding values are given for various amounts of magnetic leakage in tabular form, and curves were exhibited at the meeting showing how the impedance, current, power, and magnetising effect vary for different values of a.

To test his conclusions the author made experiments on two coils close together, the observed increase in impedance amounting to 3·2 per cent.

In addition to the analytical investigation, the subject is treated geometrically at considerable length.

Prof. MINCHIN showed that the impedances might be represented by two hyperbolas, having p^2 as abscissæ and the squares of the impedance as ordinates. These could be readily constructed from the data given. A line representing the primary inductance drawn on the same diagram intersects one hyperbola, showing that the impedance has always a maximum value. By a simple construction the phase angle between the primary and secondary currents could be determined for any given conditions.

Dr. SUMPNER observed that increased impedance on closing the secondary necessarily meant a decrease in the lag of the primary current behind the primary potential difference.

Mr. BLAKESLEY was pleased to see the geometrical method of such service, and thought it much simpler than the analytical one. The reason why increased impedance on closing the secondary of ordinary transformers had not been noticed was because their lag angles were very large. In a figure published some years ago to represent the actions of transformers the angles he had chosen were such as would make the primary impedance increase on closing the secondary. Giving an expression connecting the primary currents on open and closed secondary respectively, he now showed that to get increased impedance the sum of the lag angles in primary and secondary must exceed 90deg. To get large power in the secondary the primary lag should be nearly 90deg., and the secondary about 45deg. He also pointed out that some of the figures in the Paper might be simplified considerably.

Prof. PERRY said he had long had the impression that if a sufficiently small current were taken from the secondary increased impedance would be observable in all cases, and he quoted some numbers he had given in the *Phil. Mag.* for 1891, showing a decided increase.

Mr. RIMINGTON, in reply, said he was not aware that the effect he had now brought forward had been observed previously. The result was completely worked out analytically before using geometrical methods.

An experiment on

"Electric Radiation in Copper Filings,"

shown by Mr. W. B. Croft, was similar to those described by Dr. Dawson Turner at the Edinburgh meetings of the British Association. A battery, galvanometer, and glass tube containing copper filings, were joined in series. Under ordinary circumstances no current, passed but immediately an electric spark was produced by an electric machine many feet away, the galvanometer was violently deflected, and remained so until the tube was tapped. On trying different materials, aluminium and copper seemed about equal, but iron not so good. Carbon allowed the current to pass always.

Prof. MINCHIN said the phenomena were strikingly like those exhibited by his "impulsion cells," for the moment a spark passed, even at a distance of 130ft., they became sensitive to light. Very minute sparks were capable of producing the change, but by adding capacity to the sparking circuit the effect could be greatly modified. Replying to a question from Mr. Rimington, he said the change was due to electro-magnetic vibrations and not to light emitted by the sparks.

Mr. BLAKESLEY inquired if lengthening the sparks produced greater effect on the copper filings.

Mr. LUCAS asked if the resistance of a tube ever became infinite again left for a long time.

In reply, Mr. CROFT said the current sometimes passed before the spark actually occurred between the knobs. He had not left tubes for very long, and had not found the resistance reappear without tapping.

LEGAL INTELLIGENCE.

Fry and Francis v. The St. James' and Pall Mall Electric Light Company (Limited).

This action came before Mr. Justice Kekewich on Wednesday, the question raised being whether the Company, under its Articles of Association, was justified in carrying over from profits £1,000 in each of two years to a fund called the redemption fund, to the detriment of the Founders' shares issued by the Company. The plaintiffs (Mr. Charles Robert Fry and Col. George Edward Francis) held, the former two and the latter ten, Founders' shares, besides being Ordinary shareholders, and they sued on behalf of themselves and the other holders of Founders' shares in respect to the distribution of profits, to one-half of which they were entitled. For the year ended December, 1890, a dividend was paid at the rate of 5 per cent., a sum not sufficient to enable Founders' shares to come within the distribution; but at the end of 1891 8½ per cent. was paid on the Ordinary shares, and the holders of Founders' shares each received £10. 15s., representing one-half of the surplus profits for the year, and in 1892, beside satisfying the Preference shares, 7½ per cent. was paid to the Ordinary shareholders, and 3 guineas to each Founders' share. The Directors, however, in each of these years carried over from profits £1,000 to a redemption fund, as plaintiffs said, to the detriment of Founders' shares, and in favour of the Ordinary and Preferential shares. The point was: Were they justified in so setting aside this sum?

The case for the plaintiffs was argued by Mr. Renshaw, Q.C., and Mr. Whinnie; and for the defendant company by Mr. Warmington, with whom was Mr. Swinfen Eady, Q.C. Their contention was that there was no imputation of *malâ fides* on the part of the Directors, who had acted on the advice of the most experienced persons and in the ordinary conduct of the business of the Company. Unless their *bonâ fides* were disputed and a question of *ultra vires* was raised, plaintiffs had no *locus standi*, besides which the Directors asserted that the Memorandum of Association authorised them to act as they had done.

In the result, his Lordship said that the point raised in this case was a new one, and raised for the first time, Founders' shares being a modern invention, and not yet having attained any technical meaning. The *bonâ fides* of the Directors were not impugned, and if it were a question of internal management, according to well-known principles and decisions, the Court would certainly not interfere with what the Directors had done. They were removable representatives of the shareholders, and entitled to manage the business of the Company to the best of their ability. This was not a question of the power of the Directors, but one of contract, based on the Memorandum of Association, and he thought he was bound to hold the holders of Founders' shares to be parties to those Articles. He could not think their provisions operated to shut the mouths of holders of Founders' shares in the way suggested. If their mouths were not so shut, the accounts showed that something of the net profits of the undertaking had not been divided, and ought to have been divided. Such being his construction of the contract, he considered the plaintiffs entitled to the claim they made, and he gave judgment for them accordingly, with costs against the Company.

CORRESPONDENCE.

THE ORGANISATION OF RESEARCH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The question concerning the publication and dissemination of physical news having reached an urgent stage, it is well to bear in mind the various directions in which we may look for a solution. It appears hardly likely that the original publication of papers will become much more centralised, and if it were, the centralisation would have to be complete in order to ensure its usefulness. There are in reality two problems involved, which may be stated as follows: First, to enable physicists and those interested in physical science to obtain a fair and comprehensive idea of the work that is being done in various branches of physics. Second, to provide specialists with prompt and reliable information concerning the methods and results of those engaged in research akin to their own.

The demand giving rise to the first problem is supplied to a great extent by existing publications. But although a *Physical Review* now exists in name, there is no actual periodical representing a complete solution of the first problem. The difficulties of such a solution are obvious. We should require a physical *Review of Reviews* containing sketches of all the current contributions to the advancement of physical science, woven into a concrete image of physical progress by the pen of a physicist well acquainted with the various modern schools, and capable of interpreting their work in language familiar to the majority of his readers. I do not say that such a man could not be found; the difficulty would be to make the business worth his while.

An alternative solution consists in the publication of abstracts only, like those published by Wiedemann in his *Beiblätter* The chief drawback of the latter lies in the fact of their being published in a language not sufficiently familiar to the majority of English speaking physicists to enable them to pick out at a glance what they require. The simple translation of the *Beiblätter* into English, as advocated by Prof. Fitzgerald, would obviate this difficulty, and place at our disposal the fruits of German thoroughness. Whether such an expedient would suit the pardonable pride of British and American physicists, and whether the cost of translation, including compensation for the present English circulation of the *Beiblätter*, would fall short of that involved in starting an English periodical on some independent and original line, are questions which cannot be hastily pronounced upon.

As they stand, the *Beiblätter* represent a gallant attempt to solve the two problems together. But there is a third method, specially suited to the second problem, which has not, as far as I am aware, been pointed out yet. It is something in the way of a scientific news agency, a central office for the distribution of physical information of a specialised class to those interested in a special subject. Such an office should collect all the physical papers appearing in the four principal scientific languages, viz., English, French, German and Italian, and send out references, abstracts, or translations to its subscribers. The abstracts, &c., should appear in the language of the subscriber if the office is to be international, or in the language of the country concerned if national. It would follow as a matter of course that the extracts sent to a large number of subscribers would be multiplied by one of the numerous hectograph or mimeograph processes, or even printed in the ordinary way. Such an agency should pay its own way almost from the first, as no work would be done except that already known to be required. If it could be done in connection with one of the papers devoted to one or more branches of physics (as is *The Electrician* itself), so much the better. It would require a staff of specialists like that employed by the Chemical Society for its excellent abstracts.

In conclusion, I may mention that an International Scientific News Agency exists already in Astronomy. I refer to the Bureau at Kiel in connection with the *Astronomische Nachrichten*.—Yours, &c., E. E. FOURNIER.

October 21, 1893.

PROF. POYNTING'S STILL MORE MODERN VIEWS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have just had the advantage of reading Prof. Poynting's exceedingly interesting and suggestive "examination" of Dr. Lodge's "Modern Views of Electricity," with, I hope, equal pleasure and profit. There is one remark, however, which I should like to be allowed to make. On page 576 the "agnostic in ethereal matters" is represented as saying that "we have no sense affected by the ether alone." I have frequently heard this statement, but it does not seem to me to be in accordance with facts. What is the eye, if not a special sense organ, adapted to respond to a certain small range of ethereal vibrations, and *to nothing else*? The skin, of course, is sensitive to much besides ethereal vibrations, but it is also sensitive to these (likewise within a very small range), or how could we receive by radiation the sensation of heat? Of course, we cannot see the ether as we can a glass of water, or smell it as we can a rose, but it seems to me a mistake to say that we have no sense affected by it alone. Is it not rather that we have not been able to refer the affection to its true cause?—Yours, &c., E. M. C.

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TO THE EDITOR OF THE ELECTRICIAN.

SIR: I tried to anticipate the objection of "E. M. C." by inserting the word "alone" in the phrase which he criticises. In trying to represent the views of the agnostic it would probably have been more correct to say that "we have no sense affection which we refer to the ether alone." Certainly we refer all the energy transformations which are the physical accompaniments of our sensations to the presence of matter. If our hypothesis as to the nature of light leads us to suppose that the eye is stimulated by the ether, and by nothing else—a rather large *if*—we only mean immediately, for in tracing back the disturbance in space, we always find matter as the source from which it proceeds, and we refer our sensation to that matter. If transformations of energy occurred in materially void spaces, and if we had some sense affected by such transformations, then I imagine that this sense would give us a concept which we should call ether.

May I add a word here to say that I am very glad that Dr. Lodge thinks some of my criticism reasonable and worthy of consideration. As to the point on which we appear to disagree most strongly, probably I did not properly express the objection I have to the so-called "perfects." I do not think I shall have to re-arrange my ideas if the oxygen atoms are found to conform perfectly to the ratio 15·9, or whatever it may be, to the hydrogen atoms, are found, in fact, to be perfectly truly manufactured. What I object to is the abstraction such as we have in a "perfect conductor," where we form a conception by removing the known properties of matter. Probably I am here the victim of a hypothesis. Having come to regard a current in a conductor as essentially a propagation of some kind of strain energy into or out of a wire *sideways*, I do not see how to provide for the case of the conductor, which neither stores up nor transforms the strain energy when sent into it. There appears to me absolute difference in kind between a resistance very small and a resistance zero. I should expect the perfect conductor when found to turn out merely a non-electric, reflecting all the electrical energy incident on it.—Yours, &c.,

J. H. POYNTING.

ALTERNATE-CURRENT DISTRIBUTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Though I have already trespassed too much on your space, perhaps you will allow me to correct some misapprehensions in your reference to my letter in the current number of *The Electrician*. The 80·5 per cent. *includes* the estimated loss of 2½ per cent. on the low-pressure mains. The latter estimate is not mine. It is merely the fact, about which I was unaware there was any dispute, that with a current density of 1,000 amperes per sq. in. there is a drop of 2½ volts per 100 yards. On a 100 volt network this is a loss of 2½ per cent. Again, you say that I suggest that the sub-stations will have to improve 10 per cent. to attain an efficiency of 80·5 per cent. This is an error. I give that figure as an estimate—I believe I have shown a favourable one—for actual sub-station distribution, and while holding with you that sub-stations *may*, perhaps, do better eventually, I shall be agreeably surprised if, at present, any station engineer will come forward and prove that where the plant is running all day the company gets paid by its customers for more than 80 per cent. of the wattage sent out from the station.

When you suggest that an automatic switch is a confession of weakness, I agree that it is; it is a confession of "magnetising current," and though "magnetising current" is frequently ignored in text-books, it is unfortunately less accommodating in regard to coal-bills. It is, of course, possible, as we all know, to construct transformers taking practically no current on open circuit, but this means serious loss of efficiency when the transformer is loaded, and hence I venture to regard the automatic disconnection system as the best and most economical way out of the difficulty. I am afraid I do not share your view that complexity is necessarily an evil to any one but the manufacturer, unless it means failure in action. Mr. Tomlinson's switch, though applicable only to sub-stations, is decidedly more complex than the other you described in your issue of June 9th, as intended for use with separate transformers. In conclusion, I would suggest that as the "up-keep" (waste on open circuit) can easily amount to £12 per annum, even with a 2½-H.P. transformer, and as it is the companies who sustain this loss, it is naturally they whom one would expect to be inclined to pay for an appliance by which it may be avoided.—Yours, &c.,

October 30th. R. N. LUCAS.

PRIMARY BATTERIES IN THEORY AND PRACTICE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Aylmer has called my attention to an error which appears in my Paper on Primary Batteries (*The Electrician*, October 27, p. 695), and which I should be glad to correct. Referring to the Leclanché dry cell, I stated that it is only necessary to pour some water into the cell in order to renovate it, in the event of its becoming too dry. This is, however, incorrect. A solution of sal-ammoniac, or other suitable compound, must be employed for this purpose.—Yours, &c.,

W. R. COOPER.

Woodlands, Clapham Park, London, S.W.
October 28, 1893.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1893 Edition of "'THE ELECTRICIAN' ELECTRICAL TRADES' DIRECTORY AND HANDBOOK" contains over 1,000 pages, several new and handy features having been added. Price 7s. 6d., post free 8s. 3d.; abroad 8s. 10d. *Comparison with any similar electrical publication is specially invited.*

The 1894 Edition is in preparation, and will be published in January next. New names, alterations of addresses, &c., are received at any time, but the Directory blanks and circulars are not sent out until later in the year, in order that the most recent, and consequently the *correct*, addresses *only* shall appear in the book. Full printed particulars can be obtained, post free, from "The Publisher," *Electrician* Office.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, which has a special interest at the present time, will be ready next week, and will be forwarded on receipt of the published price, 7s. 6d. (abroad 8s.), or it may be obtained from any bookseller. A prospectus can be obtained on application to the Publisher.

TENDERS INVITED.—The Corporation of Sunderland, it will be seen by our advertisement columns, invite tenders for the supply, in connection with their scheme of electric lighting, of (1) boilers; (2) engines, dynamos, pumps, steam-pipes, &c.; (3) motor alternators, switchboard, &c.; (4) main switchboard, instruments, and connections; (5) batteries; (6) insulated cables, &c.; (7) supplying and laying culverts, &c.; (8) copper strip; and (9) gunmetal grip boxes. Persons or firms wishing to tender for any of the above contracts must send their names and addresses to the Borough Engineer, Town Hall, Sunderland, from whom drawings, specification, and forms of tender are to be obtained. Tenders must be addressed to the Chairman of the Highways Committee, and be sent in to the Town Clerk's Office, Sunderland, on or before Friday, November 17th.

——— The Electric Lighting Sub-Committee of the Corporation of Newport invite tenders for the supply and erection of engineering and electrical plant and apparatus for the equipment of the Municipal Electricity Works of the County Borough of Newport. The plan of buildings, map, specifications, &c., can be obtained at the offices of Mr. Robert Hammond, consulting engineer to the Corporation, 117, Bishopsgate-street, London, E.C.; and tenders must be addressed to Mr. Albert A. Newman, Town Clerk, the Town Hall Newport, (Mon.), not later than Monday, November 20th. Further particulars are given in our advertisement columns.

——— The Gas and Lighting Committee of the Bolton Corporation invite tenders for the supply and erection of switchboards, accumulators, connections, &c. Specifications, &c., can be obtained from Mr. J. H. Rider, the borough electrical engineer, and tenders must reach Mr. Alderman Miles, chairman of the above committee, at the Gas Office, Bolton, not later than Saturday, November 18th. Further particulars appear in our advertisement columns.

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TENDERS INVITED.—The Corporation of Dewsbury invite tenders for the work required in the erection of an electric lighting station within the borough. Plans may be seen at the office of the Borough Engineer, from whom specifications, bills of quantities, and forms of tender may be obtained. Tenders are to reach Mr. E. Mawdesley, the Town Clerk, by the 17th inst.

——— The Municipality of Mahon, Spain, invite offers for the electric lighting of the town. Particulars may be obtained from the Ayuntamiento Constitucional of Mahon, and tenders must be in by November 16th.

——— The Cheshire Lines Committee invite tenders for General Stores and Permanent Way Materials, including telegraph materials, instruments, wire, &c. Tenders must be in by 10 a.m. on December 2nd.

PERSONAL.—Dr. W. E. Sumpner has been appointed head of the electrical department of the Battersea Polytechnic.

SALE BY AUCTION.—Messrs. Wheatley Kirk, Price and Goulty announce a sale by auction on November 17th, on the premises of the Vulcan Iron Works, situated at Beccles, Suffolk, together with freehold land and buildings. A large quantity of plant and machinery is for disposal.

LIQUIDATIONS.—On Thursday last week a petition came before Mr. Justice Vaughan Williams for the winding-up of the Ipswich Electricity Supply Company, which, however, was adjourned for a week.

——— A petition has been presented by Mr. Thomas Brooks Browne, advertisement contractor, for the winding-up of the Medical Battery Company (Limited), and is down for hearing on the 8th inst.

——— Mention was made before Mr. Justice Vaughan Williams last week of a petition for the winding-up of the Wrexham and District Electric Supply Company (Limited); but leave was asked for the petition to be withdrawn, which was granted.

——— The shareholders of the Steam Loop Company (Limited) have decided to voluntarily wind up the Company.

——— A meeting of the members of the Maquay Syndicate (Limited) is to be held at Mr. Thomas Rawlins's, 45, King William-street, E.C., on November 18th, at noon, for the purpose of receiving the liquidator's account of the winding up.

——— Mr. Frederick Samuel Lucey, of 3, Bucklersbury, E.C., has been appointed official liquidator of the International Cable Company (Limited), in the place of Mr. John Lord, deceased.

WILFUL DAMAGE.—The man M'Queen, who, as mentioned last week, was charged at the Manchester Police Court with wilful damage at the Mosley Hotel, by pulling a fuse out of its socket, causing the electric light to suddenly go out, was, with another man named Bridge, charged with a similar offence at the same time, sentenced on Tuesday to a month's hard labour.

BANKRUPTCY.—A first and final dividend of 2s. 4½d. in the £ has been declared in the estate of Austin Herbert, formerly carrying on business as an electrician at St. James-street, Nottingham.

DISSOLUTION OF PARTNERSHIP.—Notice is given of the dissolution of the partnership between James Robert Fawkner and Henry John Rogers, carrying on business at 10, New Bridge-street, E.C., as engineers and contractors, under the style of Fawkner, Rogers, and Co. All debts to and from the firm will be received and paid by H. J. Rogers.

AWARDS.—Mr. Frederic Nell informs us that the Victor Turbine has been awarded a first prize gold medal at the Chicago Exhibition.——Messrs. Doulton and Co., of Lambeth, London, S.E., have obtained six highest awards for their various manufactures exhibited at the Chicago Exhibition.

EXHIBITIONS.—There is to be an International Confectioners', Bakers', Grocers', and Biscuit Manufacturers' Annual Exhibition at the Agricultural Hall, Islington, London, N., from November 4th to the 11th, at which the machinery used in the various trades represented is to be shown working.

AGENCY.—Messrs. Paterson and Cooper inform us that they have been appointed agents for the United Kingdom for the sale of Messrs. Richard Freres' electrical and industrial measuring instruments.

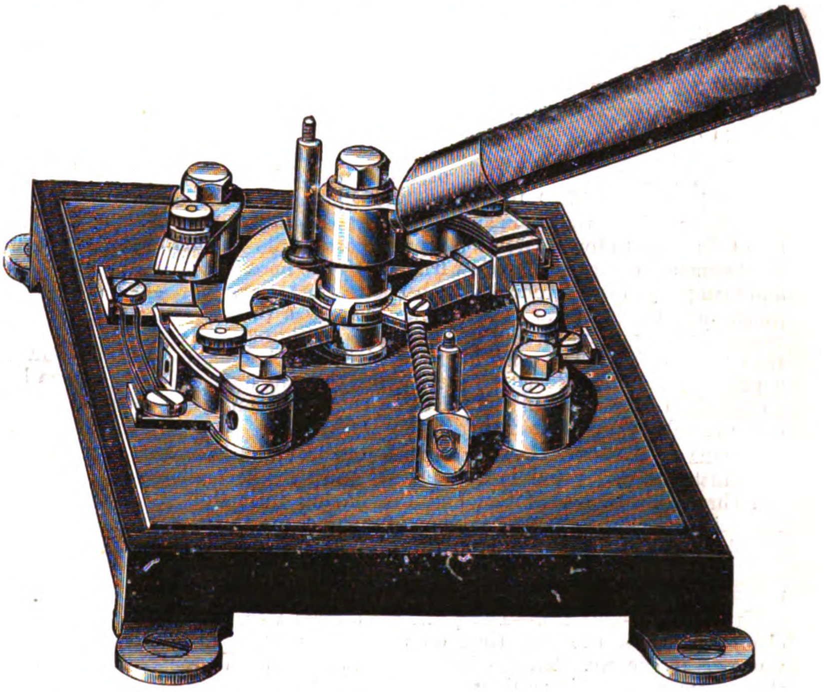
A NEW TRAMCAR.—Major-General Hutchinson, R.E., recently inspected on behalf of the Board of Trade, the Lührig tramcar, which is about to be used on the Croydon and Thornton Heath section of the Croydon and Norwood Tramways Company. The new car is a German invention, and is propelled by means of gas. It is self-contained, and has a running capacity for about 15 miles. Refilling takes place in rather over a minute through an ordinary india-rubber delivery hose connected with a nozzle in the body of the car. There is no smell or vibration and very little evidence of the waste gas going into the atmosphere. From experiments made by Prof. A. B. W. Kennedy, F.R.S., it is expected that in ordinary circumstances the cost of traction will be reduced by about 65 per cent. The gas is ignited by an electric spark, and the motive power, which consists of two double-action I.H.P. gas engines, is completely hidden, together with the fly-wheel, at the back of the seats. Major-General Hutchinson expressed his approval of the car, and passed it, subject to the carrying out of certain minor alterations.

"MECHANICS."—This is the name of a new journal, to be published monthly, commencing with the new year, price 3d. Amongst the advantages claimed for it are that there will be "no algebraic equations, no mysterious diagrams, and no abstruse theories."

ELECTRICAL FITTINGS.—Messrs. Wm. McGeoch and Co. have just issued a new fully-illustrated catalogue of electrical apparatus manufactured by them, of which stocks are kept at London, Glasgow, Birmingham, and Sunderland. A variety of switches, cut-outs, ceiling roses, lamp-holders, globe-holders, ball and counterweight fittings, standards, brackets, &c., are included in the catalogue.

ANTI-FRICTION METALS AND TIN ALLOYS.—Messrs. Höveler and Dieckhaus send us particulars and prices of their white anti-friction metals and tin alloys, for which they have obtained a first prize (medal and diploma) at the Chicago Exhibition.

THE "COMPANY'S" SWITCH.—Messrs. Verity and Co. have shown us a specimen of their double-pole switch, especially intended for



use as the main switch for houses connected to supply systems. It has a quick make-and-break, and appears to be well adapted for its work. The handle is easily removable.

ANTI-SULPHURIC ENAMEL.—Messrs. Griffiths Bros. and Co. inform us that their anti-sulphuric enamel is being employed at the large central station at Brussels for the protection of the metal and woodwork from acid fumes.

MESSRS. DRAKE AND GORHAM.—This firm inform us that, owing to their constantly increasing business, they have found it necessary to provide additional accommodation for their staff.

ABERDEEN.—The Lighting Committee of the Corporation have decided, in order to give an idea of the effect of the electric light in the streets, to light a small area of the city in advance of the general scheme.——A deputation of the Corporation recently visited the principal watering places in England and France, with a view of drafting a scheme for the establishment of a new bathing station on the beach. Their proposed scheme includes an esplanade, with a pavilion for entertainments, and an electric tramway from Castle-street to the proposed esplanade. The scheme is to come before the Town Council at their next meeting.

AGRICULTURAL HALL.—At last an attempt is being made to light this huge building by electricity. We learn that 40 of the Electrical Company's "Luna" arc lamps have been supplied for

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lighting the main hall, the current for which is generated by a Brush high-tension dynamo, driven by a 50-H.P. Stockport gas engine. The installation has been carried out by Messrs. Vaughan and Brown.

BRIGHTON.—Mr. J. T. Chappell, the contractor who had in hand the extension of the Corporation Electric Lighting Station in North-road, recently failed, and the work was consequently at a standstill. The Works Committee, however, instructed the borough engineer and surveyor to take possession of the works and the materials, plant, &c., in use for the same, and the extension is being carried out under the direct control of the Corporation.

CAMBERWELL.—A special meeting of the Vestry is to be held on December 6th for the purpose of considering the advisability of applying to the Board of Trade for a Provisional Order. At the last meeting an Electricity Committee was appointed.

CONCERT.—A smoking concert will be given this (Friday) evening by the Telephone Athletic Association at the "Haunch of Venison," Bell-yard, Temple, E.C., to commence at 7.30 p.m.

DEWSBURY.—The Local Government Board has sanctioned the borrowing of £25,000 for electric lighting purposes, and have also approved of the use of the site of the old gas works at Battle Carr for a central station.

EALING.—Mr. Codrington, one of the Local Government Board inspectors, held an official inquiry on Thursday last week with reference to the application by the Local Authority for permission to borrow £25,000 for the purpose of electric lighting.

GOVAN.—The Govan Combination Parochial Board have had estimates submitted to them for the lighting of the new asylum at Hawkhead, showing that electricity would cost £635 per annum, oil gas £282, and Glasgow Corporation gas £200. The Board have decided to adopt the latter.

H.M.S. "HOWE."—In connection with the refitting up of this battle ship, the Dockyard authorities at Chatham being unable, owing to the limited time available, to undertake the renewing of the electric light and gun-fire circuits, the work was entrusted to Messrs. King, Brown and Co., of Edinburgh. The "Howe" is lighted by means of 520 16-c.p. incandescent lamps, in addition to the usual yardarm reflectors and semaphore signalling lamps, cables also being laid to four search-light projectors, while the gun-firing arrangements comprise electric wiring, with the necessary batteries and firing keys for the four 63-ton barbette guns, the six broadside guns, and five torpedo tubes. The work was carried out continuously day and night, and was completed within ten weeks from the date of order. The experiment of placing such a contract with a private firm has proved so satisfactory that we understand the authorities contemplate taking the same course in connection with other vessels at present refitting in the Dockyard.

HOWRAH (CALCUTTA).—The scheme for providing an electric light installation for public and private purposes seems likely to fall through, Messrs. Martin and Co. having intimated to the Municipal Commissioners that they cannot accept the terms proposed by the latter, whereby the plant would become their property after 20 years, which period would be too short for the firm to recoup themselves for their outlay.

KINGSTON-ON-THAMES.—The principal streets were lighted with electric light for the first time on Wednesday. The installation was a great success. Thirty-six arc lamps have been erected in the streets, each having a lighting power equal to 100 candles, displacing 75 gas lamps. The Town Hall, Municipal Offices, Free Public Library, and several shops and private residences are also lighted by electricity. The contract was carried out at a cost of £16,000. A formal inauguration ceremony will take place to-morrow (Saturday).

LAMBETH.—The Crystal Palace District Electric Supply Company have informed the Vestry that they intend to apply to the Board of Trade for a further Provisional Order under the Electric Lighting Acts.

LECTURE.—Mr. Whitehouse, instructor in telegraphy at the Municipal Technical Schools, Birmingham, delivered a lecture on Monday last on the phonopore. The lecturer was listened to with marked attention by a large audience, and at the conclusion he received a vote of thanks.

LLANDRINDOD WELLS.—The Local Board after consulting with a firm of electrical engineers, have decided to apply to the Local Government Board for a Provisional Order to enable them to supply electricity.

LYNTON.—The Local Board, having declined to purchase the electric lighting plant from Mr. Benn, that gentleman has intimated his intention of applying to the Board of Trade for a Provisional Order.

MONMOUTH.—A special meeting of the Town Council was held on Friday, when the plans for a new drainage system for the borough, combined with electric lighting, were approved. The scheme and plans have been forwarded to the Local Government Board for approval, with an application for powers to borrow £18,000 for the purpose of carrying out the scheme.

PENRITH.—The Local Board of Health have resolved to apply to the Board of Trade for a Provisional Order for electric lighting.

PONTARDAWE.—Messrs. W. Gilbertson and Co. (Limited) have applied to the Board of Trade for a licence to light certain streets in Pontardawe with the electric light.

PORTSEA ISLAND.—The Board of Guardians have decided to have their offices in St. Michael's-road lighted by electricity.

SALFORD.—The Corporation recently sought to obtain powers from the Local Government Board to borrow £50,000 for electric lighting purposes. The Board, however, have sanctioned the borrowing of £32,000 for this purpose, repayable within twenty-five years.

SIAM.—The *Rangoon Gazette* of September 11th, in the course of an article on "Public Works and Companies in Siam," alludes to the Bangkok Tramways Company (Limited). The line is six miles long, and one-half the distance has been equipped with electrical plant by the Short Electric Railway Company, of Ohio, on the overhead wire system, at a cost of £6,500. The electric cars had only been running a few weeks, and it was consequently impossible to form any just comparison of the working cost of electric traction with that of the superseded horse traction, but it was estimated that a saving in the working expenses of over £30 a month would be effected. Should this prove correct, the entire line would shortly be worked by electricity. Reference is also made to the Siam Electric Light Company, which got into difficulties at the beginning of 1892, just when they were about to start lighting. The plant and apparatus were supplied at a cost of £45,000, £15,000 of which was disputed, and an arbitration resulted in the amount being reduced to about £13,000. The Company, however, found themselves unable to raise any more capital, and the Government, to prevent any difficulty, took over the whole concern for £20,000, paid all creditors at once, and were then in possession of a first-rate electric lighting plant for less than half the cost price. Nothing, however, has since been done, and the valuable machinery has been idle for six months, and there is apparently no present intention of starting the works.

STIRLING.—It was stated at a meeting last week that an electric lighting company were prepared to light the town, and to buy up the Stirling and Bridge of Allan Tramway Company, so as to work the cars by electricity. The light was to be supplied at a cheaper rate than gas, and the adoption of electricity for the tram-cars would, it was said, enable the Company to charge only half the present fares.

ST. HELENS.—The Gas and Lighting Committee of the Corporation have resolved to apply to the Board of Trade for a Provisional Order to supply electricity.

TAUNTON.—The purchase of the electric light works by the Town Council was finally completed at the meeting last week, when cheques for the amount of the purchase were drawn, and the transfer completed.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

October 9, 1893.

18,880. G. W. FAIRALL. Wolverhampton. Improvements in automatic electric intermittent motors for driving the mechanism of recording instruments and the like.

18,894. A. MUIRHEAD and J. A. L. DEARLOVE. London. Improvements in standards of electromotive force.*

18,912. E. TYER. London. Electrical apparatus for signalling on railways.

18,918. J. WOODWARD. Toronto. Improvements in current motors.

October 10, 1893,

18,945. A. G. BROOKES. London. Improvements in compositions for use in telephonic transmitter circuits and in the process employed in their production. (A. C. Cousens, United States.)

18,951. J. EDMONDSON. Halifax. Improvements in electricity meters.

18,977. T. B. SHARP. Birmingham. Improvements in regulating the supply of electricity to electric glow lamps.

18,986. W. TAYLOR. London. Improvements in and relating to electric motors.

18,990. W. P. THOMPSON. Liverpool. Improvements in the method of and apparatus for electrically heating or working metal. (C. L. Coffin, United States.)*

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19,018. J. A. Davis and R. A. Fowden. London. Improvements in a system of electrical transmission.

19,024. J. M. Andersen. London. Improvements in trolly supports for electric railways.*

19,044. S. Pitt. London. Improvements in obtaining synchronous working of two rotating electric motors. (J. H. West, United States.)

October 11, 1893.

19,079. G. J. Parfitt and G. J. T. J. Parfitt. Keynsham. Improvements in switches used for the proper control of electric light currents.

19,088. M. Immisch. London. Improvements in cables for telegraphic and telephonic purposes.

19,094. J. F. Hoyne and G. R. Stoddart. London. An improved shade for oil, gas, electric, or other lights.

19,102. W. J. Brewer. London. Improvements in and applicable to suspension tracks for overhead cable or railway systems.

19,112. E. Freund. London. Improvements in electrical fittings.

19,122. C. T. Praed and W. H. Akester. London. A duplex electric arc lamp.

19,127. S. R. Linville and L. F. Hettmansperger. London. Improvements in printing telegraph systems.

19,145 H. Guthrie and M. Guthrie. Improvements in apparatus for the electrolytical decomposition of brine and other liquids.

October 12, 1893.

19,146. J. F. O'Brien. Liverpool. Improvements in or relating to telephone book holders or the like.

19,152. R. Beavan. Sydenham. Mercurial voltmeter.

19,183. A. Muirhead. London. Improvements relating to the transmission of signals through submarine and like cables, and apparatus for effecting the same.

October 13, 1893.

19,250. E. Marsh. Leeds. An improved method and means for slaughtering or killing all kinds of cattle scientifically by electricity.

19,251. C. B. Crawshaw and J. Battye. Dewsbury. An electric indicator for use in colliery engine-houses and railway signal cabins.

19,283. E. C. de Segundo and W. Derham. London. An electric heater.

October 14, 1893.

19,319. J. Graizier and E. Batault. London. Improvements in measuring and recording instruments for electric currents.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d. each.

1892.

1[illegible]36. Hutin and Leblanc. Transforming alternating into continuous electric currents.

1[illegible]43. Stevens. Electric telegraphic apparatus.

2[illegible]611. Brown. Alternating-current motors.

22[illegible]35. Binswanger. Electrical switches, &c.

22,129. Wharton. Electric switches.

22,858. Davenport. Electric arc lamp.

23,674. Harrison. Distributing electricity.

24,071. Schiff. Evaporating solutions by application of an electric current.

1893.

2,318. Williams. Electric percussive tool.

13,774. Spratt. Maintaining the human body in electrical connection with the earth.

14,756. Brookes. (Ryan.) Dynamo-electric generators and motors.

15,479. Howard. Electric arc lamps.

15,669. Browne. (Vogelsang.) Electrolytic treatment of liquids.

16,019. André. Metal posts for electric wires, &c.

16,074. Geyer and Stegmeer. Lighting gas by electricity.

16,136. Boult. (Hensel.) Battery electrodes.

BOOKS RECEIVED.

"The International Columbian Naval Rendezvous and Review of 1893 and Naval Manœuvres of 1892." (Navy Department, United States, America.)

"Prospectus of McGill University," Montreal.

"Annual Report of the Commissioner of Patents for the Year 1892." (Washington Government Printing Office.)

"Continuous-Current Dynamos and Motors." By Frank P. Cox, B.S. (New York: The W. J. Johnston Company, Limited.)

"Town Councillors' Handbook to Electric Lighting." By N. [illegible] Russell. (London: Biggs and Co.)

"Alternate-Current Transformers." By R. W. Weekes. (London: Biggs and Co.)

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts for the month of October are £3,000, as compared with £3,539 in the corresponding month of last year.

COMPANIES' MEETINGS.

Eastern Extension, Australasia and China Telegraph Company (Limited).

The fortieth ordinary general meeting of this Company was held on Wednesday at Winchester House, Old Broad-street, under the presidency of Sir John Pender, G.C.M.G., M.P.

The SECRETARY (Mr. F. E. Hesse) read the notice calling the meeting, and the minutes of the previous meeting, which were approved by the present meeting and signed by the Chairman as correct.

The report of the Directors having been taken as read,

The CHAIRMAN said: I will go over some points relating to our proceedings during the past six months, in order that you may have a little more information than the report has afforded you. The gross revenue for the half-year under review—to June 30th last—has amounted to £257,986, against £246,988 for the corresponding period of 1892, showing an increase of £10,998. The working expenses have amounted to £78,229, against £79,281 for the corresponding period of 1892, showing a decrease of £1,052. The usual interim dividends, at the rate of 5 per cent. per annum, have been paid for the past half-year, amounting to £62,500, and the balance of £81,116 has been carried forward, as against £70,271 for the corresponding period of 1892. The second year of the Australian tariff guarantee arrangement expired on April 30th last, when it was found that the loss for the year had amounted to £43,558, as compared with £55,040 for the first year of the guarantee. One half of this loss, or £21,779, has been made up by the guaranteeing Governments, and the remainder has been distributed between this Company and its partners in the "pool" as follows:—Eastern Extension Company £14,069, Eastern Company £6,208, Indo-European Company £925, and the Persian Gulf department of the Indian Government £577. During the current or third year of the guarantee the loss will, as far as we can at present judge, be comparatively nominal, owing to the additional 9d. that was added to the tariffs at the request of the Colonies having come into force on January 1st last, and to the abnormally large traffic that was carried a few months ago, when the bank reconstruction schemes were being arranged. You have heard a good deal about the New Caledonia cable. That cable has now been laid by the French company to which I referred at the last meeting. It has received from the Queensland Government a small subsidy of £2,000 a year, and a similar subsidy has been received from the Government of New South Wales, while the French Government have given a guarantee of £8,000. Its promoters have claimed for it that it is the first link of the much-talked-of Pacific cable between Australia and Canada, but after the strong opposition displayed to it both in the Colonies and on this side, it is not likely to be anything more than a local line, and as a local line it will be rather a "feeder" to us than a competitor. As to carrying this line through the Pacific at the present moment, there is no earthly use for it, and if one may judge from the financial position of the respective Colonies, they are not likely to spend money for an object which they have already attained, namely, a reliable service. Governments do not go into transactions of this kind for the purpose of losing money, and if they were to endeavour to introduce any such system in opposition to commercial enterprise, I am perfectly sure that they would not have the sympathy of either England or of their own Colonies. It might cheapen the tariffs a little, but I think that with the position we occupy now—not only through our reserve fund, which is large, but also through our financial arrangements with the Colonies—they are not likely to become parties to any large amount in any such arrangement. The Governments of Queensland and New South Wales have already been called to account for what they have done, and if I may judge from the tone of our own Government and the feeling here, I think this matter is not likely to go further for a very long time to come. When another system is required for connecting the old country with the Australian Colonies you may depend upon it that we shall have a finger in the pie (applause). I will now refer to a subject which should be a lesson to those who aspire to lay cables. It is also a satisfactory matter to us that, having looked so far ahead, we have been able to avert what might at the present moment have been a very serious state of things indeed. Only last week both our Port Darwin cables became interrupted within a few hours of each other, many hundred miles apart, and but for our third cable to Western Australia the Colonies would have been entirely cut off from telegraphic communication. Fortunately we had a repairing vessel available close by, and within a few days we hope that both cables will be repaired (cheers); but similar troubles arising from inequalities of the bottom and coral landing places would most certainly occur in the Pacific, making it absolutely necessary to provide a duplicate line, with at least two maintenance ships, and a large sinking fund, which would require to be got out of earnings, to replace the cable within a reasonable period (hear, hear). I think that that will show you that those who do not know much about cables—if they will benefit by the experience of those who possess such knowledge—should think twice before they spend money upon a new system when there is a thoroughly good service already in existence that can do all the work that is required (hear, hear). At the last general meeting reference was made to negotiations that had been in progress for a good many years for strengthening the China section of the Company's system. I may tell you that for the last 10 years we have been working, not only with the Colonial Office here, but with the Straits and Hong Kong Governments, on the subject. We endeavoured to obtain from them a concession with some subsidy for the work we proposed to do. We have one cable there, and it is a very valuable link as far as it goes; but I have just shown you that our experience clearly points to this—that where commerce is being based, as it is now, on telegraphic communication, a single line is not sufficient to

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maintain the regularity of such a system. We have nearly duplicated the whole of our cables, and we have endeavoured to duplicate this line that I am now referring to by obtaining from the Government advantages which we thought we were entitled to. We have not succeeded in getting money, but within the last two days we have signed and sealed an agreement which will justify us in laying another cable from Singapore to Hong Kong, connecting en route Labuan, near to British North Borneo, which has hitherto been without telegraphic communication with the rest of the World. If we have not got money we have obtained certain privileges and advantages, of which I am not prepared to tell you all the details to-day, but of which by-and-by you will know something more. I think, however, that I may say this—that what we have obtained will be quite as valuable, if not more so, than if we had got the money we originally asked for (applause). You will have seen in the report the allusion made to the loss we have sustained by the death of our esteemed and valued colleague, Sir James Anderson, who, as you know, was connected with this Company from its inception. As an old sea captain he knew a good deal about the details of ships and cables, and he was altogether a most excellent and valuable colleague. As an old friend of his I need not say that I feel his loss very much; but I may also add that we have now placed our system upon such good foundations that with careful attention and the oil that is necessary to be applied to the working of any great machine, it will run perfectly smoothly, so that we may continue to occupy the proud position which we now hold and upon which we may all congratulate ourselves (applause). I believe there are very few chairmen who have had of late the opportunity of submitting to their shareholders, as I have done to-day, such a very satisfactory report on the past six months' working, and you may well be proud of it (hear, hear). This is not the bonus period; that will be at the end of the next six months. Meantime, I can assure you, without any hesitation, that the system is being worked now in as satisfactory and prosperous a manner as it has been at any period of our existence. The vacancy that was caused by the death of Sir James Anderson has been filled by the appointment of Sir Albert J. Leppoc Cappel, K.C.I.E., late Director-General of the Indian Government Telegraphs, to a seat at the Board. The experience of Sir Albert Cappel during his long residence in India, and his connection with the telegraph system there, was his qualification for joining this Board, and I may tell you that in making these appointments we act with the view of giving the utmost strength and stability to our telegraphic system. You will have also seen from the report that in consideration of the ever-increasing duties and responsibilities devolving on the management, and to the fact that the duties of Managing Director have been performed by myself without salary ever since the death of Col. Glover twelve years ago, the Board have thoughtfully—and I might almost say wisely—proposed, as I have performed the duties, to add to my remuneration the salary that used to be paid to the Managing Director (cheers). I am very glad to hear that indication of your approval, because in my quarter of a century's connection with submarine telegraph cables it has been my experience generally—not so much in the last ten years, but previously—that the great aim and object of these meetings was apparently to cut down Directors' fees (laughter). But I must tell you plainly that if you want good men—men who have brains to apply to the work, time to devote to it, and who have ambition to make what they are attending to a marked success, you cannot pay them too well. I do not believe there is a single Director who sits here for the purpose of simply earning his fees, but we all know the value of money. We know that time is money, and where men give up their time to work like this, and make it as marked a success as we have done, I think they ought to be paid well, and I am pleased to find that the shareholders approve of such action as that which I have just mentioned. I think I have now given you probably as much information as it is in my power to give you to-day with respect to the last six months' working of the Company. I hope that by the time I meet you again our duplicate China cable will have been laid, and that I shall be able to tell you that we stand in a position not only satisfactory to the public generally, but equally satisfactory to the shareholders also (applause). With these remarks I beg to move

"That the report and accounts of the Directors now submitted be received and adopted."

The Most Hon. the Marquis of TWEEDDALE: I beg to second that motion.

The CHAIRMAN then expressed his readiness to answer any question which the shareholders might desire to ask, but no one rising to address the meeting, he put the motion in the usual way, and having declared it carried unanimously, added: That is the whole of our business to-day.

Mr. GIVENS thought that the shareholders should not separate without offering a hearty vote of thanks to the Chairman and Directors for the admirable way in which they had managed the business of the Company hear, hear). He concluded by moving a resolution to this effect.

Mr. CLAY seconded the motion.

Mr. H. T. BURGESS, in supporting the resolution, said he thought the shareholders would be very much wanting in gratitude were they not to recognise by a hearty vote of thanks the splendid management of the Chairman and Directors (applause).

The resolution was thereupon put to the meeting and carried unanimously.

The CHAIRMAN: I am very much obliged to you, and I thank you on behalf of my colleagues and myself for what I may call a full and fair recognition of the Directors' services. As I have said before, I think the more that confidence can be established between the shareholders and the Board, the more satisfactory and prosperous the Company will be. That has been our policy throughout; it will continue to be our policy, and I hope I shall always be able to show you such good results arising from that policy as I have done to-day (hear, hear).

The proceedings then terminated.

Aluminium Company (Limited).

The sixth annual ordinary general meeting of this Company was held at the Cannon-street Hotel yesterday, under the presidency of Mr. Gerald W. Balfour, M.P.

The SECRETARY (Mr. G. H. Clarkson) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN, in moving the adoption of the report and accounts, said that the misfortunes and disappointments of the Company had been so often referred to at their previous meetings that it was a double pleasure for him to come before them on that occasion with words of encouragement and hope. The tide had indeed begun to turn when he last addressed them, but during the financial year which preceded their last meeting the trading account still failed to exhibit a profit, although a great improvement was shown. On the present occasion, however, they were able to announce a trading profit of £7,000, and that was not all. Their business had been, and was, a growing one. In the first four months of the financial year they were now considering—that was to say, June, July, August, and September, 1892—they did not make any trading profit, but a loss of £2,500, which was owing, however, to very special causes. During the following eight months, on the other hand, they made a profit of about £10,000, and their average daily output for this period was 2½ times greater than it was during the first four months in which they incurred the loss of £2,500. Further increases had since been made, and their average daily output at the present time was 4½ times what it was during the first four months of the year under review. Assuming, therefore, as they were entitled to do, that the trade profits would be increased in proportion, they were now making at the rate of over £25,000 a year. During the last few months they had granted a licence to one of the most important chemical firms in Germany to manufacture under their patent. The plant would be at work in a very short time, and the royalty payable under their licence would go to increase their profit. Deducting from the trading profit mentioned their fixed charges of £10,000, of which £7,000 represented debenture interest, the sum of £15,000 would be left to provide for depreciation and dividend on the "A" shares. This was assuming that the proposals which the Directors made for reducing the capital were accepted by the shareholders. Their present success had been achieved in the face of great difficulties, the nature of which might be understood when he stated that at the present time there was hardly a single one of the processes with which they started still in use at Oldbury. In fact, the title of the Company had become a misnomer, since they no longer produced aluminium. They had developed the trade in sodium, partly by finding new uses for it, and partly by reducing the cost of production. They had made contracts with all the principal users of sodium over a considerable number of years, and there was not very much fear that they would be exposed to competition even—which they did not think at all probable—if someone were to invent a process by which sodium could be made and sold profitably at their present price. One material which they manufactured—peroxide of sodium—was a completely new commercial product; they already had a large business in it, and it was showing signs of being likely rapidly to increase. In fact, he thought it was not too much to say that peroxide of sodium would probably eventually supersede all other bleaching materials in certain particular lines. The change of front which they had been obliged to execute had not been made without heavy loss, and it had long been evident that they would have to write down their nominal capital very largely. They had, however, felt that it was useless to take this step—the operation involving a large amount of expense—unless and until their doing so would be likely to make a dividend possible. In the opinion of the Directors this time had now arrived. He wished to point out that the writing down of the capital could not possibly affect the real value of the Company's property, but what it did influence was the power of the Company to pay a dividend. Unless they wrote down their capital they would be unable to divide a penny of dividend until they had made good their losses, and if the shareholders desired to see any immediate return on the money they had invested in the Company it was absolutely necessary for the capital to be written down. They might say, perhaps, that it was rather a drastic measure to reduce the capital as the Directors proposed, from £5 a share to £1 a share, but he would remind them that it was impossible for them to write down their loan capital, which, however, they expected to be able eventually to get rid of altogether, when the market value of their shares would rise in proportion. With respect to the new electro-chemical process invented by Mr. Castner, the matter was referred to at their last meeting, when, however, a careful reticence was observed with respect to the character of the process. The causes for this reticence no longer existed, and he might tell them that the process was for the manufacture of caustic soda and chlorine direct from common salt by electrolysis. The manufacture of caustic soda and bleaching powder was one of the most important chemical industries in the country. He was expressing the opinion of great authorities when he said that all processes now in use for the manufacture of these materials must give way to an electrolytic process, and they believed that they were first in the field with an electrolytic process which was of a thoroughly satisfactory character. All the hopes which they held out at the last meeting as to the value of this process had, they believed, been amply realised. It was a process that turned out the material in a state of chemical purity—a thing unknown to commerce up to the present time, and they believed that it could be produced at a very much lower price than at present. Those who were concerned in electrical processes might be interested to hear that the process he was referring to reached an efficiency very close to the margin of what was theoretically possible, and therefore he did not see that any invention of a similar kind was likely to improve upon it. The process was in work at Oldbury not on a miniature scale, but on a scale which would be employed in actual practical manufacture, and there was nothing now experimental about it, except in so far as they might gather further information regarding the amount of wear and tear caused by long and continuous running. Their experience during the past year

in working this process had been most valuable, and it had resulted in their filing two additional patents in connection with it, and this, of course, added very materially to the strength and the value of the original patent. The Directors believed that the process was one of extreme value, and their hope—for which they had good grounds—was that ultimately it might be the means of returning to the shareholders a considerable amount of the capital which it was now proposed to write off.

Sir HENRY E. ROSCOE, M.P., F.R.S., in seconding the motion, referred with satisfaction to the improvement in the position of the Company. The demand for the sodium and the peroxide of sodium which they manufactured has been increasing, and there was every prospect of this continuing. They were greatly indebted to all who were connected with the works at Oldbury, and especially to Mr. Castner, for the efficient manner in which the two processes were carried on. The new process referred to by the Chairman originated in an endeavour on their part to prepare a pure article of caustic soda. The reason they started the new process was to enable them to manufacture sodium at a cheaper rate than they could do with the article on the market, which was the only article they could purchase. From that grew up the larger view of the question referred to by the Chairman, whose statement he could endorse that in future the mode of making this most important article—which was now made not by the ton, but, perhaps, by hundreds of thousands of tons—would be by a process similar to that which the Company now had in hand The question was, How far their process was the one that would be worked? and all they could say was, from what they knew of other proposals as well as their own, that they believed theirs would hold the field. On that point, however, they would know more at their next meeting.

A short discussion followed, and in answer to questions,

The CHAIRMAN stated that the "B" debentures had in no way impaired the securities of the holders of the "A" debentures. They sold their material as rapidly as they made it. It was always advisable not to be too sanguine; but the Directors honestly believed that they were not too sanguine with respect to the new process to which he had referred. After careful consideration, the Directors came to the conclusion that as they had made losses equivalent to the amount they proposed to write off, it was better to reduce the capital to the extent mentioned. He then put the resolution, which was carried unanimously.

The retiring Directors, Lieut.-Gen. Sir Andrew Clarke, R.E., G.C.M.G., and Mr. John S. Parkin, were then re-elected, as were also the auditors, Messrs. Broads, Paterson and Co.

An extraordinary general meeting was held subsequently, when

The CHAIRMAN proposed a resolution for reducing the capital from £400,000 to £80,000, divided into £60,000 "A" shares and 20,000 "B" shares, such reduction to be effected "by cancelling capital which has been called up but is unrepresented by available assets to the extent of £4 per share upon the 80,000 shares which have been issued and are outstanding, and by reducing the nominal amount of all the shares in the Company's capital from £5 each to £1 each."

The motion was seconded, and was carried with one dissentient, an amendment to the effect that the reduction in the nominal value of the share should be to £2 instead of to £1 not being seconded, and, therefore, falling through.

A vote of thanks to the Chairman and Directors was then proposed and carried unanimously.

Monte Video Telephone Company (Limited)

The annual ordinary general meeting of this Company was held at the offices, Gresham House, Old Broad-street, on Tuesday, Mr. Herbert Ward presiding.

The SECRETARY (Mr. E. M. Reiss) read the notice calling the meeting.

The CHAIRMAN, in moving the adoption of the report and accounts, said: Gentlemen, I will first call your attention to the statements contained in the two first paragraphs of the report. You will observe that during the year ended July 31st last our net profits amount to the sum of £6,895. 17s. 6d., which is about £500 more than the net profits of last year, and it must be remembered at the same time that last year's profits showed an increase of £1,622 over the previous year, so that there is no doubt that the Company's operations in Monte Video continue to make satisfactory progress, notwithstanding the prevailing hard times in Uruguay. The strictest economy has been observed in all matters relating to the general working of the Company, and all the *employés* have been called upon to bear reductions in their salaries, which I must add they have all done most cheerfully. The central office building in Monte Video has now become the unencumbered property of the Company, the last instalment of the purchase having been paid on March 6th last, since which time we have received regular monthly drafts from the manager. One of your Directors has only just returned from Monte Video, and I am happy to be able to inform you that he is thoroughly satisfied with the manner in which our business is conducted by the manager and his staff, and also with the condition of the Company's property; thus you will observe that the most recent report coincides with and corroborates statements referring to the same subject contained in my own report of last year after my visit to Monte Video. The number of paying subscribers is now 1,383, showing an increase for the year of 53, and with a return to more normal conditions in commercial circles generally in Uruguay there is no doubt the number would be substantially increased. The Directors have to announce that the Committee of the London Stock Exchange granted on June 12th last an official quotation to the Company's shares, both Preference and Ordinary. I now beg to move that the report and accounts be received and adopted, and shall be pleased to answer any questions or give any further information that proprietors may desire.

Mr. C. H. SANFORD seconded the resolution.

Mr. LOCK said that he would like to revert for one moment to the subject which he had the pleasure of discussing with the Chairman and Mr. Sanford that morning, and that was with regard to the way in which it was proposed to deal with the net profit for the year. It would no doubt be remembered by the shareholders that last year a considerable sum was made in net profit, and the whole of it was retained by the Board for the purpose of paying off part of the purchase price of the premises acquired in Monte Video, an object most desirable, but one which ought to have been dealt with strictly in the interests of the Preference shareholders. On the present occasion the same course was proposed, and the money which had been earned had been intercepted, as it were, by the Board, who, instead of paying the dividend to the Preference shareholders, proposed to take the money and use it for capital expenditure. Last year it was admitted by the Board at the general meeting that the net profit shown in the account was the property of the Preference shareholders, and it was a mistaken idea that the Board had the power to use that money as capital expenditure; and, therefore, instead of adopting the report, the Directors consented to modify their views on the subject, and they themselves proposed a dividend of, he thought, 3 per cent. per annum. On the present occasion he did not see how the Directors could do anything but adopt the same course, as the money belonged as much to the Preference shareholders this year as it did last year, and that being so it was difficult to understand how it was that the Directors had come to the conclusion to utilise the balance of net revenue for the purpose of paying the sum of money due for the Monte Video premises. On those grounds he asked the Directors to again modify their views, and propose a small dividend payable to the Preference shareholders as they did on the last occasion. He did not think that the Preference shareholders were at all anxious for the money itself, it would be quite sufficient for them to know that their rights were acknowledged. He proposed that a dividend of 4 per cent. or 5 per cent. should be declared, and as to the means of paying it he felt sure that the Preference shareholders would be only too glad to accept debentures or some such similar security.

Mr. PRAED said that he thought the Directors ought to take steps to prevent the spending of more money in Monte Video, which clearly should be paid in dividends to the Preference shareholders.

Mr. BALFOUR said that he must take entirely a different view of the subject. The Company was not in a position to raise further capital, and so he considered that the Directors were clearly justified in using the money in the manner they had. He thought that it was the duty of the Directors to get rid of, and not increase the paper money of the Company, and it was certainly the wisest and strongest policy to start in the future with a clean balance-sheet.

Mr. C. H. SANFORD (a Director) said that Mr. Lock asked the Board to recommend a dividend of 4 per cent. or 5 per cent., which was more than they had earned, without putting aside anything for depreciation. Such a course would be most absurd and disastrous, and he did not wish, as a Director of the Company, to do anything that would not bear the strictest investigation. They had taken since they first acquired the business £19,000 from the shareholders for the purpose of improving the property, and they had only failed to pay the dividend on the Preference shares because they had been obliged to pay for the purchase of the central premises. Of that sum, £2,737 might be said to have been contributed by the Preference shareholders in the last two years, and the rest by the Ordinary, and he considered that all the Preference shareholders should support the Board, and help to maintain the value of the shares and the reputation of the Company. The Directors had, in the bad times through which the Company had passed, managed by the strictest economy to show a better result than had been laid before the proprietors in good times.

Mr. LOCK said that he thought the only shares which had benefited had been the Ordinary.

Mr. C. H. SANFORD said that was not so. He had taken legal advice from his own solicitor on the matter of the dividend, and he had been told that in order to declare a dividend they would have to adjust the accounts and return to the Ordinary shareholders what had been taken from them. In answer to a question as to whether the Board expected any further heavy expenditure under the head of construction, he said that it was quite impossible for him to answer such a question definitely, but he could go so far as to say that the Board did not expect anything of the kind.

Mr. TOUCH said that he did not quite understand the question which had been raised with regard to adjusting the accounts. He thought that if the accounts had been passed in previous years, and a dividend had been paid, and if there was now a balance in favour of the Company, the Preference shareholders were entitled to receive that balance in dividends.

Mr. C. H. SANFORD said he had been legally advised that the adjustment must take place, and that the Company should raise money by debentures, if necessary all the shareholders contributing, and so make up the money they had expended on capital account. He had been advised that the Board had no power to declare a dividend in paper, as had been proposed.

Mr. TOUCH said that the difficulty with regard to the dividend arose from the fact that the shares were not cumulative. The Company had made the necessary profit to declare a dividend, and he thought it ought to be done; but the Preference shareholders could agree, instead of taking the money which the Company was in so great a need of, to accept promissory notes as they did last year, or the Board could give them debentures. It was only fair, he thought, that as the shares were not cumulative, the profits should be secured to them in some such manner.

Mr. C. H. SANFORD said he had been blamed for what had taken place last year, by one of the Preference shareholders. The Board could not declare a dividend and say that it was to be paid in paper as they had been advised to the contrary.

In reply to a question, the CHAIRMAN stated that they had no fear of the opposition Company in Monte Video.

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After some further discussion, Mr. TOUCH moved the following amendment :—

"*Resolved, that the report and accounts be referred back to the Directors, in order that they may recommend the payment of a dividend of 3 per cent. per annum to the holders of the non-cumulative Preference shares of the Company.*"

And also the following resolution :—

"*That the Preference shareholders agree to lend the amount of the above dividend to the Company until such time as the Company is in a position to repay the same interest running thereon at the rate of 4 per cent. per annum until repaid.*"

Mr. ELLIAS seconded the motions.

Mr. JONES said that if the resolution were passed it could do no good.

In answer to Mr. Praed, Mr. SANFORD said that the Board did not anticipate they would have to take the revenue of the Company in the future for the improvement of the property, and the shareholders might rest content that such a thing would not be done if the Board could possibly avoid it.

Mr. PRAED suggested that the amendment should not be pressed.

The amendment was put to the meeting and lost.

Mr. TOUCH demanded a poll, and a difficulty arising as to the three shareholders necessary to make such a demand, the CHAIRMAN said that in order to take a poll as it was the desire of Mr. Touch, Mr. Sanford (one of the Directors) would make a legal demand for one.

Mr. SANFORD moved the re-election as a Director of Mr. E. F. Powers, which was seconded by Mr. JONES, and carried unanimously.

Mr. BALFOUR proposed Mr. Frank William Jones as a Director, and Mr. SANFORD seconded.

Mr. TOUCH moved that the question of electing a new Director be deferred for the present.

The election of Mr. Jones was ultimately agreed to.

Messrs. Gérard Van de Linde and Son were re-elected auditors of the Company.

Subsequently the CHAIRMAN declared the following result of the poll :—For Mr. Touch's amendment, none ; against, 21,785. For the Chairman's original resolution, 16,785 ; against, none. The amendment was therefore lost, and the original resolution carried.

A vote of thanks to the Chairman closed the proceedings.

International Okonite Company (Limited).

An extraordinary general meeting of the International Okonite Company (Limited) was held at Cannon-street Hotel, on Friday, October 27th, (1) to consider and, if thought fit, to pass a resolution to the effect "That the name of the Company be changed to 'The Okonite Company (Limited).'" (2) To consider and, if thought fit, approve the draft alterations in the Articles of Association of the Company submitted to the meeting. These resolutions to be submitted for confirmation as special resolutions to a second extraordinary meeting to be subsequently convened. Mr. Samuel Pope, Q.C., presided.

Mr. A. B. SEYMOUR (the Secretary) read the notice calling the meeting, and the proposed alterations in the Articles of Association were circulated amongst the shareholders.

The CHAIRMAN said that the meeting was of a special nature to consider resolutions for which the shareholders had already had notice. He would explain the position to them as clearly as possible, and detail the circumstances that had led to the calling of that meeting and the prospects of the Company. He could not allow any wide and general discussion however to take place. The history of that meeting was simply this :—It was a meeting called by the Directors in compliance with the wishes of a large section of the share and debenture-holders in the Company, representing about half the capital. It would be recollected that at the last meeting reference was made to the hopes that the Directors indulged in of success at Manchester. The position of matters on the other side of the Atlantic was that the Company was doing very good business indeed in New York, and making a satisfactory profit upon its operations, but at Manchester they had unfortunately been making losses, and the profits made in America had to go against the losses on this side of the water. The American board felt that this state of things could not continue, and they, therefore, sent a deputation from their body over to England, in order to see what steps should be taken to put an end to such an unsatisfactory condition of things. They arrived at the conclusion that the best course to pursue was to at once close operations in this country, and to really confine the business of the Company to America, where a profit was being made. Accordingly, in April last it was decided that the best course to pursue in the interests of the shareholders was to close the Manchester works, and as far as possible to get rid of all liabilities upon this side. The Board decided, however, to retain office until they met the shareholders and laid the position of affairs before them. They determined, however, not to take fees for doing practically nothing, although they had the right to draw fees and to remain in office till the year 1895. They felt that "it would be monstrous to draw their fees out of the Company practically for doing little or nothing." Their object was to make the Company successful. They had, within the last few days, received an encouraging statement from the other side in regard to the American business, and an independent investigation had been made at the instance of one of the members of the Board, and he stated that the result of that was that he was informed that the Okonite Company was one of the few commercial concerns in America that in the recent times of depression had made a satisfactory profit. The latest advices led them to believe that for 1893 the debenture interest would be paid, the Preference dividend, and a surplus left for the Ordinary shares. Therefore the present proposals were greatly to the benefit of the Ordinary shareholders, because there was no losing English business left to deplete the American profits, and since the Preference dividend was provided for already, all the surplus went to the advantage of the Ordinary shareholder. If times improved later on, and it was deemed advisable to do so, they might resuscitate the English business. If the resolutions were carried that day the Board in England would cease. He concluded by calling upon Mr. Short, one of the American Directors, to address the meeting, and afford any further particulars, and moved the approval of the resolutions.

Mr. SHORT seconded the motion, and said that it had been forced upon the American Board, and that there was no alternative but to take the course that they had done. It did not seem to American ideas to be the correct thing that they should be making profits there, and continuing a business in England which not only made no profits but involved a considerable loss. The position of the Company was such that they were unable to take advantage of market fluctuation in rubber, and they must have sufficient funds to enable them to do so, and to be independent of the banks. They were getting considerable orders in America, and he advocated the carrying of these amendments as essential to the well-being and future prosperity of the Company.

The CHAIRMAN said that the matter was now open for discussion.

A SHAREHOLDER : Have you sold the factory at Manchester ?

The CHAIRMAN : No.

ANOTHER SHAREHOLDER : Can Mr. Short tells us as to the likelihood of any dividend ; then we shall be on surer ground. I do not want a pledge.

Mr. SHORT : In regard to this it is very difficult to answer, and it is hardly worth while making a statement unless it can be made with some assurance ; but I can say this, that sooner or later we shall pay a dividend.

Mr. DOBREE, a Director, thought that was not a very hopeful way to put it.

Mr. SHORT said he meant that they would pay within a year or so, and in reply to another remark he said he thought they would pay the Preference dividend within a year.

The CHAIRMAN : Within this year ?

Mr. SHORT : Within the coming year.

The CHAIRMAN said that the latest statement from the other side to which he had already referred encouraged the belief that the result of 1893 would be to pay interest on debentures, dividend on Preference shares, and leave a surplus for ordinary dividend.

Mr. J. PUCKERIDGE asked the nature of the assets at Manchester, and if readily realisable.

The CHAIRMAN said that they consisted of freehold and leasehold premises, plant, and machinery. It was difficult to say what could be realised in the present depressed times, for instance, he should not regard a mill as readily realisable. Leakage had been stopped at Manchester. The liabilities were practically nil.

Mr. HOPPS said that he too had had an independent opinion from the other side as to the Company, which was of a most unsatisfactory nature, and he spoke of the manner in which it was regarded in Wall-street.

A disjointed discussion followed, in the course of which the CHAIRMAN said that they were not there to consider the question of what the Board did in getting rid of Messrs. Shaw and Connolly at Manchester. The success that they expected did not follow the steps taken, and this was due to the financial troubles in America. The question before the meeting was to amend the Articles of Association.

Mr. BOND wished to know if there had been an established loss of capital, and if it would affect the dividend when earned ?

The CHAIRMAN said it would not affect the dividend.

Mr. BOND said there were learned opinions to the contrary.

Mr. SHAW then proceeded to discuss the first alteration, viz., to rescind Article 35 and substitute the following :—"The Directors may accept surrenders of shares on such terms as they think fit," without any proviso. It was his desire that that Article should contain a proviso preventing the Company from investing money in its own shares or lending money upon the security of its own shares.

Mr. FREDK. RAWSON said that it seemed this resolution put the Company entirely into the hands of the American Board. He asked how many American Directors there were ?

Mr. VAUGHAN STEVENS (the Managing Director) said four.

The CHAIRMAN, in reply to a question, said that the Directors had not asked for proxies.

Mr. RAWSON asked if the American representative had a proxy from the American Directors, and how it would be used ?

Mr. CLEMENTS, the American representative, said that he had proxies for 5,366 Ordinary, 10,891 Preference shares, and the instructions from his principals were to vote for the amendments given notice of by the Board without amendment or modification, and he should do so.

Mr. RAWSON : That settles it then. We are in the hands of the Americans.

The CHAIRMAN said that the election of two new Directors, provided for by the new Articles, after the retirement of the present Board, was a matter for a future meeting.

Mr. RAWSON said that he had confidence in Mr. Short, the American Director. He (the speaker) had £8,000 in the Company, and he thought the shareholders in England ought to back up the English Board in refusing to do anything unless their views in this matter were accepted.

Mr. SHAW said he had given notice of six amendments, and he meant to read them.

Mr. HOPPS seconded Mr. Shaw's amendment.

Mr. BOND assumed that the American votes could carry the amendments by more than a bare majority.

The CHAIRMAN : More than half the capital.

Mr. BOND asked the effect of altering Article 35 in regard to the Stock Exchange quotation.

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The CHAIRMAN said that he believed, if the Stock Exchange Committee choose to act upon it, that alteration of Article 35 would deprive the Company of their Stock Exchange quotation. He (the speaker) thought it a wrong amendment, and the English Board had urged the American Directors not to persevere in it, but they had been determined. He would be glad if Mr. Clements could be induced not to use his votes for that amendment.

Mr. CLEMENTS said that his instructions were positive, and he had no option in the matter.

The CHAIRMAN said it was practically impossible to unite against the block of nearly half the capital represented by the American Board.

Mr. RAWSON asked if a three-fourths majority was necessary.

The CHAIRMAN: No.

A SHAREHOLDER said that he was speaking in regard to Section 51 of the Act. If he was right in the fact he was right in the law.

The CHAIRMAN then said they must have three-fourths of those present.

In reply to a question the CHAIRMAN said that if he demanded a poll it would have the effect of wasting the time and money of the Company. They could not win against the American Board. The object of the alteration of Section 35 was to facilitate, he suspected, the different methods of American finance.

A SHAREHOLDER said it would prevent the sale of shares here.

The CHAIRMAN: There is no market.

Mr. RAWSON urged for an adjournment of the meeting, or a poll of the shareholders.

The CHAIRMAN: If you can get five shareholders, representing a fifth of the capital, demanding a poll I am bound to accept it.

Major JONES said he agreed with Mr. Rawson, and he would throw his own large holding into the scale.

A SHAREHOLDER: Perhaps Mr. Short can explain why the Directors in America insist upon this, and whether they know the probable effect would be to deprive us of a Stock Exchange quotation in London?

Mr. SHORT reviewed his connection with the Company, and said that if there was any special and particular motive in the amendment of Article 35 it had not been made known to him. He approved of the general policy of the American Board.

Mr. RAWSON suggested an adjournment and the appointment of a committee of three shareholders to send a "whip" round to defeat the American Board.

The CHAIRMAN: Nothing could be worse policy than to act in a spirit of hostility to our American colleagues.

After some further discussion the CHAIRMAN appealed to Mr. Clements as to whether he was compelled by his instructions to carry the alteration in the Article now under review (No. 35).

Mr. CLEMENTS suggested that all the motions should be carried to-day, as his instructions were definite, and that before the confirmatory meeting he would refer to the Board on the other side the views of the shareholders, with his own opinion thereon. He invited Mr. Shaw to send in his objections in writing.

Mr. RAWSON said that he thought Mr. Clements was "drawing a red herring across the trail," as the second meeting only required a bare majority. Mr. Clements was acting for the American shareholders.

The CHAIRMAN said then he should put the resolution, prefacing it by the remark that the meeting had given expression of considerable sympathy to Mr. Shaw's amendment, and reserved its right to impede or destroy the position of affairs at the subsequent meeting.

The CHAIRMAN then put the alteration to Article 35 to the meeting, and declared it carried.

Mr. SHAW asked that his amendments might be read.

The CHAIRMAN remarked that they had omitted to pass the first resolution for the alteration of the name of the Company, leaving out the word "Interna'ional" from the title of the Company, the name remaining "The Okonite Company (Limited)."

Mr. CLEMENTS then proposed, and Mr. STEVENS seconded, the change in the name of the Company, which was carried.

Mr. CLEMENTS then moved the other alterations *en bloc*, and Mr. STEVENS seconded.

Mr. SHAW moved his amendments, which were then read by Mr. STEVENS.

The CHAIRMAN said he did not agree with all of them.

After some further discussion the other resolutions were put *seriatim* and carried.

On the motion of Mr. CLEMENTS, seconded by a SHAREHOLDER, a vote of thanks was accorded to the Chairman, and the proceedings (which lasted two hours) terminated.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, pages 320-348, *&c., &c.*]

CENTRAL AMERICAN PUBLIC WORKS COMPANY (LIMITED).—The objects of this Company, which was registered on October 26th, with a capital of £100,000, in £10 shares, include the following:—To purchase, acquire, or construct, or cause to be manufactured, wires and cables of all kinds for the purpose of telegraphs and telephones, to lay and work the same, and to carry on the business of telegraphy and the transmission of messages in all its branches and in all parts of the world.

PATENT PLATE STRUCTURE COMPANY (LIMITED).—This Company was registered on October 25th, with a capital of £10,000, in £5 shares, to carry on the business of mechanical engineers, iron and brass founders, machine and engineering tool makers, metal workers, boiler makers, &c.

LONDON AND HAMPSTEAD BATTERY COMPANY (LIMITED).—The first annual return of this Company, which has just been filed, shows that out of a nominal capital of £50,000, divided into 7,000 £6 per Cent. Cumulative Preference and 3,000 Deferred Shares of £5 each, 615 of the Preference and all of the Deferred Shares have been subscribed for and allotted. The whole of the Deferred Share capital has been issued as fully paid. Upon 249 of the Preference Shares the full amount has been called, and upon the remaining 366 shares a call of £3. 10s. has been made. The calls paid amount to £2,170, leaving the sum of £356 in arrears.

FORD-LLOYD MANUFACTURING COMPANY (LIMITED).—The statutory return of this Company, made up to October 18th, has been filed. The nominal capital is £10,000, in £1 shares, and 4,207 of these have been taken up, of which 4,000 were issued as fully paid to Edwin J. Tumber and Arthur Ford-Lloyd, in consideration for the sale to the Company of the business of electrical engineers carried on at 8, Mount-pleasant, Clerkenwell, E.C., including the sole rights of sale in connection with the E. S. Dry Battery. Upon the remaining 207 shares the full amount has been called and paid.

HALIFAX AND BERMUDAS CABLE COMPANY (LIMITED).—The usual annual return of this Company, made up to October 4th, shows that the whole nominal capital of £50,000, in shares of £5 each, has been issued as fully paid, the paid-up capital being nil.

CITY NOTES, &c.

ALUMINIUM COMPANY (LIMITED).—The report for the twelve months ended June 30th last states that the Oldbury trading account shows a profit of £7,245, but this amount was not quite sufficient to meet all fixed charges at the head office, including debenture interest. The volume of the Company's business has increased very rapidly during the last few months. The Directors think this a suitable time to re-arrange the capital, and at an extraordinary meeting a resolution will be proposed to write off £4 per share, thereby reducing the nominal value of £1 per share. The Directors believe that the present income of the Company will be sufficient to meet all fixed charges, to provide adequately for depreciation, and to leave a balance for dividend on the reduced share capital.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended October 29th were £848, as against £889 for the corresponding period of last year, being an decrease of £41. The total receipts for the half-year amount to £13,766, against £13,509 in the corresponding period of 1892, being an increase of £257.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the month of October, 1893, amounted to £61,409, and to £61,069 in the corresponding period of 1892.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the month of October, 1893, amounted to £41,443, and to £43,342 in the corresponding period of 1892.

ELECTRIC AND GENERAL INVESTMENT COMPANY (LIMITED).—The Directors have declared an interim dividend on the capital paid up on the Ordinary shares of the Company at the rate of 10 per cent. per annum for the six months ending November 30, 1893, the dividend to be payable on and after December 1st next.

GENERAL ELECTRIC COMPANY (OF AMERICA).—The Board of Directors have made an interesting announcement to the stockholders concerning the sale of the treasury securities, which it is declared have a nominal value of $12,000,000. These securities have been sold to a syndicate which has formed a company to be known as the Street Railway and Illuminating Properties, for an amount understood to be $4,000,000, and this money will be used to take up the Company's floating debt. 45,000 shares of Preferred stock of the new company and 45,000 shares of Common stock are to be issued against these $12,000,000 securities, which are bonds and stocks of local street railways and illuminating companies which the General Electric Company has received in payment for plants and for royalties. Many of the securities are paying dividends, and the syndicate estimates that these dividends will be equal to a 6 per cent. dividend on the $4,500,000 Preferred stock by the new Company, or $270,000, and "substantial sums on the Common stock." The shares of the Street Railway and Illuminating Properties are offered to the General Electric stockholders in blocks, each block to consist of one Preferred and one Common share. The price for each block will be $100, and all stockholders of record at the close of business, October 27th, holding eight shares, will be enabled to subscribe for one such block.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to appoint a special settling day and to grant a quotation to the Perpetual Four per Cent. Debenture Stock of the City and South London Railway Company.

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WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended October 27, 1893, after deducting 17 per cent. of the gross receipts, payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,704.

STOCK EXCHANGE.—Wednesday last being the 1st November, the London Stock Exchange was closed; hence the following prices of securities are made up to Tuesday evening, instead of Wednesday evening, as usual.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Oct. 25.		Price Tuesday, Oct. 31.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Oct. 31. Highest	Lowest
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,134,640	Stock	12/6	Anglo-American	43	45	46	47	5 17 0	Jan. Apr., July, Oct.	46½	44½
£2,932,680	Stock	25/0	Do Preferred	80	82	83	85	6 9 5	" "	85	80½
£2,932,680	Stock	5/0	Do. Deferred	7½	8	7¾	8¼	..	..	8⅜	7¾
£195,100	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	100	103	100	103	3 17 8	January and July	..	..
130,000	£10	4/0	Brazilian Submarine xd & bonus	12	12½	11¾	12¼	5 6 1	Mar., June, Oct., Dec.	12½	11¾
£36,400	£100	5%	Do. 5 per Cent. Bonds	100	103	100	103	4 17 1	January and July	..	—
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	..	—
$7,716,000	$100	7%	Commercial Cable Capital Stock	135	140	136	140	5 0 0	April and October	..	..
16,000	10	8/0	Cuba Submarine	11½	12½	11½	12½	6 8 0	February and August	12⅛	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	..	..
60,710	20	3/6	Direct United States	11	11½	10⅞	11⅜	6 6 2	Jan., Apr., July, Oct.	11½	10⅞
400,000	10	2/6	Eastern	14¾	15	14¾	15	5 4 0	" "	15¼	14¾
70,000	10	6%	Do 6 per Cent. Preference	15½	16½	15½	16½	3 12 9	" "	16 1/16	—
£1,294,100	Stock	4%	Do 4 per Cent. Mort. Debenture Stock .. xd	115	118	113	116	3 9 0	May and November	116	114½
£105,900	100	5%	Do 5 per Cent. Debentures, 1899	108	111	108	111	4 10 1	February & August	..	..
250,000	10	2/6	Eastern Extension	15	15½	15	15½	4 11 10	Jan., Apr., July, Oct.	15 3/16	15
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113	116	113	116	3 9 0	February & August	..	..
£70,600	100	5%	Do. 5 p. c.(Austln. Gov. Sub.) Debs 1900	102	105	102	105	4 15 3	January and July	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb.,1900	101	104	101	104	4 16 2	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101	104	101	104	3 16 11	February & August	..	..
£200,000	£25	..	Do. 4% Mauritius Sub. Debs.	104%	107%	104%	107%	..	May and November	..	—
180,227	10	1/6	Globe Telegraph and Trust	8⅜	8⅞	8⅜	8⅞	5 1 5	Jan., Apr., July, Oct.	9 1/16	7
180,042	10	6%	Do. 6 per Cent. Preference	15	15½	14¾	15	4 0 0	" "	15½	14 15/16
150,000	10	5/0	Great Northern	20	20½	20	20½	4 3 0	Jan., April, and July	..	..
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	103	106	103	106	4 14 4	March & September	..	..
17,000	25	12/6	Indo-European xd	41	44	40	43	5 16 3	May and November	42	..
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	3 6 8	" "	..	—
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	105	108	5 11 1	March & September	..	—
£100,000	£100	4%	Pacific European Telegh. 4% Guar. Debs. "Red" 1942	102	105	102	105	3 16 11	..	..	—
11,802	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	..	..
3,381	£100 Cert.	35/0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	" "	..	..
15,609	10	5/0	West African Telegraph	5½	6½	5½	6½	7 13 10	January and July	..	..
£260,900	100	5%	Do. 5 per Cent. Debentures	98	101	98	101	4 19 0	March & September	..	..
30,000	10	2/0	West Coast of America	2	3	2	3	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	103	99	103	7 15 4	June and December	100¾	99½
88,321	10	6d.	West India and Panama	1⅛	1⅜	1⅛	1⅜	..	..	1¼	..
34,568	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10	10½	5 14 3	May and November	10⅜	10 1/16
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9	10	9	10	6 0 0	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	106	109	106	109	4 11 9	June and December	..	..
64,242	15	4/6	Western and Brazilian	6¾	7¼	5½	6½	5 15 7	May and November	6¼	5⅝
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5¾	6¼	5¼	5¾	..	..	5½	5¼
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¼	1¾	1	1½	..	..	..	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	103	106	103	106	5 13 2	February & August	..	..
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	103	106	103	106	5 13 2	" "	..	..
$1,214,000	$1,000	7%	Western Union 7 per Cent. 1st Mortgage Building	115	120	115	120	5 16 8	May and November	119	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	105	102	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	..	..	—
224,850	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	—
220,000	£1	4·76d.	Oriental (11s. paid)	3/16	5/16	3/16	5/16	7 18 2	Yearly	..	..
458,867	5	2/6	National	4⅝	4⅞	4¾	5	5 0 0	June and December	4⅞	4 13/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	13½	14½	13½	14½	4 2 9	" "	14⅜	..
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	13½	14½	13½	14½	4 2 9	" "	..	..
90,950	5	2/0	Do. 5% Non-Cumulative 3rd Pref.	5½	5¾	5½	5¾	4 10 11	..	5⅝	..
726,477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully paid)	113	115	113	115	3 8 3	January and July	114	113½
58,000	5	1/0	United River Plate	2	2½	2	2½	..	January and July	..	..
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	..	..
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11¼	11¾	11¼	11¾	..	—	11 11/16	11⅝
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (£4 paid)	12¾	13¼	12¾	13¼	..	—	13¼	12 15/16
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	..	—
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	—	—	—
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	—
8,822	£5	..	House to House Electric	..		..		..	—	—	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		..	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	..	—
30,000	£5	3/4 '92	Liverpool Electric Supply (£3 10s. paid)	4¼	4½	4¼	4½	..	..	..	—
15,000	£5	5/0 '92	Do. (fully paid)	6 3/16	6 7/16	6 5/16	6 7/16	..	..	..	—
111,000	5	..	London Electric Supply	¾	1	¾	1	..	..	..	—
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	7	7½	7¼	7¾	2 11 7	..	7½	7¼
£100,000	Stock	5%	Do. 5 per Cent. Debs. (Bonds of £10, £20, & £40)	104	107	104	107	4 13 6	June and December	..	..
6,452	£10	..	Notting Hill Electric	5	6	5	6	..	—	..	..
19,980	£5	9½%	St. James' and Pall Mall	6	6½	6	6½	..	—	..	..
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	—	8¼	..
59,900	5	1/6	Westminster Electric Supply (fully paid)	5	5½	5	5½	3 3 8	—	5 7/16	5 5/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
77,978	3	2/1	Brush Electrical Engineering	2¾	3¼	2¾	3	6 0 0	..	..	..
75,000	2	6%	Do. 6 per Cent. Preference	2⅛	2⅜	2¼	2⅜	5 1 1	—	2⅜	2¼
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	107	109	107	109	4 2 7	March & September	107½	107
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	3½	4½	3½	4½	..	January and July	..	..
12,139	5	..	Edison and Swan United	..		..		..	—	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	—	..	..
49,900	10	12/0	Electric Construction	1¾	2¼	1¾	2¼	..	—	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	⅜	⅝	⅜	⅝	..	—	—	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	—	—	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21½	22½	21½	22½	5 11 1	February & August	21¾	21½
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	101	103	101	103	4 7 5	March & September	..	..
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	..	..	..
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	..	..	..
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/0	4/0	3/0	4/0	..	December and June	..	..
78,949	5	1/9	Swan United (£3. 10s. paid)	2	2½	2	2½	13 19 8	May and November	—	..
37,350	12	12/0	Telegraph Construction and Maintenance	32	34	32	34	5 5 11	March and July	..	..
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101	104	101	104	4 16 2	January and July	..	..
39,639	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		—	—	—	..
41,098	£5	..	Do. Preference (fully paid)	..		..		—	—	—	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	¾%	City and South London Railway	30	35	28	33	2 5 5	May and November	..	—
37,500	£10	—	Liverpool Overhead Railway	5½	5⅝	5½	5⅝	—	—	..	—

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THE ELECTRICIAN:

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NOTES.

Now that the lamp monopoly is at an end, so far at all events as the master patent is concerned, many a box full of old lamps which had been put away will be opened. We must confess some surprise at the thoroughness with which the Edison and Swan United Company managed to keep the field to themselves. The suppression of large firms by accidents of the law and by lavish expenditure of the shareholders' money was comparatively simple, but the surreptitious use of contraband lamps was much smaller than might have been expected. The Company kept a sharp look out, but Woodhouse and Rawson lamps were not long ago still used in the Midlands, in perfect innocence, by those who had purchased them from dealers or agents, and in complete ignorance of any monopoly. The natural extinction of such lamps, and the stoppage of further supplies has left probably very few in regular use. One evasion of the monopoly was practised for a long time without hindrance, namely, the use of contraband lamps for temporary lighting for balls, &c. The excuse was that these lamps were never sold, they were used for a night and taken back again into stock. The Edison-Swan United Company have been much more successful in strangling illicit competition than the Telephone Company. Scores of imported or of home-made telephones were in use during the monopoly, and as a telephone has a longer life than a lamp, a considerable proportion no doubt still exist.

Anyone wishing to make a resistance for merely getting rid of a few watts, and not caring about its exact value in ohms, will find that a filament of carbon attached to platinum wires, and sealed into an exhausted glass globe, in many cases serves the purpose admirably. But for the last four or five years there has been some difficulty in buying such resistances, because, on passing a fairly large current, say one-third of an ampere, through them, they became so hot that they emitted light. This did not interfere with their usefulness as resistances, but to make or to use them was illegal. Nevertheless, such resistances have been bought and sold within the last few years; but, so far as we know, they were always used as resistances, and not as lamps. Restrictions are now largely removed, and it is worth noting that for getting rid of a small amount of electrical energy for laboratory work, a lamp is the cheapest kind of resistance that can be used. It may turn out that some of the new lamps will be fit for little else.

The report of the Committee of the American Street Railway Association on "Power House Engines," abstracts of which we publish this week, contains some recommendations which, while indicating a change in American opinion, is not quite in accordance with practice in our own country. For a very long time direct-coupled dynamos and steam engines have had the upper hand in the electric lighting stations here, and have been as completely ignored in America; while, on the other hand, we have furnished our large electric railway "power-houses," as the Americans call them, with rope or belt-driven dynamos. It is not a little curious, therefore, to find that direct-coupled dynamos are recommended for generating stations for electric railways by the Committee at Milwaukee. There appears to be a decided fitness in direct-coupled plant for electric-light stations, which is not yet applicable to the same kind of plant when placed in large railway power-houses. For, in the former, the character of the load diagram is such that there must be extensive sub-division and small units of power, and the change of total load is so gradual that a very considerable part of the plant may be shut down for long periods. But in the latter the character of the load diagram is altogether different, and is such that it is impossible to shut down any but the reserve plant, for the load varies so suddenly and so largely that the full capacity of plant must always be on the *qui vive*. In this latter case, therefore, extensive sub-division and small units of plant are inappropriate. Now, where the dynamo is of moderate power, it is very practicable to design a steam engine which will run coupled to it; but where the unit of power is very much larger, it is often found to be impracticable to adapt the steam engine to the high speed which the dynamo should have, and costly to adapt the dynamo to the low speed of the engine. The engine and dynamo suit themselves and one another better where they run at different speeds; hence the necessity for gearing, a confession of inability on the part of most engine builders to run their engines fast enough.

The continued high price and scarcity of coal must at length be telling seriously upon both the electric light and the gas industries. Some ignorant daily papers have been patronisingly telling us that now is the chance for electricity to take an advantage over coal gas—now, when the price of coal gas is bound to take an upward trend. But it is of course equally expensive to purchase coal for the one mode of lighting as for the other; while both have had an equally good chance of arranging for long-term contracts at fixed prices,

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Electric supply stations are, as a rule, very badly off for coal storage compared with gas works. As a matter of fact, however, we know of one instance—and doubtless there are others—where the boilers at the electric-light station are supplied with coal from the gas works. This looks at first like brotherly love of a very millenium order; but is explained by the fact that both gas and electric-light works are owned by the same Corporation—the municipality. Anyway, money is being made and lost somewhere by the high prices in coal; and if the contract prices are favourable to gas and electricity production at the present time, it is a safe prediction that the next renewal of contracts will find the case quite altered. On the other hand, those generating stations which are not sheltered by favourable contracts must be thinking it is about time to raise the price of their units or their 1,000 cubic feet, as the case may be.

A SUB-COMMITTEE of the proposed Universal Exhibition at Paris in 1900 has decided on the Champ de Mars as a site, thus utilising the Eiffel Tower. It appears that at present it is not intended even to compete with the follies of Chicago. It is possible that by the time 1900 comes round nobody but strike agitators and colliers will have any money to spend on such amusements.

THERE is a time to speak and a time to be silent. So long as HARNESS continued to advertise profusely, the daily press stood by him and helped to spread lies. But no sooner was he arrested on a charge of conspiring to commit fraud than they all throw him over. The London evening papers flaunted the news on their posters, dropping the "Mr." in the later editions. They might have had the decency to draw a veil over the misfortunes of one who had been so good a friend to them in the days of his prosperity. This would have been a time for graceful silence on their part.

New Atlantic Cable.—It has been decided by the Commercial Cable Company to lay another cable next year.

Cable Interruption:

	Date of Interruption.
Paramaribo-Cayenne	October 25, 1893.

Tasmania.—An International Exhibition of Industry, Science, and Art will be opened at Hobart Town, Tasmania, in November, 1894, and will remain open during about six months.

Southampton Docks.—Recent further official trials of the electric crane which has been erected on the Town Quay have proved to be satisfactory, and a second electric crane is in process of erection.

Windsor.—New wires have been laid between the Queen's private telegraph office at Windsor Castle and the Borough Post Office at the corner of High-street and St. Albans-street, in readiness for Her Majesty's use upon the return of the Court from Balmoral this month.

The "Harness" Case.—An order of the Chancery Division of the High Court of Justice was made last Saturday by Mr. Justice North, directing common accounts and inquiries in *re* Wilkinson *v.* the Medical Battery Company, with liberty to apply for the sale of the business as a going concern. Further reference to the Company will be found on page 51.

Breakdown on the St. Pancras Lighting Circuit.—At about 7:30 last Tuesday evening the neighbourhood of Gloucester Gate, Regent's Park, was suddenly thrown into a state of perfect darkness owing to the failure of the electric light, which by some means became extinguished. The current was not restored till nearly an hour had elapsed.

Science at Oxford.—At a recent debate in the Oxford Union Society the claims of science upon the University were considered. Mr. J. L. S. Hatton, M.A., urged that "the greatest study of the age was science, and its greatest branches engineering and electricity." Finally, he warned the University of the possible consequences of not extending their science teaching, when it was increasing at such a rate throughout the land.

Electric Lighting of Winchester.—The premium offered by the Corporation of the City of Winchester for the best scheme submitted for the electric lighting of the city has, on the report of their consulting engineer, Mr. Morgan Williams, been awarded to the Brush Company. The city is at present lighted by oil lamps, and has been discussing the adoption of electric lighting in a desultory way for about ten years.

Copenhagen.—The sale of electric current from the Copenhagen central station, through meters, amounted during the last six months of 1892 to 163,907,300 watt-hours, and during the first six months of the present year to 144,828,600 watt-hours. On January 1, 1893, there were about 14,800 lamps of 16 c.p., which number during the first half of the present year had risen to about 16,000 lamps. The consumption during the first half of 1893 was not so large as calculated.

Electricians and the Royal Humane Society.—At a recent meeting of the Royal Humane Society it was unanimously resolved to confer the Society's honorary testimonial on each of the following members of the crew of the steamship "Silvertown":—Sub-Lieutenant F. W. Robinson (R.N.R.), Messrs. Hugh Livingstone, H. Grimes, J. Miller, and A. Day, junior, for their courage and humanity in having saved the life of W. Bobbitt, a cable hand, who was in imminent danger of drowning by the upsetting of a surf-boat in the surf at Salina Cruz, on the Mexican coast, when two lives were unfortunately lost.

Electric Fighting Men.—It is said that a Mr. Doric Cheater (save the mark) has offered to the Spanish Government, for the trifling sum of five million pesetas, his invention of "an automaton soldier made of forged iron, capable of firing 40 shots a minute at the enemy," the machine being manipulated electrically. In the place where a soldier's brains ought to be the automaton is stuffed with dynamite; so that his captors would get a severe "blowing up" in the event of his being taken prisoner. It is not said what would happen if *both* armies were composed of electric automata!

Lightning Express Railway Service System.—We are informed that Mr. F. B. Behr has made arrangements with the Thames Ironworks and Shipbuilding Company for carrying out experiments on a large scale on this system, with a view to perfecting the electrical details. This system, which is commented on in *The Electrician*, Vol. XXXI., p. 526, is based on the Lartigue single rail system, and has been worked out very thoroughly by Mr. Behr. It is to be hoped that the great difficulties which necessarily beset an express railway service will be found to be not insuperable, but that the efforts which Mr. Behr is making will be crowned with success.

The London County Council and Technical Education.—The Finance Committee recommended, and it was agreed, that the balance of the £30,000 which the Council on March 28th last appropriated for the purposes of technical or manual instruction, being part of the moneys received by the Council under the Local Taxation (Customs and Excise) Act, 1890, in respect of the financial year ended March 31, 1893, should, after deducting £677. 9s. 11d. for expenses and £2,000 which had been advanced on account to the Technical Education Board, be handed over to that Board, as they considered it desirable that the funds should be administered through and by it.

Society of Arts.—The first meeting of the 140th session of this Society will be held next Wednesday, November 15th, when the opening address will be delivered by Sir R. E. Webster, M.P., Chairman of Council. Among the Papers announced to be read after Christmas we notice the following "Automatic Balance of Reciprocating Machinery and the Prevention of Vibration," by W. W. Beaumont; "The St. Pancras Electric Light Installation," by Prof. Henry Robinson;

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"Electric Signalling Without Wires," by W. H. Preece, F.R.S. A course of Cantor lectures on "Photometry" will be delivered on April 2nd, 9th, 16th by Capt. W. de W. Abney, F.R.S.

Racing Extraordinary!—A Paris Paper, says the *Indian Engineer*, reports that a company has been formed at Madison to construct a Hippodrome, the like of which has never been seen. It will consist of a long racecourse perfectly straight and of two stands each capable of seating 5,000 people which are to run on rails laid each side of the course. These stands are to start at the same time as the horses and will keep up alongside of them (being driven by steam or by electricity), and spectators will be able to watch every race from start to finish. Up to now jockeys are the only people exposed to any risks of accidents on the turf; now these risks will be shared by the public and bets can be made on the chances of a general smash-up.

Cambridge.—The Engineering Laboratory Syndicate ask for a grant of £1,000 to enable them to complete the buildings required for the accommodation of the department. From private sources nearly £5,000 have been subscribed for the purpose, but this is insufficient for the whole of the work in contemplation. Prof. Ewing reports that no less than seventy-four students have entered for courses in engineering during the present term; and it is very desirable that their work should not be hampered by delay in providing the necessary rooms for their accommodation. It had been hoped that subscriptions towards so valuable an extension of the scientific equipment of the University would flow in liberally, but the stream of benefaction seems for the present to have dried up.

Royal Society.—The following is a list of those who have been recommended by the President and Council of the Royal Society for election into the Council for the year 1894, at the anniversary meeting on November 30th:—President: Lord Kelvin. Treasurer: Sir John Evans. Secretaries: Prof. Michael Foster, Lord Rayleigh. Foreign Secretary: Sir Joseph Lister. Other members of the Council: Prof. Isaac B. Balfour, Andrew A. Common, Andrew R. Forsyth, Richard Tetley Glazebrook, Prof. Alexander H. Green, Sir John Kirk, Prof. Oliver J. Lodge, Sir John Lubbock, William D. Niven, William H. Perkin, the Marquis of Salisbury, Prof. J. S. Burdon Sanderson, Adam Sedgwick, Prof. Thomas E. Thorpe, Prof. William A. Tilden, and Prof. W. Cawthorne Unwin.

The Junior Engineering Society.—On the afternoon of Saturday, 21st ult., a large party of members of this Society visited the Tilbury Docks of the London and India Docks Joint Committee, and the p.s. "Royal Sovereign," of the Victoria Steamboat Association. They were shown over the docks by Mr. Seater, on behalf of the superintendent, Mr. R. Adams. The hydraulic power engine and boiler houses, electric light plant, hydraulic travelling cranes, sheds, the dry docks and their pumping machinery, lock, deposit removing apparatus, and other features of engineering interest were seen. The "Royal Sovereign" was viewed under most favourable conditions, the vessel being in dry dock at the time. Mr. Peter Blair Black, the Association's consulting engineer, and designer of the vessel, received the party, and showed them round.

Metropolitan Electric Supply Company.—The Metropolitan Electric Supply Company, in a circular just issued, state that the increase of business is being satisfactorily maintained. The number of lamps connected to the Company's system, which in November, 1892, amounted to 114,656, and at the date of the general meeting in April last to 134,453, now amounts to 1[illegible]7,556, and additional applications are in hand for the supply of current to 7,557 lamps. The gross revenue for the six months ended June 30, 1893, shows a very satisfactory advance upon that for the corresponding period of 1892, while the working expenses for the same period fully bear out the view which the Board have frequently expressed as to the small additional cost of production as compared with the increased revenue earned. The gross revenue for the quarter ended September 30th shows, it is stated, that the rate of increase over 1892 continues.

A Portable Electric Lamp.—At a recent meeting of the North of England Institute of Mining and Mechanical Engineers, Mr. V. C. Doubleday exhibited and described a new electric lamp, specially designed for the use of miners. The appliance, which bears the name of the Sussmann lamp, is about the size and weight of a miner's "Davy," which it resembles in shape. It gives light, however, from the top instead of from the bottom, and emits a fairly brilliant beam of about three candles. The source of energy is a secondary battery, which is charged from a dynamo in the ordinary way. The Sussmann storage cell, however, is stated to be absolutely dry. There is obviously some exaggeration here, but it is no doubt possible that liquid acid is dispensed with. Double protection is afforded to the carbon filament, which, besides being necessarily enclosed within a vacuum bulb, has in front of it a plate of thick glass. It yields its normal light for a period of 16 hours, but can be so constructed as to give a larger output for a shorter time.

An Electric Turntable.—An expert in railway matters declares, says the *Electrical Review* of New York, that the day is not far distant when the switching engine will be entirely done away with, its place being taken by the electric capstan. The latter is already in use to a certain extent on some of the Pennsylvania lines. The motor, which actuates the capstan by means of gearing, runs at the rate of some 1,200 revolutions a minute, and the gearing, motor and switch of the capstan are all contained in a water-tight iron case, the top of which comes flush with the ground; there is a cover to it which is readily removable, so as to give easy access to the motor for oiling and cleaning. The wires containing the current for the motor are carried through an iron pipe below the surface of the ground, and the switch for starting and stopping the motor is operated readily by the foot of the attendant in charge of the capstan. Such capstans were made in this country some years ago, but it is doubtful whether they are superior to hydraulic capstans in common use.

An Electric Railway Trial.—The managers of the Intramural Railway at Chicago have for some time felt, says the *Electrical World* of New York, that trains much heavier and longer than ordinary lines could be operated, and recently made a trial to prove that this was the fact. W. E. Baker, manager of the road, late at night started out a train composed of one live motor car, two still motor cars, and nine empty cars, weighing in all about 196 tons. This heavy train was pulled along apparently without effort, even when it turned the loops at either end of the road, each of which has a radius of over 100ft. On the following day, which was "railroad day," invitations were issued to the railroad magnates assembled at the Exposition, and a train of eight cars (one motor car and seven trailers) was provided. The train was loaded to its fullest capacity, no less than 800 persons being carried. The motors ran smoothly at their maximum speed, and the test was satisfactory in every respect. The weight of the train can be estimated at 212½ tons. This performance may be compared favourably with that on any steam elevated railroad, and speaks well of the confidence of the managers in their road and its equipment.

Electrical Communication with Lightships.—Two new vessels are being prepared under the direction of the Trinity House to relieve the lightships at the North Goodwin Sands and the Kentish Knock. The new ships are being built under contract, and they embody many improvements upon the lightships of older type, each being supplied with powerful syrens, the one for the North Goodwins being worked by steam, and that for the Kentish Knock by a hot-air engine. Both vessels will be in direct electrical communication with the shore, the cable from the North Sands having its land connection at Dumpton Gap, and that from the Kentish Knock at Kingsgate Bay. The Post Office authorities, as we have already announced, will lay the cables, and the cost of the work and maintenance charges will be defrayed out of moneys specially voted for the purpose by Parliament. For nearly 20 years the Goodwins have been protected by four lightships in addition to intermediate buoys. The vessel at the North Sand Head is the oldest, having been established exactly 100 years; the Gull lightship took up its position in 1809; the lightship at the South Sand Head was moored there in 1832, and the one on the easterly side of the bank in 1874, the number of wrecks diminishing as each additional light was brought into use.

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The Care of Boilers.—Boilers when not in use require as much care as when under steam; yet frequently they receive less. The French naval authorities have recently issued an important order on this subject, which is well worth noting:—

"On board all ships in the reserve, as well as on those which are laid up, the boilers will be completely filled with *fresh* water; and this is to apply to shell boilers as well as to those of the tubulous or pipe type. In the case of large boilers with large tubes, there will be added to the water a certain amount of milk of lime, following the instructions furnished by Belleville and Co. for the preservation of the tubes of their boilers, or a solution of soda may be used instead. In the case of tubulous boilers with small tubes, milk of lime or soda will be added (but the solution will not be so strong as in the case of the larger tubes), so as to avoid any danger of contracting the effective area by deposit from the solution. The strength of the solution will just be sufficient to neutralise any acidity of the water. Care must also be taken to preserve the outside of the steel or iron tubes in the case of boilers which are not to be used for long periods. To this end they will be painted with red lead or coal tar as far as it is possible to reach. For those places which are inaccessible, a protective coating will be obtained by burning under the tubes a certain amount of tar or coal tar, whose smoke will form a coating of soot, and thus prevent the air from reaching the surface of the tubes. In addition, the boiler casing will be closed and kept air-tight after placing inside some quicklime. Periodical inspections of boilers thus treated will be made, to ensure the complete filling of the tubes with water."

The Institution of Civil Engineers.—The seventy-fifth session of the Institution of Civil Engineers will be commenced on the 14th inst., and the meetings before Christmas are likely to be occupied—in addition to an address from Mr. Giles, the President—with the design and construction of impounding reservoirs for water works at Tansa (Bombay), Baroda, and Jeypore, with machinery for the manufacture of casks, and with the development of hydraulic power supply in London. Among the subjects on which Papers are invited are the following:—The cost of working electrical tramways, taking account of interest on capital, and of a sinking fund for depreciation; the most suitable form of electric light mains, having regard to durability, economy of conducting material and facility for making and laying house connections; the risks of electric lighting to life and property, with the means to be taken to prevent or to reduce them; the best arrangement of engine for any given electric light station; electrical motors for (*a*) inland navigation, (*b*) ocean vessels; electric lighting and haulage plant in mines and collieries; the effect of small quantities of impurities in commercial copper as regards its use in electrical work; the electro-deposition of copper; on the application of water power and its transmission to a distance by electricity; the design of electric locomotives; the practical working of multiphase alternate-current motors; the forms of electrical conductors for lighting, stationary power, heating and traction purposes.

Patent Law in the United States.—In the recent Western Electric (Scribner) arc lamp decision, says the *Electrical World* of New York, two important points of general interest are defined by the United States Court of Appeals, before which the case came. The first relates to the distinction between the abandonment of an invention and the abandonment of an application for letters patent by failure to carry out certain provisions of law. The Court held that besides the power conferred upon the Commissioner of Patents to relieve an applicant from an abandonment of his application under the statute, an application which had lapsed or been rejected or withdrawn may be renewed or repeated so long as the invention itself has not been abandoned by reason of a two years' public use, or otherwise. The other point has a collateral bearing on the trolly cases now in Court, as it relates to the question if the change in functions of a device constitutes an invention. The Court holds that the invention is in the device. In the case at issue the judge illustrated the distinction by the statement that the "magnetic current" (*sic*) itself is not a part of the device any more than water is an element of a water wheel; in one case water is the power and in the other the electric current, and devices are contrived for the purpose of controlling and applying the power. This view is interesting in connection with the claim that the fundamental mechanical principles involved in the street railway trolly were anticipated by numerous patents previously issued for trollies to be used in the operation of telegraph instruments on steam railway cars, and therefore the trolly patents in litigation are void through resting on a mere functional difference—conveying a small current to a telegraph instrument in one case and a large current to a motor in the other.

A 1,000 H.P. Electric Locomotive.—This locomotive, says the *Electrical Engineer* of New York, is the outcome of the resolve made some two years ago by the President of the North American Company, after consultation with Mr. F. J. Sprague, to ascertain to what extent electricity could be applied to the railways under his direction. A board of engineers appointed by him drew up a set of specifications embodying their recommendations, but these have been radically departed from in the actual locomotive. This locomotive, which is nearing completion, has been constructed to test the feasibility of handling freight at the terminal yards of the Chicago and Northern Pacific and Chicago North-Western system at Chicago. The problem included the design of an electric locomotive of ample power, which could be controlled as readily and be as reliable as a steam locomotive. Secondly, it involved a set of conductors and method of supporting them which could be relied upon for ample supply of current and continuous contact at all speeds on curves, switches, and cross-overs; and, finally, an automatic block signalling system which would not be thrown out of operation by the use of the tracks as conductors. Of the seven or eight designs prepared, the one adopted sticks closely to the best established steam locomotive practice: a rigid frame and a multiplicity of drivers connected together; and to these are added armatures mounted directly on the axles, and field magnets rigidly carried on pedestal boxes, the equalising spring movement only affecting the superstructure. This construction is in marked contrast to the methods more recently advocated, of suspending the armatures on sleeves concentric with the axles; but the reasons which have led the designers to the form adopted would appear to be thoroughly well based on past experience.

The Comparison of Specific Inductive Capacities.—To those interested in the determination of comparative specific inductive capacities, says a writer in the *Electrical World* of New York, one of the greatest drawbacks to experiment in this direction is the necessity for the employment of great condenser surface in order to obtain, by the usual direct deflection method, readings sufficiently great to be reliable. The writer having had occasion to compare the specific capacities of a number of insulating substances, and having been met on the threshold of his investigations by the obstacles referred to, devised a simple method, by the use of which it was possible to obtain satisfactory results, even when exceedingly small surfaces were used. The apparatus required is an electrically-vibrated tuning fork, of about 280 double vibrations per second, one limb of which is provided with a platinised extension vibrating between two light platinised springs, which are limited and damped so that their individual periodicities may not conflict with that of the fork. These springs are adjusted relative to the fork extension, so that when in vibration it shall make contact with them alternately, but shall be out of contact with both springs at the position of rest. The tuning-fork is well insulated, and provided with a binding post for the attachment of the lead. One spring is connected with the pole of the battery, the other spring to one terminal of galvanometer, and the fork to one terminal of condenser, the other terminals of the battery, galvanometer, and condenser being connected together. The action when the fork is in vibration is that at one limit of swing the condenser is charged by contact with the battery spring, and at the opposite limit the charge is neutralised through the galvanometer by contact with the other spring. The succession of impulses being so rapid (280 per second) the effect upon the galvanometer is nearly that of a continuous current, and the deflection consequently steady. The rate of vibration of 280 was adopted because it nearly approached the rate of the vibrational induced currents on telephone lines, due to electric light circuits; any other rate might be adopted but the higher the more difficult of adjustment, and the lower the further removed from continuity are the discharges. It is possible with this arrangement to measure the static capacity of a person insulated from the floor, and to note the increase of capacity due to the approach of other (uninsulated) persons to him, when using a Thomson reflecting galvanometer and fifty cells of battery.

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THE PRINCIPLES OF THE CALCULUS.

Engineers are often afraid of the differential and integral calculus, because they think it is difficult and savours of too much "theory." Yet it is wonderful how often the principles of the calculus enter into the thoughts of practical men. There are two distinct ideas in the calculus: the idea of a "rate" and the idea of a "summing up," or the differential and integral ideas as they are called. The idea of a "rate" or "rate of change" enters into many engineering questions. The horse-power of a motor is its rate of doing work, and the velocity of a body is its rate of change of place. There are two ideas involved when we set a motor to do a piece of work: the idea of the total work to be done, and the idea of the time in which the work is to be done. If the motor works always at the same rate, its power at any time is equal to the total work done divided by the time. But very often the motor works at a very irregular rate, so that its power at any instant cannot be so determined. In this case we may suppose the motor to work for a fraction of the time at one rate, then for a fraction of the time at another rate, and so on. The motor will do the work irregularly, but the work which it will do during each fraction of the time that the rate is constant will be equal to the product of that rate into the fraction of time; or the rate during this time will be equal to the portion of work done divided by the time. Now, if the motor changes its rate of working very frequently it will not be able to do much work in each little bit of time that it is working at a constant rate. Still, the rate will always be equal to the ratio of the little bit of work done to the short bit of time it takes to do it uniformly. But if the motor is constantly changing its rate of working, so that at each little interval of time it is working at a different rate to the interval before and after it, we cannot consider that there is any length of time, however short, in which it is working at a perfectly constant rate. If we consider a large fraction of the time we find that the rate changes very much in that time, and is very different at the end to what it was at the beginning. If we consider a shorter length of time we find that the rate has not changed quite so much. And the shorter and shorter we consider the little bit of time, and the work done in that time, the less and less shall we find that the rate has changed; although we shall also find that the little bit of work done has diminished, too, as the time is shorter. Now, if we take a very, very short bit of time, so infinitesimal in its duration that only an infinitesimal bit of the work will be done in it, we shall of course find that the change of the rate of working in this time will be infinitesimal, or, in other words, that the rate is constant within measurable amounts. And if the rate is constant during this brief time it is, as we have already seen, measured by the ratio of the bit of work done to the brief time occupied in doing it. But both of these are infinitesimally small. We call the infinitesimal bit of work *the differential of the work*, and the infinitesimal bit of time *the differential of the time*; so that

$$\text{Power} = \text{rate of working} = \frac{\text{differential of work}}{\text{differential of time}}.$$

If we call the power P, and the differential of the work $d\,W$, and the differential of the time, $d\,t$, we have the expression

$$P = \frac{d\,W}{d\,t}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and this form of expression is called a *differential coefficient*, or the differential coefficient of W with respect to t. If, instead of P, W, and t, we have any three variable quantities which depend on one another in some way, such as z, y, and x, we put

$$z = \frac{d\,y}{d\,x}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

z is the differential coefficient of y with respect to x. This means simply that the value of z, which is obtained by dividing the little bit of y, $d\,y$ by the little bit of x, $d\,x$, which corresponds to it, gives us the exact *rate* of change of y with respect to x; so that the idea of the differential calculus is contained in a nutshell in the easily understood idea of a *rate*.

Not more difficult is the idea of the integral calculus, which is the notion of "summing or adding." Let us return to our consideration of a motor which is doing a piece of work, W, at a varying rate. The whole time, t, in which this work is done is composed of a succession of little bits of time, $d\,t$, following one another in a sort of stream, and there is a different value of P in each separate differential of the time. If we transpose the equation (1) for P, we can get

$$d\,W = P\,.\,d\,t.$$

That is to say, the little bit of work done in the time $d\,t$ is the product of P, the power, into $d\,t$. Let us number the successive differentials of time $d\,t_1$, $d\,t_2$, $d\,t_3$, and so on, and the power in each P_1, P_2, P_3, and so on. Then the little bit of work done in the first is

$$d\,W_1 = P_1\,d\,t_1,$$

and in the second

$$d\,W_2 = P_2\,.\,d\,t_2,$$

and so on, but the whole work, W, done in the whole time t, is the sum of all the fragments of work done in the successive fragments of time, or

$$W = d\,W_1 + d\,W_2 + d\,W_3 + \quad . \quad . \quad . \quad . \quad .$$
$$= P_1\,d\,t_1 + P_2\,d\,t_2 + P_3\,d\,t_3 + \quad . \quad . \quad . \quad .$$

Now we cannot add these little elements (as they are called) by the rules of ordinary addition; firstly, because there is an infinite number of them; secondly, because they are all different in size; thirdly, because they are each so infinitesimal that we cannot attach any numerical value to any single one of them. And yet, if we could find some method of summing up all these elements of work, we should get the total work done. Such a method is found in the integral calculus, and is called *integration*. Thus, if we wish to express that the expression

$$d\,W = P\,.\,d\,t$$

is to be integrated, we write the sign of integration, $\int$, before it, thus:—

$$W = \int d\,W = \int P\,.\,d\,t$$

Or, W is the integral of $d\,W$ or the time integral of the power. In order actually to perform the operation of integration we must, of course, know something of the law by which P, W, and t vary among themselves.

THE UNITS OF HEAT AND TEMPERATURE.

The C.G.S. system, as we have remarked some time ago, fails to directly include heat and temperature among the quantities which it defines. Some of the earlier attempts in this direction were merely due to a desire to gather all physical quantities under one uniform system. For all ordinary purposes the Centigrade scale is perfectly satisfactory. For extreme temperatures or for exceptional accuracy the necessary thermometer must be abandoned, and the scale of the air thermometer is used. In the researches of Profs. Dewar and Fleming the use of an air thermometer is, of course, out of the question, since air liquefies at the low temperatures employed. Extrapolation of the straight part of the scale might suffice, but either this or the hydrogen thermometer are only conventions. The recent results of Profs. Dewar and Fleming were expressed in "platinum degrees." This scale, though curved relatively to the air thermometer, at all events extends to the required range. The consideration of an absolute scale of temperature hence acquires a new interest.

Shortly after the last Electrical Congress at Paris some suggestions were made by Prof. Forbes and Mr. W. H. Preece with reference to the establishment of a true scale of temperature. Their views are stated by them in an article which appeared in *The Electrician* for September 20, 1889. The Units Committee at the Bath meeting of the British Association had suggested the *therm* as the unit of heat, while the French Congress had adopted the word *calorie* in spite of the fact that two distinct units were known by this name. Prof. Forbes and Mr. Preece suggested that it was not necessary to have a new unit at all, and that the heat which was the equivalent of the energy of one watt acting for one second, or the joule as it is sometimes called, should be taken as the unit of heat. They further suggested that the unit of temperature should be

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that rise of temperature through which one gramme of water could be raised by the agency of an amount of heat of one joule. If the mechanical equivalent of heat is taken as 42,000,000 ergs or 4·2 joules, it is clear that this quantity of heat will raise one gramme of water 1°C., and that 1°C. is equal to 4·2 degrees of temperature on the new scale suggested.

Two objections can be raised to this proposal, one of which was mentioned at the time by the authors of the article. They referred to the fact that the mechanical equivalent of heat was not known with sufficient accuracy for this new unit of heat to be possible. The best determinations differed as much as two per cent. from one another at that time. This objection has now been removed by the careful and accurate research recently completed at Cambridge by Mr. E. H. Griffiths, of Sidney Sussex College, Cambridge. The value obtained by him for the mechanical equivalent was 41,940,000 ergs, or 4·194 joules, and this value very closely agrees with an independent determination recently published by Prof. Rowland.

There is, however, another objection to the adoption of the joule as an indirect unit of temperature, and this arises from the fact that the specific heat of water is not the same at all temperatures. The amount of heat needed to raise one gramme of water from 15°C. to 16°C. is different from that needed to raise it from 16°C. to 17°C., although the difference is but slight. Mr. Griffiths, in the course of his research, had to determine very carefully the specific heat of water at different temperatures, and found it to diminish by 0·026 per cent. for every degree centigrade rise of temperature. So that, assuming the specific heat of water at 15°C. to be unity, its value at any temperature t°C. is

$$1 - 0{\cdot}000266\,(t - 15).$$

It is therefore clear that if water is taken as the standard substance, it is not possible to define a unit of temperature, as that rise of temperature through which a unit quantity of water is raised by the absorption of a unit amount of heat.

It may be asked whether any substance does exist for which this definition would be applicable. The answer to this question is probably in the negative. Substances do not appear to behave uniformly in regard to the action of heat on them. It is well known that if several thermometers are made, in which the liquids used are different, the indications of these instruments differ in general from one another, although they may all be exactly alike at two particular temperatures. Even air thermometers, that is, thermometers in which the expansible substance is some permanent gas, differ from each other to a slight extent. The exact measurement of temperature is a matter of great difficulty; but even as long ago as 1854 Sir W. Thomson showed that it was possible, in accordance with the theories of thermo-dynamics, to determine the temperature of a body absolutely, without reference to the properties of any particular substance. The ideal perfect gas does not exist; but Sir W. Thomson showed how it was possible, by making certain experiments on the ordinary permanent gases, to deduce what the behaviour of a perfect gas would be, and thus to determine temperature in a manner independent of the peculiarities of any special substance. The value obtained by Mr. Griffiths for the specific heat of water at different temperatures is in the same way quite independent of the material used in his thermometers, since these have been calibrated in accordance with the absolute scale of temperature, and it does not appear that the suggestion of Prof. Forbes and Mr. Preece is applicable except to some ideal substance, although it may be true with sufficient approximation for most purposes.

THE ELECTRICAL CONCENTRATION OF VITRIOL.

BY BERTRAM BLOUNT, F.I.C., F.C.S.

For any operation which can be regarded as merely a question of the expenditure of a given number of heat units the use of an electric current obtained at its present cost is obviously absurd. But it is only by quitting the laboratory and entering the world where things are bought and sold that one can learn how indirect and slender is the influence of energy expenditure upon commercial cost. The discrepancy is unnatural and oftentimes deleterious to sound physical morality, but it exists and must be reckoned with. When read aright it may serve as a formative lesson instead of a disintegrating influence. It is only a half-truth that is paradoxical.

The reason why the proposition to use electrical energy for the concentration of vitriol is not fantastic, can be discerned when the conditions of the present process are considered. Vitriol in its most concentrated commercial form—for except by the process of freezing out ordinary concentrated acid or by adding the anhydride to the hydrated acid so as to bring it to the theoretical composition H_2SO_4, vitriol of 100 per cent. strength cannot be obtained—has a high boiling or rather decomposing point (338°C.), and is powerfully corrosive. These two properties increase the difficulty and cost of its concentration to an extent out of proportion to the amount of energy theoretically necessary to remove the superfluous water. The materials of which the vessels containing the acid to be concentrated can be constructed, are few; glass, porcelain and platinum practically exhaust the list. Now, in any system of heating by transmission through the walls of a vessel, a non-metallic material is at a disadvantage on account of its poor conductivity, which causes waste of heat and liability to fracture by the local strains set up on sudden and irregular change of temperature. It comes about, therefore, that platinum is generally preferred, in spite of its high price and the not inconsiderable corrosion to which it is liable. Recently an alteration of practice has set in, which is of especia[l] significance when considered in relation to concentration per[formed] electrically. Plant has been designed, consisting usuall[y] of a series of vessels of glass or porcelain arranged terrace-wise in which the heating is not strictly external, the series of vessel[s] being bodily enclosed in a flue, and the surface of the acid i[n] each, as well as the liquid dropping from one to the other, bein[g] exposed to a stream of hot gases, and being thereby robbed o[f] its surplus water. By this means the necessity for transmittin[g] every unit of heat through a refractory envelope is removed, o[r] at least diminished, and economy in energy and monetary cos[t] has naturally resulted.

Seeing that electrical heating, when judiciously performe[d] can be effected with an expenditure of current but little i[n] excess of that theoretically requisite, it is pertinent to enquir[e] what is the total quantity of heat, calculated from thermo[-] chemical data, needed to concentrate a given weight of sulphuri[c] acid of known strength. The whole question is ably discusse[d] by Herr A. H. Bucherer in a recent number of the *Chemiker Zeitung*, and the items of heat expenditure stated in detail. Assuming that 117 kilos of acid at 60°B. yield 100 kilos of the acid at 66°B., that being the highest grade usually made, and that the mean specific heat of the acid is 0·33, and adopting the usual values for the latent and specific heat of steam and for the heat of combination of the water originally present, with the acid from which it has to be expelled, the figure obtained for the quantity of heat necessary to concentrate the amount of acid mentioned above, is found to be 32,679 Cal., corresponding to 44·2 H.P. hours. This, at the rate of 4 pfennige per horse-power-hour, comes to 20 marks per metrical ton of concentrated acid, or, adopting the farthing rate upheld by Mr. Swinburne to a little over 10s. per English ton. Even the lower of these rates is distinctly high, and compares unfavourably with the cost of heat supplied directly from a furnace, the efficiency o[f] which must be low indeed to necessitate a similar expenditure. As has been already remarked, however, the cost of any metho[d] of concentration does not depend exclusively on that of the heat units required. Its merits must be judged as a whole.

The simplest way of applying electrical energy to the con[-] centration of sulphuric acid consists in passing a current which may be uni-direction or alternating, through a platinu[m] wire immersed in the acid, contained in a glass or porcelai[n] vessel, packed in non-conducting material to minimise the los[s] of heat by conduction and radiation. The voltage for eac[h] vessel must not be so great that the difference of potenti[al] between the point of entrance and that of exit of the platinu[m] wire is large enough to cause any appreciable electrolysi[s]. Provided the wire be disposed in the vessel in such a mann[er] that two points on it, the difference of potential of which [is] considerable, are not in juxtaposition, 5 volts per cell is n[ot]

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... to prove excessive, particularly as the surface of the wire ... any case small, and the resistance of the electrolyte fairly ... In the event of loss by useless electrolysis proving to ... more formidable item in the account than appears ...le, an alternating current would have to be adopted. The temperature of the platinum wire may be taken as about ... above that of the acid which it is concentrating, whence it follows that, taking into consideration the specific resistance of platinum at 480°C., and its capacity for imparting heat to the medium (sulphuric acid) which surrounds a wire 0·5cm. in diameter and 77cm. in length would require a current of 364 amperes at a pressure of 5 volts to maintain its temperature, and would concentrate 24 kilos of ... in five hours.

The calculation of the cost of electrical concentration, when other items than energy are considered, can hardly be satisfactorily undertaken without the data afforded by large scale experiment. A comparison of the cost of the fuel needed, with coal at 10s. a ton, is, however, possible.

	Per ton of acid 66°B.
Electrical concentration	10s.
Direct heating	2s.
Theoretical cost	0·2s.

It is evident, therefore, that the advantages in other respects than fuel consumption would have to be shown to be very marked to counterbalance the high cost of electrical heating. A decision for or against the new system cannot be definitely announced; but on *primâ facie* grounds its economy is more than doubtful.

ELECTRIC TRACTION AT HIRSLANDEN.

With the object of steadying the load on the generating plant of an electric tramway, the Oerlikon Works have been led to try the use of accumulators at the power station. We have received a long description of the plant from Dr. Paul Schoop, in whose opinion this system presents many advantages. He says that it is well known that a saving of fuel is realised when steam engines work constantly at full load charging batteries, therefore avoiding the smaller efficiency of the engines at various loads. The first cost of plant, he says, is often the same in both cases, whether the plant is erected with or without a battery, the boilers, engines and dynamos being only one-third to one-half of the capacity with the battery combination.

We have often heard promises of this kind, but storage batteries in this country have never produced any results approaching this. Dr. Schoop assumes, however, that if a battery proves good enough with electric lighting it must prove better still with a tram line.

The plant for an ordinary trolley system for the line at Hirslanden consists of a steam engine of 50 H.P., with a corresponding boiler and a dynamo, giving about 60 to 65 amperes at 550 to 500 volts. The steam engines run at 250 to 300 revolutions, and the generators, compound-wound machines, run at 500 revolutions.

The steam consumption of the engine per horse-power hour is 30lb. at full load, 35lb. at half load, 40lb. at a quarter load, and 50lb. at one-eighth load. A slow-speed condensing engine (Sulzer, Winterthur) of 50 H.P. takes 17lb. steam per horse-power hour at full load and 23lb. at quarter load.

A battery of 270 cells (combining the features of the Oerlikon battery with those of the Tudor batteries) is used, each cell consisting of three positive plates (0·300 meter long and broad, and 8mm. thick), and four negative plates of the same size and thickness. The plates are hung in glass cells, and separated from each other by glass tubes of ¼in. diameter. The capacity of the battery is 140-150 ampere hours, and the battery stands a discharge of 35 amperes during three to four hours. The discharge may be 75 amperes during a little more than an hour if necessary. This battery therefore represents a reserve of 70 kilowatt hours (or 94 H.P. hours), and may discharge 37 kilowatts (or 50 H.P.) during an hour at least. If necessary, 110 kilowatts (or 75 H.P.) may be discharged, this figure being the maximum discharge for intervals of not more than five minutes.

The whole work on the tramline is therefore provided for a period of three hours from the battery alone, which suffices to carry on the work, and may, in case of any interruption or accident with the engine or dynamo, instantaneously be taken out of the battery. The generator, which need not be a compound-machine, but is preferably a shunt-dynamo, sends the negative current first through an automatic switch, which interrupts the circuit in case the battery tends to discharge back through the dynamo. The battery is directly connected to the line, the positive pole being connected to the overhead wire, whilst the negative pole goes to the rails, a safety-fuse and a line cut-out being provided. The last 81 cells near the negative pole of the battery are in connection with a regulating switch, having 28 contacts. A relay, placed between the overhead wire and the rails, brings into action an automatic regulating switch, which cuts cells in or out of circuit according to the demand for power.

Dr. Paul Schoop, in conclusion, gives a long list of the advantages of using a battery in this manner. Some of these are not very apparent, for example, "with the application of steam slow speed engines can be used, affording greater economy in fuel and less depreciation of the engine plant." That the building of high-speed engines has not received much attention in Germany is easily understood, but it is difficult to see what this has to do with the use of batteries. The principal advantage, perhaps, is that by the use of a battery it might be possible to employ water power for working a tram line under circumstances that would otherwise be impracticable. A constant supply of power, which would suffice for the mean power used during the day, would be unable to cope with the continual fluctuations due to the starting of cars.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, November 10th.

PHYSICAL SOCIETY.

5 p.m. (1) "On the Separation of Three Liquids by Fractional Distillation," by Prof. S. Young, F.R.S., Prof. Barrett, and Mr. Thomas. (2) "On the Critical Constants of various Ethers," by Prof. S. Young, F.R.S. (3) "An Instrument for Drawing Conic Sections," by J. Gillet, B.A.

THE JUNIOR ENGINEERING SOCIETY.

8 p.m. Inaugural Meeting, 13th Session. Mr. John Wolfe Barry, C.E., will deliver the Presidential Address at the Westminster Pal ce Hotel.

TUESDAY, November 14th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Address by Mr. Alfred Giles, President, and Presentation of Medals, Premiums and Prizes awarded at the close of last session.

WEDNESDAY, November 15th.

ROYAL METEOROLOGICAL SOCIETY.

8 p.m. Ordinary Meeting. (1) "The Great Drought of 1893 and its attendant Meteorological Phenomena," by Frederick J. Brodie, F.R.Met.Soc. (2) "Thunder and Hail Storms over England and the South of Scotland, July 8, 1893," by William Marriott, F.R.Met.Soc.

SOCIETY OF ARTS.

8 p.m. First Ordinary Meeting. Opening Address of the 140th Session by Sir Richard E. Webster, Q.C., M.P., Chairman of the Council.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. (1) "New British Freshwater Algæ," by Mr. W. West. (2) "On the Value of Aperture in Microscopical Research" (with lantern), by Mr. T. F. Smith. (3) "A Parasitic Disease in Flounders," by Mr. G. Sandeman.

THURSDAY, November 16th.

CHEMICAL SOCIETY.

8 p.m. (1) "The normal Butyl, Heptyl, and Octyl Esters of Active Glyceric Acid," by Percy Frankland, F.R.S.. and John MacGregor, M.A. (2) "The Ethereal Salts of Diacetyl-glyceric Acid in their relation to Optical Activity," by Prof. Frankland, F.R.S. and Mr. John MacGregor, M.A.; and other Papers.

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THE GLOW-LAMP MONOPOLY.

To-day witnesses the end, so far as Great Britain is concerned, of one of those commercial monopolies which have imposed themselves upon electrical enterprise. In the present instance, as in the case of the telephone, the monopoly was felt the more galling because it was known to be based on a legal fiction of the thinnest kind, a sort of judicially sanctified fraud against common sense. The patent which expires to-day was granted in 1879, one of those eventful years when invention and commercial enterprise were rapidly opening up the electrical industry. Those who think that electric lighting began only when JABLOCHKOFF lit up the Avenue de l'Opera in the summer of 1878 must have forgotten all the earlier forms of arc lamp, from the primitive device of STAITE down to the excellent lamps of SERRIN and LONTIN, still in use for light-

house illumination. Jablochkoff's simple "candle" indeed awoke men's minds to the wider possibilities which had existed already for some years in the mechanical generation of electric currents by the dynamos of Gramme and of Siemens. Across the Atlantic Wallace, Brush, and Elihu Thomson were already busy perfecting machinery and lamps for arc lighting, whilst in England, the original home of the arc lamp, Werdermann, Lane Fox, and Swan were at work in the field where Davy, Faraday, Staite, Holmes, Wheatstone, the Varleys, and Sir W. Siemens had been pioneers. Arc lighting for public squares was, indeed, comparatively well known, if little used, save for festivities like those of the marriage of the Prince of Wales in 1863, when London Bridge was lit up. But the general idea was that some way must be found for "subdividing" the too-brilliant light. Lighting by incandescence, as we now know it, was practically unknown outside the laboratory, though the platinum spiral lamp and the carbon-strip vacuum lamp had been suggested at various times. What the general enlightened knowledge of electric lighting was in August, 1878, may be seen from the Paper read in that month to the British Association by Mr. J. N. Shoolbred. There is no suggestion of the use of a distribution at uniform electric pressure with mains and branches, or of lamps of high resistance set in parallel. The first suggestion of any such system came in October of that year from Mr. Lane Fox, whose patent specifications bear witness to the accuracy with which he forecasts the requirements of the future system. To the use of high-resistance lamps in parallel were adjoined provisions that the luminous surface was to be relatively small, and proportional to the amount of light emitted; that the material should be refractory, of high specific resistance; that the ends of the luminous bridge should be thickened where they are clamped to the conducting wires: that the latter should be of platinum, passing through a glass globe, sealed into the glass; and that the globe should be exhausted by the aid of a mercurial pump and hermetically sealed. All these features he described in his patents. At the same date it was noised from across the Atlantic that Mr. Edison, then famous for his achievement in devising the phonographic reproduction of speech, had invented a new lamp which solved the problem of the indefinite subdivision of the electric light. Great was the sensation produced amongst the "bulls" and "bears" of the Stock Exchange. In spite of the advice of scientific men, a regular panic set in amongst gas shareholders; and stocks, at the end of October, sold at about half their previous value. When, a few months later, the secret of the Edison patent was revealed, it was greeted with the derision of the whole electrical community. A low-resistance spiral of platinum, not even in a vacuum, and with an automatic device to short-circuit it, lest it should melt and thereby extinguish all the other lamps in series with it, was the feeble cause of all this foolish panic. And the new dynamo which was to furnish current for the new lamp was to vibrate like a tuning-fork, instead of rotating! At the same time Swan, aided by Stearn, was improving the vacuum pump, and endeavouring to produce carbon bridges suitable for a durable vacuum lamp.

There was, in 1879, a general feverish expectation that something new and practical must shortly come forth. Edison kept the pot boiling with new ideas and vague descriptions of lamps. One by one the points enunciated by Lane Fox were appropriated into the Edison patents. The lamps originally proposed to be used in series were now represented in parallel; the high-resistance feature described in October, 1878, by Lane Fox was embodied by Edison in May, 1879, in a final specification to a patent which originally had been filed for low-resistance lamps. In February, 1879, Swan lectured upon and publicly exhibited a lamp constructed by himself and Stearn, having a carbon wire mounted upon platinum wires which passed through and were sealed into a glass globe which had been carefully exhausted of air. The successful public operation of this lamp caused even the New York journalists to chaff Mr. Edison upon his failure. Had Swan at this stage patented what he had attained to, he would have been unquestioned master of the situation. But with that modesty which characterises him he preferred to wait until he could point to some one really original feature. There was nothing new in carbon wires, or in vacuous globes with platinum wires sealed into them, or in using carbon in a vacuum. When early in 1880 he arrived at a novel point—the preparation of thin carbon bridges from "parchmentised" cotton thread, he at once patented the improvement. Nevertheless his lamp of February, 1879, contained all the essentials of the modern lamp. Its exhibition and successful operation ought to have for ever made it impossible for the monopoly of carbon vacuum lamps to fall into the hands of another and less scrupulously modest inventor. Carbon, the one element that answers the necessary conditions of infusibility and high specific resistance, was known, was triumphantly demonstrated to possess these qualities, was found not to waste away in the vacuous globe. Discovery of the properties, and invention of the combination were alike complete. Nothing remained, save to improve in detail the methods of manufacture of the various parts. Nevertheless, in November, 1879, a claim for this very combination was, by the astuteness of his patent agent, put forward on behalf of Edison, who had now abandoned platinum wires and betaken himself to the despised carbon. The notoriously-simple game of calling an old thing by a new name was once more played with success. Wires of carbon no thicker than one millimetre in fineness were already in commerce. To call a wire a wire would have been too plain. It was therefore re-christened as a "filament," as though it was a novelty. The absurdity of the whole thing ought to have been plain enough when years afterwards the lawyers of the Edison Company had to argue that the wire used by Swan in February, 1879 was a "stick" and not a "filament," notwithstanding which the Edison Company attacked the makers of the "Sunbeam" lamps for infringement, on the ground that the bridges of carbon in them (which were thicker than Swan's wire) were filaments! Mr. Justice Kay, before whom the most important of the various actions was tried, did indeed see through this unworthy device for seizing an invention by using a new name for an old thing, and gave judgment against the Edison claim. His decision was, however, upset in the Court of Appeal, though it would probably have been re-affirmed by the House of Lords had the matter gone so far. A judicious compromise of interests by the parties to the litigation prevented this appeal to the highest Court. Consequently, the Edison and Swan Company held, by this accident of law and the craftiness of patent draughting, the monopoly which expires to-day. It will scarcely console those who for the past five years have had to pay exorbitant prices for their lamps to learn that in no other country of Europe have the monopolists been permitted to build up a similar judicial fraud. Both in Germany and in France patents have been allowed to Mr. Edison for his particular way of constructing lamps; but not so as to give him a monopoly over Mr. Swan, whose prior success entitled him so obviously to something more than equal rights as an original inventor.

The crowning absurdity of the patent which expires to-day is that no lamp has ever been known to have been made in

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accordance with its directions, except for purposes of litigation. Mr. Edison has not, so far as we know, been on unfriendly terms with the English Company. If he had had a "tar-putty filament" lamp in his possession it would have been worth one or two thousand pounds as evidence before Mr. Justice Kay; but we do not think it would have affected the judgment. Mr. Edison himself has not indeed profited much by the English monopoly (he is said to have received but one dividend, and that only recently); Mr. Swan, on the other hand, has, we understand, enjoyed a direct but an utterly inadequate reward. To Mr. Edison, however, in the eyes of the ordinary public, belongs the honour of having "invented the electric light."

We do not blame the Edison-Swan United Company for keeping up this delusion any more than for maintaining their monopoly. They acted on purely commercial lines; we are dealing with scientific history. The indomitable energy of the American inventor had started an electric light "system," and the Edison Company over here had simply to push it; they had, at first, to initiate nothing. To Major Flood Page belongs great credit for a uniform policy, not, of course, in the interests of science or of electric lighting, with which we are concerned, but which are nothing to him, but in the interests of the shareholders of the Company, for which non-shareholders, of course, do not care a rap. He succeeded by force of the ablest counsel in winning every law-suit, and without reducing the huge capital of the Company to pay off dividend after dividend until all arrears were clear. This was not done without some very severe dealings with small traders, whose business was not, perhaps, worth troubling about. The Company had the reputation of giving the smallest discounts, least credit, and no grace whatever when payment became due, but all this was in the interests of the shareholders, and by-gones are now by-gones.

To-day the least vestige of a connection between Mr. Edison and the invention of the carbon glow lamp is swept away. The clever composition of his patent No. 4,576 of 1879, and the still more clever handling of it by learned counsel, have kept up the legal fiction for the time appointed by our patent law. Now that the tar-putty patent is no more, nothing stands between Mr. J. W. Swan and the honour of the invention of the carbon glow lamp.

JOSEPH WILSON SWAN.

To-day (November 10, 1893) is eventful in electrical history as the date of the expiry of the master patent of the incandescent lamp with which the name of the subject of our portrait and sketch will for ever be closely identified. To Joseph Wilson Swan belongs the honour of having invented the carbon incandescent lamp, as well as of having perfected the process of its manufacture, although he unfortunately delayed in applying for a patent, and was thus, for legal purposes, forestalled by Mr. Edison.

Pirating a phrase of Wendell Holmes, Mr. Swan says he is 65 years young! To be exact, Joseph Wilson Swan's birthday was October 31, 1828. He is a native of Sunderland, was educated there, and lived there until his eighteenth year, when he removed to Newcastle-upon-Tyne. At Newcastle Mr. Swan spent the next thirty-five years of his life—chiefly in commercial pursuits. These were, for the most part, connected with chemistry, and did not prevent, but rather helped, Mr. Swan to keep in touch with progress in scientific discovery. It was during this time that he carried out the experimental work which culminated in the invention of his electric lamp. For the last twelve years he has resided at Bromley, Kent, where he has devoted himself entirely to research—chiefly in relation to electro-chemistry. Some of the results of this work were brought out at the lecture delivered by Mr. Swan at the Royal Institution last year.

Mr. Swan is what is popularly known as a self-made man, that is to say, he does not owe a very large debt of obligation to educational training. The days of his youth were not the days of physical science colleges. What scientific knowledge Mr. Swan acquired in early life, he acquired in spite of great difficulties and discouragements. Mr. Swan is a born inventor. The bias of his mind is essentially scientific and artistic, and his inventions, which are many, lie in these domains.

His name is known most widely in connection with the incandescent electric lamp. The first lamp ever publicly exhibited, having the typical features of the lamp which has done more than anything else to popularise electric lighting, was exhibited by Mr. Swan in 1879. Another of Mr. Swan's inventions (the carbon process) has made his name a household word among photographers all over the world, but the public do not so generally know that it is to Mr. Swan we owe this most excellent of all the permanent photographic processes for the facsimile reproduction of works of art. This was the outcome of the work and ideas of thirty years ago when Mr. Swan was greatly interested in the manufacture of collodion, a manufacture which he brought to a high state of perfection by means of an original method of making pyroxyline, which has never been published.

The world of art also owes to Mr. Swan, conjointly with Mr. Woodbury, the discovery of a new principle in mechanical printing, on which is based the process known as Woodbury-type. In applying photography to ordinary mechanical modes of printing, Mr. Swan was one of the first, if not *the* first, to recognise the necessity for changing the uniform character of the gradation of light and shade in a photograph to gradation of a different character adapted to the usual methods of mechanical printing. In a more or less modified and improved form, Mr. Swan's devices to this end—patented many years ago—are still employed, and their results are seen in the wonderful photogravure reproductions of pictures, which have done so much to familiarise the public with good works of art, and in the photographic block illustrations which are so frequently seen in periodical literature. The great revolution in the art of photography, which has made every other man, woman, and child a photographer, originated in the discovery by Mr. Swan of the now universally-known means of so greatly accelerating, by the action of heat, the sensitiveness of bromide of silver diffused through gelatine. Mr. Swan may justly be said to have created the modern "dry plate," though he did not publish his discovery except through the medium of a new manufacture, the secret of which very quickly spread in every direction.

Amongst the multitude of inventors associated with the improvement of the Planté-Faure secondary battery, it is apt to be forgotten that Mr. Swan was the originator of the cellular form of accumulator plate, and that it was he who first produced a miners' electric safety lamp, by a combination of his two inventions of the incandescent lamp and an improved secondary cell. We have not space to enter fully into descriptions of all Mr. Swan's inventions, but we cannot omit to mention his motor electric meter, which was one of the earliest of this type, nor his electric fire-damp detector.

Mr. Swan's latest achievement is the production of gold-leaf by electro-deposition, and, *àpropos* of this, he has been heard to remark, with a twinkle in his eye, that it was the only form of gold that had ever stuck to his fingers. The late President of the French Republic, and the University of Durham were amongst the foremost to publicly recognise the merits of Mr. Swan's invention of the incandescent lamp, the former creating him Chevalier of the Legion of Honour, and the latter conferring on him the degree of M.A., *honoris causa*.

A man of varied tastes and accomplishments, in literary matters Mr. Swan is critical and fastidious, and is a passionate lover of poetry. He has Tennyson by heart in every sense; nearly all the master wrote is as much in his mind as in his library. The anniversary of Mr. Swan's birthday has just passed, and we heartily wish him many happy returns.

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REVIEWS.

A B C Five-Figure Logarithms for General Use. By C. J. WOODWARD, B.Sc. (London: E. and F. N. Spon, and others, 1893.)

This compact little book, which is neatly and conveniently put together, contains the common mantissæ of numbers up to 10,000, the logarithmic sines, cosines, tangents, cotangents to 10 seconds of arc, together with full explanations and simple exercises, showing how to use the tables. Not a little ingenuity has been exercised by the compiler in devising a system of arrangement, whereby the person who uses these tables may quickly and expeditiously arrive at the desired result. In the use of ordinary logarithm books there is much turning over of leaves before the desired page is found; and, where a lengthy calculation has to be made, the mere mechanical part of looking out the "logs" takes a great deal of time. Mr. Woodward has adopted the time-saving plan of providing each page with an index pip, after the manner of ledgers, index files, and memoranda books, so that the numbers to which the logarithms on the several pages relate can be seen at a glance and without having to turn to any page except the ones actually needed. Then again, there is an easy and efficient system of index letters on each page, enabling the user to quickly find the last figure in the mantissa in a subsidiary table at the bottom of each page. The book is divided into two parts, the first containing common logarithms of numbers, the second containing trigonometrical logarithmic quantities. To one who is already familiar with the use of tables, 10 minutes will suffice to enable him to work with Mr. Woodward's book, and he will find that a great many 10 minute's will before long be saved if he has occasion to use logarithms frequently.

Factory Accounts. By EMILE GARCKE and J. M. FELLS. Fourth Edition, revised and enlarged. (London: Crosby Lockwood and Co. 1893.)

On turning over the leaves of this work the first impression conveyed by the elaborate methods of bookkeeping which it describes is that any firm to whom it could be useful will already have adopted some system of its own, and that it would be hopeless for a small concern to introduce such complications into their business. But, apart from its value to accountants, there is much to be learned even by a very small firm from this, practically the only work on the subject. The authors touch here and there on questions of political economy, but the book is thoroughly practical, and the fact that it has reached its fourth edition shows that it has been properly appreciated. Some valuable appendices have been added.

Electric Lighting and Power Distribution. Part III. By W. PERREN MAYCOCK. (London: Whittaker and Co.)

We regret that the third and concluding part of this book in no way makes amends for the shortcomings of the first two parts. The author has characterised our review of the first part as "palpably unjust"; we therefore confine ourselves to three instances taken at random, on which we base our opinion of the present volume. A water voltameter is described on the third and fourth pages, but no information is given as to the volumes of gases given off; this is not scientific. In describing Planté's secondary battery the electrolyte is represented as consisting of one part of sulphuric acid in [illegible] parts of water, but nowhere in the sixteen pages devoted to modern secondary batteries is any further information given either as to the proportion of acid to water or as to the [illegible] of specific gravity of the electrolyte; this is not practical. A form of Goolden regulator is illustrated which has been superseded by an improvement some four or five years ago: this is careless. We hope that the work will be well pruned in any subsequent editions through which it may pass; it will then, as it is profusely illustrated and written in simple language, serve as a fairly good elementary textbook or a popular treatise for beginners.

Electric Light Fitting. By J. W. URQUHART. Second Edition. (London: Crosby Lockwood and Co. 1893.)

This book has been enlarged by the addition of chapters on street cable work, specifications, and fire risk. The sample specification is very poor; the chapter on fire risks consists of Mr. Heaphy's laws and "useful facts." The rest of the book is fairly up to date, but contains several suggestions of doubtful value. Combined switches and cut-outs are recommended, "reducing, as they do, the labour of fitting fuses." The author acknowledges that "many electricians will not permit the distribution of fuses throughout the system for house wiring. In such cases it is considered safer to assemble all the fuses upon a fuse board." While there are objections to scattering of fuses in unnecessary places, such as switches, it is certainly unwise to assemble *all* fuses upon a fuse board. It is suggested that the primary of a house transformer should be opened when all the lamps are switched off. "It may, of course, be effected by an automatic switch, but it is far more likely that a hand switch will prove the more reliable. The electricity user will be expected to do this himself, and will no doubt attend to it, *if the supply meter be upon the primary circuit of the transformer*." The italics are the author's. A statement of this kind is enough to shake confidence in the practical value of the whole of the rest of the book, which, however, contains a good deal of useful matter. A table of the resistance of wires is given, but no rules for selecting wires to give a desired fall of volts.

Mechanical Engineering Materials. By E. C. MARKS. 1893. Manchester: The Technical Publishing Company.

No objection can be taken to the small size of a pocket-book. The author chooses a size, and fills it with as much matter as it will hold. A treatise on the strength of materials and on the design of engineering construction, consisting of only 52 crown octavo pages, needs some excuse. This is to be found in the Preface. The author states that the contents "embrace the requirements of the City and Guilds of London Institute in a great part of one section of their annual examination in 'mechanical engineering.'" If we believed this statement, our opinion of the City and Guilds of London Institute would be considerably modified. The excuse, however, cannot justify the meagreness of the work. Not even all of the little it contains is useful. A paragraph on brass informs us that "about 35,000 persons, including men and women, boys and girls," are employed in the brass trade at Birmingham. Immediately facing this is a paragraph on delta metal, and we learn that the name "is but a name only, and in no way indicates either its properties or the purpose to which it may be suitably applied!"

Practical Electric Light Wiring. By F. C. ALLSOP. (London: Whittaker and Co. 1892)

In 270 pages, well illustrated, and containing nothing obsolete, the author does not manage to give a really complete account of the modern practice of wiring. The worst fault is that no wiring table or rules are given, except a table based on 1,000 amperes to the square inch. Nothing whatever is said about fall of volts. A diagram of the wiring of a house on the distributing board system, shows only one such board, in the entrance hall; pairs of conductors rise to each floor, and branch off to the rooms with no cut-outs at the joints. Another diagram of the tree system shows that method much more completely. Nothing is said about two-way switches for corridors, &c., or about three-groove moulding, which is in common use.

The Principles of Fitting. By a FOREMAN PATTERN MAKER. (London: Whittaker and Co.)

"No volume, that I am aware of," says the author, in his preface, "has yet been written upon the subject of Fitting." Very good reasons might be given for this gap in modern literature, and the present work fails to convince us that the art can be taught by a book. The substance of this book appeared as a series of articles in the *English Mechanic*, and will no doubt be appreciated by amateurs.

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INDIAN TELEGRAPHS IN 1892-93.

The administration report of the above has lately been published in India, and reveals satisfactory progress. The Department has now 41,030 miles of line and 126,251 miles of wire, an increase in five years of 30 per cent. The amount expended on lines and buildings up to the current year is equivalent to about £5 millions. The lines, including cables, have cost about 992 rupees, or £62 per mile. In the year under review 2,405 miles of line have been added to the system. The number of offices have increased by 314, the total standing now at 2,553. This may seem a small number for a large empire, but the circumstances of Indian life are such that in towns and villages under 10,000 inhabitants the telegraph is little used. But the increase in 1892-93 of about 14 per cent. is significant of the demand that is arising for the wire for chiefly trading purposes. The revenue receipts show an increase of about £15,000 (at 10 rupees per £1), and the total revenue earned yields a return of 4·46 per cent. on the total capital outlay. The public may, therefore, rightly expect to look for the profit to be devoted to the provision of increased facilities. At the same time, since one-fifth of the entire revenue is made up of rent of lines on railways and canals, and the charges for these lines are notoriously high, no doubt the shareholders in the railways in question will think the time opportune for agitating for a reduction.

Foreign private messages have increased; but owing to reduction in transit rates, the revenue in this respect has not recovered to its former figure. The service between Bombay and Madras, in connection with the Eastern and Eastern Extension Telegraph Companies' cables, is as a rule excellent, although, as in the case of all land lines, occasionally interrupted by unusually severe storms. This important link in telegraphic communication with the Far East was one in the perfecting of which Sir A. J. Leppoc Cappel, when Director-General of Telegraphs in India, much interested himself.

Inland private messages have more than doubled in value and in number in nine years; the number in 1892-93 was nearly three millions. Here, again, the number is insignificant as compared with that of a European country, but it is not many years ago that a million of people in Calcutta despatched only 1,000 messages a day. The fact is that by far the greater part of the population of India is so poor that the expense of a telegram can rarely be indulged in.

Probably the intermittent character of the traffic accounts for the fact that no high-speed apparatus has before the current year been adopted. Hitherto hand-signalling and receiving by Morse sounder have been invariably in vogue, but the Wheatstone automatic apparatus has now been successfully used between Calcutta and Bombay at a speed of some 200 words per minute.

In the Government resolution dealing with the operations of the telegraphs, Mr. Bignell is specially mentioned for his services with the Isazai Expedition. This officer has had charge of the telegraphs in the Punjab for many years, and he has done valuable work in connection with many of the frontier campaigns.

In leaving India Lord Roberts expressed his obligations to Mr. Brooke, the Director-General of Telegraphs, and his establishment for the assistance rendered by them in military works.

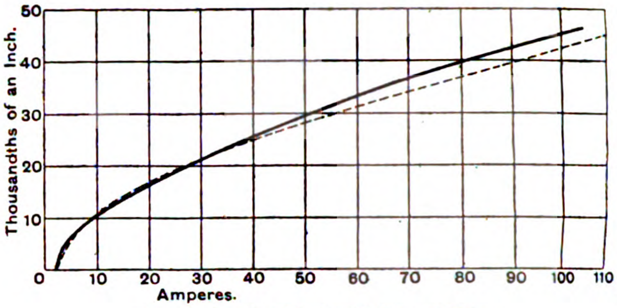
THE FUSING POINT OF COPPER WIRES.*

BY J. C. LINCOLN.

The accompanying figure shows a curve giving the relation between the fusing points and diameters of copper wire. The ordinates represent diameters in $\frac{1}{1000}$th of an inch, and the abscissæ the corresponding fusing currents.

The readings were taken under the following conditions:— The brass terminals in which the fuse was fastened were 5in. apart between their nearest points, and weighed 2oz. each; their shape was such that the wire was raised from three-fourths to one inch above the slate base. The room in which the experiments were made was guarded from draughts, and had a temperature of about 80°F. A Weston direct-reading ammeter was used in series with a rheostat and the fuse.

The points determined are plotted and the full curve drawn through their mean positions. A large number of readings was taken, giving a reliable character to the curve which, as will be seen, is a very fair one.



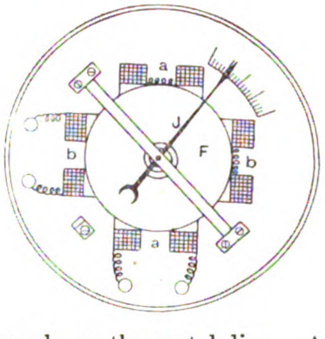
Curve showing Fusing Points of Wire.

The curve was found to have approximately the equatio $x=0{\cdot}14\,y^{1\cdot7}+2{\cdot}3$; the dotted curve is drawn to correspon exactly with this equation.

* From the *Electrical World* of New York.

AN ALTERNATE-CURRENT PHASEMETER.*

The Allgemeine Elektrizitäts Gesellschaft has adopted, f the purpose of measuring the difference between the phases two alternating currents, the apparatus which is represented the accompanying figure. This instrument is constructed o metal disc, J, to which there is affixed a needle or poin which moves over a graduated scale. Two perpendicular co *a* and *b*, are traversed by the two alternating currents, p ducing a magnetic field which is so compounded as to exer



rotary action or couple on the metal disc. A spiral spring, opposes the rotation of the disc, and the point of equilibriu of the couple determines the position of the needle.

* From *La Lumière Electrique*

BOWDEN'S PATENT CABLE COUPLING.

Bowden's patent electric cable coupling was designed wit view to providing a convenient and safe means of divid high-pressure cables into sections, so that any portion of a m can be cut out and worked upon, without interfering with supply of current on the remaining portion of the cable. couplings are of small size, being about $4\frac{1}{4}$in. diameter at t largest part, and a pair of them lie easily in a surface bo ordinary size. By means of this appliance the main car severed in a few minutes and without risk to the operator makes a perfectly water-tight joint, and will work satisfacto even under water.

The illustrations show at Fig. 1 an outside view of coupling in its normal working condition; at Fig. 2 a vie it uncoupled, and having the rubber cup turned back so expose the inner coupling nut and render it accessible. F

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shows the coupling disconnected, but having a rubber "dummy cup" connected to the end of the "live" main. Figs. 4 and 5 show a pair of couplings arranged in a street box. Fig. 6 shows one of the couplings held in a light wrought-iron clip by means of the projecting iron pins at the sides of the central

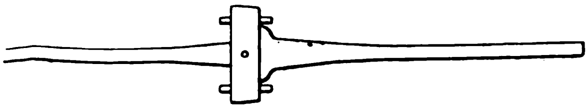


Fig. 1.

coupling ring, and in which position a curved spanner similar to that used for an ordinary hose-coupling is applied for screwing up or unscrewing the coupling ring. Coming to the actual construction of the coupling, it consists of two sets of coupling nuts, an inner one for connecting the ends of the conductors,

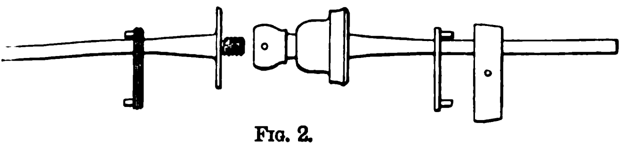


Fig. 2.

and an outer one for pressing together the enlarged and specially-formed ends of the rubber insulation. The rubber insulation takes the form on one end of the cable of a cup, and on the other end of a disc, each being made with a tubular neck, which slips on to the cable.

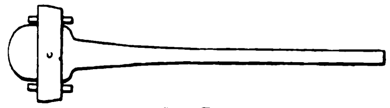


Fig. 3

The cup has a flange, the outer diameter of which is the same as that of the disc.

The central outer ring, which is of brass, is threaded inside at one end, and screws on to a brass washer or ring correspondingly threaded on its outer edge, which is shown hanging at

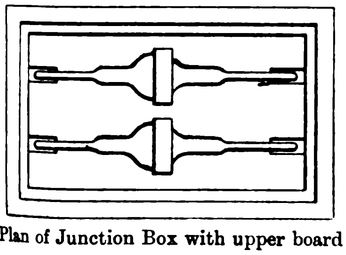
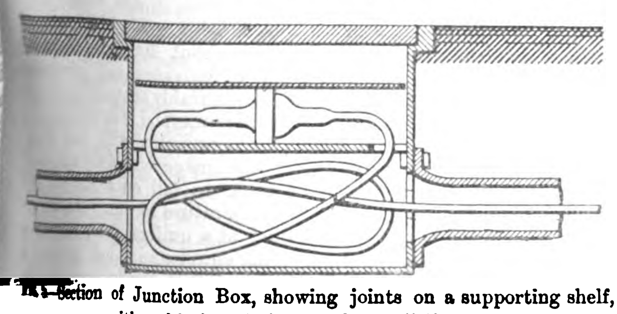


Fig. 4.—Plan of Junction Box with upper board removed.

the left of Fig. 2, while it presses, by means of an internal flange, against the other brass washer shown hanging on the cable at the right of Fig. 2, between the rubber cup and the central coupling-ring. By this means the flange of the cup is tightly clamped against the disc, forming a water-tight joint.



—Section of Junction Box, showing joints on a supporting shelf, with a thin board above to keep off dirt.

The inner coupling arrangement consists of two male screws, right and left-handed respectively, which are bored to fit the copper portion of the cable, and sweated to its ends. A nut, tapped right and left hand to suit the screws, is fitted in such a manner that when turned sufficiently to separate the ends of the cables, as shown in Fig. 2, it can be turned no further, and consequently, cannot be accidentally unscrewed so as to drop. The nut is covered with rubber, so as to be insulated; it is easily turned by hand, but has two small holes to admit of the use of a wood-handled lever for tightening it to secure a perfect contact between the ends of the conductors. The coupling, which is supplied by Mr. William Boby, of Union-court, London, is provided with about 3ft. 6in. length of cable, and the cup and disc are put on at the same time as, and virtually form one piece with, the rubber insulation of the cable.

The House-to-House Electric Light Company, of West Brompton, have had the couplings in use for about eighteen

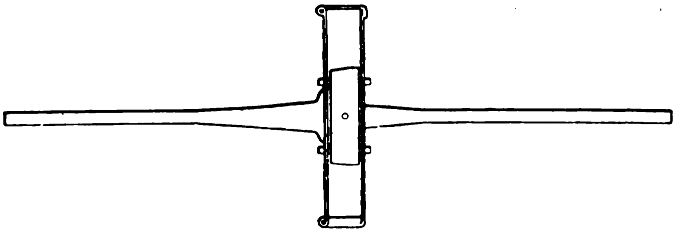


Fig. 6.

months, and find them satisfactory. The electrical contact seems perfect, and they find the appliance a great convenience; they have about 70 in operation.

The Electricity Supply Company of Spain put 12 into their mains as a trial, with the result that 100 are now in course of construction for them. Forty of the couplings have been supplied to the City of London Electric Light Company.

ELECTRIC PYROMETRY.*

A new phase in the history of the measurement of high temperatures began with the work of Sir William Siemens, who showed that the variations in the electrical resistance of a heated metallic conductor would afford a pyrometric method. The names of Muller, Quincke, and Ressig may be mentioned in connection with early work in this direction, but Siemens was the first to demonstrate the practical nature of the method. The first notice I can find of his experiments is given in a letter to Dr. Tyndall, dated December, 1860. Twelve years later, in a lecture delivered before the members of the Royal Institution,† Siemens made some interesting remarks on the industrial aspect of pyrometry as limited by capabilities of the mercurial thermometer. He said, "when we ascend the scale of intensity, we soon approach a point at which mercury boils, and from that point upwards we are left without a reliable guide; and the result is that we find in chemical books on chemical processes statements to the effect that such and such a reaction takes place at a 'dull red,' such another at a 'bright red,' or a 'cherry red,' or a 'white heat,' expressions which remind one," he adds, "of the days of alchemy rather than chemical science at the present day." With reference to this it may be observed that if, as Sir William says, technical men "were left without a reliable guide," directly the limits of the mercurial thermometer were passed it was their own fault. The thermo-couples proposed by Becquerel and others would have given them trustworthy measurements of high temperature, but they either lacked knowledge of the sources of information or the skill to use the far from complicated appliances at command. An excellent dead-beat galvanometer, so essential in connection with all pyrometric methods of which electricity is the base, was long ago provided by Sturgeon; but metallurgists, who sadly needed a good pyrometer, were either ignorant of the existence of such physical instruments, or untrained in their use, and are now only beginning to recognise the necessity for their adoption.

The nature of Siemens's instruments may be made clear by the accompanying diagram (Fig. 1). A divided current passes from the battery, B, to a platinum wire, C, coiled round a clay cylinder, and to a resistance coil, R. At the ordinary temperature, the resistance of the platinum coil is balanced by the standard resistance, R. If, however, the platinum coil be heated, the resistance will be increased, and this increase of resistance, which can be measured in various ways, indicates the temperature of the coil C. The coil itself may be adequately protected and exposed to temperatures,

* Abstract of a lecture on "Alloys," by Prof. W. Chandler Roberts Austen, before the Society of Arts, March 6, 1893.

† *Proc. Roy. Inst.*, Vol. VI. p. 483.

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which have been determined by the air thermometer; the deflection of a suitable (differential) galvanometer, G, will then indicate temperatures directly. For instance, the temperature at which zinc boils has been accurately fixed at 940°C., and if the coil is heated in the vapour of boiling zinc, the angle through which the galvanometer mirror is deflected marks the temperature of 940°C. For many years this electrical-resistance pyrometer was the only appliance believed to be trustworthy which could be placed in the hands of artificers. Its usefulness was widely recognised, and a Committee of the British Association was appointed to report upon it. The result of the inquiry* rather tended to shake confidence in the instrument, as it was shown that it was liable to changes of zero. Mr. H. L. Callendar† has, however, done admirable service by proving that, with certain precautions, the method may be rendered trustworthy. He winds the platinum wire on a plate of mica, excludes reducing gases (as the Committee suggested) by enclosing the coil in a tube of doubly-glazed porcelain, and uses a

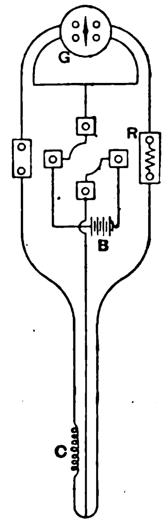

FIG. 1.

zero method of measuring the current with the galvanometer. It will have been evident from the works of the Becquerels and of Deville that by the year 1880 two main systems of pyrometry had been well established; these depended respectively on the use of the air thermometer and of thermo-couples. Siemens's electrical pyrometer, though its utility was admitted, was expensive, and confidence in it was not established. The basis of optical pyrometry had been firmly laid, but the measurement of high temperatures by optical methods had not passed into the domain of industrial work. The publication of the article "Pyrometry," in the last edition of the "Encyclopædia Britannica," in 1886, enables us to judge what progress has been attained at the period when this important work appeared. In 1886, the author of that article, Mr. N. Shaw, who is so eminently qualified to form an opinion, took a distinctly gloomy view of pyrometry. He concludes his

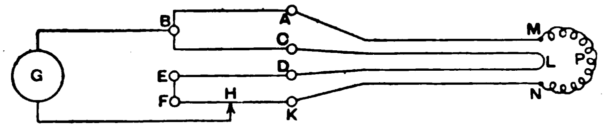

FIG. 2.

excellent article by suggesting doubt whether any of the instruments he describes "can be easily made to take up the temperature of the body or enclosure under investigation," and he points out that "perhaps the most important modern attempts at the development of pyrometry are those connected with the identification of the law connecting the temperature with the amount and nature of energy which it radiates, for on such attempts depends the possibility of measuring the temperature of a hot body by means of the light it emits" . . . . and he adds that, "at present there is no general agreement between scientific men as to the form the relation takes." In 1886, the year Shaw wrote, the beginnings of very distinct advances in practical pyrometry were made. Callendar published the first part of the work that are subsequently developed in his well-known Paper,‡ which restored confidence in the electrical resistance pyrometer. In the following

* "British Association Report," 1874, p. 242.
† *Phil. Trans.*, Royal Soc., Vol. CLXXVIII., 1887, p. 161, and subsequent Papers in the *Phil. Mag.* and *Proc. Roy. Soc.*
‡ *Phil. Trans. Roy. Soc.*, loc cit.

year Prof. H. le Chatelier* communicated a Paper to the Chemical Society of Paris on the platinum, platinum-rhodium thermo-couple, which gave an entirely new and vigorous impulse to thermo-electric methods of pyrometry, as the form of thermo-couple he employed takes up the temperature of the locality in which it is placed with astonishing rapidity, and Barus established the thoroughly trustworthy character of the platinum, platinum-*iridium* couple, and devised a very ingenious pyrometric method depending on the viscosity of gases.

Fig. 2 represents, somewhat diagrammatically, the arrangement of Callendar's apparatus.† A B, B C, are equal resistances, forming the arms of the balance. The battery is connected at A and C, and one terminal of the galvanometer, G and B; D E represents a set of resistance coils, which, together with the resistances, A B and B C, may be supplied by an ordinary box of coils of the "Post Office" pattern. F K represents a straight bridge wire, with a divided scale attached. The other terminal of the galvanometer is connected to the contact-piece, H, which slides along this wire. The leads, A M, K N, from the pyrometer coil, P, are connected to A and K; and the compensating leads, C L, L D, the resistance of which is equal to A M, K N, are connected to C and D. These four leads may be of any convenient length; they are symmetrically arranged, so that corresponding parts are always at the same temperature. When the balance is found by inserting suitable resistances in the arm, D E, and sliding the contact-piece, H, it is plain that, since the resistances, A B, B C are equal, the resistance of the pyrometer and its leads, together with that of the length, H K, of the bridge-wire, will be equal to the remaining portion, F H, of the bridge-wire, together with the coils, D E, and the compensating wires, C L D. Thus the changes of the resistance of the pyrometer-leads, A M, K N, are compensated by the equal changes in the leads C L, L D, and the resistance of the pyrometer-coil itself is directly given by the sum of the coils D E, and the reading of the bridge-wire. The resistance of a centimetre of the bridge-wire F K is made to correspond to such an increase of the resistance of the pyrometer-coil P as is produced by a rise of 1°C. The contact key H slides along this wire, and the galvanometer can easily be made sensitive to $\frac{1}{100}$th of a centimetre of this bridge-wire, so that $\frac{1}{10}$th of a centimetre, which corresponds to $\frac{1}{10}$th of a degree, can, of course, be measured with certainty. The author has worked for several days at the Royal Mint with Mr. Callendar, and is satisfied that at temperatures exceeding that of bright redness the comparative readings are accurate to $\frac{1}{10}$th of a degree. This would have been considered impossible a few years ago, and the statement will, perhaps, be received with some incredulity.

The reader will, however, remember that measuring the increased resistance of a heated conductor is not the only way in which electricity has been made serviceable in the measurement of high temperatures. It has long been known that if a junction of two metals be heated, the electrical equilibrium of the system is disturbed, and the measurement of the difference of potential produced affords a means of estimating the temperature of the junction. The use of such thermo-junctions appears, as has already been stated, to have been suggested by A. C. Becquerel in 1826, and adopted by Pouillet ten years later. Unfortunately, the metals composing the thermo-junctions were badly chosen, and their use was consequently greatly retarded until, as already stated, within the last few years, Prof. H. Le Chatelier, of Paris, advocated the use of platinum, in conjunction with platinum alloyed with 10 per cent. of rhodium. The author first adopted this couple in 1889, and has since constantly used it, in conjunction with a photographic recorder, devised for the purposes of an investigation which was entrusted to him by the Institution of Mechanical Engineers. This instrument will be described presently. In its latest form, the couple consists of two wires, one of platinum and the other of platinum-rhodium alloy, mentioned above, simply twisted at their ends or soldered with gold, and connected with a dead-beat galvanometer of about 200 ohms resistance. The Deprez and d'Arsonval form of galvanometer, particularly the latest type of this instrument, is admirably adapted for use with the thermo-couple. A photographic method was employed as early as 1887 by H. le Chatelier‡ in connection with his thermo-couple. It consisted in allowing the image of induction sparks, produced at regular intervals of time, to fall on a narrow fixed sensitised strip of glass. If the temperature to which the thermo-couple is exposed is rising or falling at a uniform rate, the photographic images of the sparks will be equidistant; but if there is at any moment an arrest in the rise or fall of the temperature, the images of the sparks will then be closer together. The distance between the individual lines affords a method for measuring the rate at which a thermo-couple receives or loses heat from any hot locality or substance in which it may be placed.

* *Bull. Soc. Chim.*, Paris, Vol. XLVII., 1887, p. 2; *Journal de Physique*, Vol. VI., 1887, p. 23.
† *Phil. Mag.*, Vol. XXXII., 1891, p. 104, and Vol. XXXIII., 1892, p. 220.
‡ *Comptes Rendus*, Vol. CXIV., 1887, p. 1443.

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The new departure in pyrometry, by which curves are automatically obtained, will now be described. It will be obvious that by confining the image of the mirror to a minute spot, and by moving the sensitised plate at a uniform rate, a time-temperature curve may be traced by the aid of photography. The author is satisfied that the thermo-junction can afford trustworthy results, accurate to 1deg., at temperatures of over 1,000°C. One important feature of the appliance is the minuteness of the space occupied by the thermo-junction, which may be suitably protected, and inserted into the midst of a very small mass of metal. The pyrometer is calibrated by exposing the thermo-junction to certain known temperatures, such as the solidifying points of salts or metals. There is no difficulty in recognising the melting or solidifying points; for, as the mass passes from the solid to the fluid state, the temperature remains constant for a brief period, the duration of which depends on the amount of material operated upon, and its latent heat of fusion; the result being that the spot of light from the galvanometer will be arrested, and the position on the scale at which it stops marks the temperature to be determined.

POWER-HOUSE ENGINES.*

The subject of "Power-House Engines for Electric Railways" embraces one of the most important and interesting subjects that street railway companies have to consider in the equipment of a power plant. The subject represents the vital part of a street railway; as the heart forces the life current through the arteries of the body, and an impairment or weakness of this vital organ will produce impaired health, so also is the power-house engine the vital part of the street railway, as it produces the power that creates and forces the electric current through the arteries (the trolly wire) of the electric railway, and, like the heart, if the engine regulates badly, it produces a bad circulation of varied potential, which impairs the service of the road. The variety of opinion, as to the best kind of an engine for street railway power, makes the subject a difficult one on which to reach a conclusion that would not be criticised, and this Committee will therefore endeavour to treat the subject impartially. The most essential points to be considered are as follows:—

(1) Perfect regulation.
(2) Highest economy.
(3) Greatest durability.
(4) Division of power into units.

(1) *Perfect Regulation.*

Good service and uniform speed of cars can only be maintained by a constant, unvarying potential, and in order to do this the engine must regulate practically perfectly, so that there will be no variation of speed as the load varies. The variation of power required on an electric railway is unquestionably considerable, caused by cars constantly stopping and starting, going up and down grade, rounding curves, using resistance in order to run slow through crowded streets (which necessarily increases the load) and in order to have perfect service, and uniform speed of cars, the engine must be constructed so as to maintain a constant and uniform speed under any variation of load. This variation of load amounts to a very considerable fraction of the whole maximum load; in small plants it may reach 95 per cent. of the maximum, and in large plants is frequently 50 per cent. If the speed of the engine decreases when a heavy load comes on, the potential is reduced, which consequently reduces the speed of the cars, and creates an extra strain upon the machinery, which, of course, means an increase in the consumption of fuel, and in various other ways produces an imperfect and expensive service. If the speed of the engine increases, when the load diminishes, it consequently increases the voltage or potential, which is liable to result disastrously to the generators and car motors. Moreover, if the engine regulates badly, and the load diminishes suddenly, the engine is liable to "race." The governor, or regulator, to be mechanically perfect should be so constructed as to control the engine under any variation of load, with a variation of speed not to exceed 2 per cent. An engine that will regulate within 2 per cent. is practically perfect for street railway work, though there are engines on the market that, on electric railroad service, can be held to 1 per cent. deviation from the mean speed. The governor should be constructed so as to be easy of access to all of its parts, and capable of being oiled while the engine is running. Particular attention should be given to the construction of the governor, to see that there are no weak parts, and it should be simply constructed. The range of cut-off must also be larger than in engines for less variable load. The cut-off should be easily regulated between the limits of $\frac{1}{10}$th and $\frac{7}{10}$ths of the stroke. The severe conditions of high speed, and sudden and extreme variations of load, make it especially important that the engine have the best possible construction, with extra weight in flywheel and bed-plate, and that the foundation be more than usually substantial.

One of the most important features to be observed, in order to maintain perfect regulation, is to place the engine in the hands of a competent engineer, who is capable of adjusting and keeping the engine in good running order; a good engine or piece of machinery, placed in the hands of an incompetent person, will never give good service or economical results, and no doubt in a large number of cases, where engines do not give good service, the expense of maintenance is high, and perhaps a large number of the frequent casualties are attributable to incompetent, careless, or negligent engineers.

(2) *Highest Economy.*

The matter of economy has been exhaustively discussed from a scientific standpoint in the various periodicals, as well as before the learned societies, and this Committee feels inadequate to the task of presenting a report that will not be a repetition of the records on the subject. The Committee will, therefore, not undertake to deal with the subject in an elaborate and scientific manner, but will endeavour to give a few practical hints that will be of interest. The economy of an engine is dependent, to a great extent, on other parts of the power plant, and it will, therefore, be proper to discuss the matter in all its phases, even though it may be a slight digression from the subject proper, as economy is the most important factor in the operation of a power plant. In order to obtain the highest economy in the operation of an engine, it is necessary to have the engine properly adjusted to its load. It is a fixed principle that the highest engine efficiency results in working the engine constantly at its maximum rated capacity; underloading and overloading are each, therefore, undesirable, though the compound condensing engines of the largest stations will stand underloading better than the simple high-speed engine, and both classes of engines will stand underloading better than overloading. There should then be ample power both in boilers and engines to obviate excessive overloading as well as to provide for contingent breakdowns or needed repairs. The packing should be kept intact, valves free of leaks, cylinder perfectly smooth and true in diameter, so that there will be no loss of live steam. The cylinders and bearings should be kept well lubricated, and one of the most important factors is to have the steam enter the engine at a steady pressure at all times. Careful attention should be given to the setting of the valves so that the cut-off will be the same at both ends of the cylinder. The engines should be set in the closest proximity to the boiler so as to require the least amount of steam pipe, as the longer the steam pipe the greater is the loss by condensation. The steam pipe should be covered with one of the best non-conducting materials, of which there are several on the market, so as to reduce to the minimum the loss by conduction, radiation, and consequent condensation. Flexible joints should be used to prevent leaks at the joints from expansion and contraction. It should be borne in mind that wherever there is a leak of steam there is a loss of money.

We are so accustomed to consider the reciprocating engine as the only steam motor within our reach that it is not surprising that a new form of steam motor should have quietly been developed without our notice. The Committee refers to the steam turbine, one form of which, the Parsons steam turbine, has recently been subjected to vigorous and searching trials and tests by Prof. A. B. Kennedy, of London, England, which has developed power at the rate of $20\frac{3}{10}$lb. of water per electrical horse-power per hour in a turbine using steam at 97lb. per square inch, and making 4,600 revolutions per minute, the turbine having a capacity of about 165 H.P. The small size of this motor, absence of reciprocal motion, and consequent independence of heavy foundation, high speed of rotation, and consequent availability for gearing direct to generator, simplicity of construction and consequent low cost, and its very high efficiency as a motor, all tend to make this a strong rival to the reciprocating engine as a steam motor for electric power and light stations.

The next point to consider is the boiler room, where the steam is generated. Engines may be of the very best type, and, together with the steam pipe, may be in perfect condition; but unless the boiler room receives the proper attention there will be dollars lost where cents are saved in the engine room. The design and proper construction of the boiler plant is quite as essential to economy as is the case with the engine. The boiler plant should have ample capacity, as there are few cases when the draught and setting are so excellent as to allow heavy forcing without a serious loss of economy. A raising of the evaporation from $6\frac{1}{2}$lb. to 7lb. of water per pound of coal represents the saving of about 7 per cent. of the coal bill, which would warrant the incurrence of an expenditure for improvements equal to one whole year's coal bill. The boilers should be equipped with good boiler-cleaners, and should be inspected regularly and kept free of scale; the flues should be kept clean and boiler walls intact.

* Abstract of Report of Committee to the American Street Railway Association at the Milwaukee Meeting.

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Fuel is one of the largest items of expense attached to a power-house, and the waste of fuel by incompetent firemen is one of the greatest leaks attached to the operating expenses ; it is a safe proposition to state that an incompetent fireman will waste enough fuel in a year to assist very materially in paying a dividend. Simply the act of pitching a shovel of coal does not qualify a man as a fireman. It requires skill and intelligence. There is a natural disposition among the labouring classes to endeavour to do their work with the least amount of labour ; and, as a rule, the fireman will fill his furnace half full of coal at one time, give it a stir with a poker, and then set down and rest until time to fill it up again, instead of firing frequently, maintaining a light fire, and scattering each shovel of coal evenly over the grate bars, by which the maximum amount of heat can be obtained from the least amount of coal. A good plan to encourage economy on the part of the fireman is to pay him a coal premium at the end of each month, basing the amount of the premium paid on the average number of bushels of coal consumed each day during the month for a certain number of cars run. This plan was adopted by the Chairman of this Committee, about two years ago, with very satisfactory results. The limit on the average number of bushels consumed per day, to secure a premium, was placed at a point that required skill and economy on the part of the fireman to keep within the limit. During the past two years they have succeeded in obtaining the premium about one-half of the time. Careful firing is a good smoke preventive. No matter if the draught is good, and the best quality of bituminous coal is used, unless the coal enters the fire-box in the proper manner, there will be more or less black smoke issue from the stack, representing a lack of combustion and waste of fuel. Careful firing preserves the boiler and saves coal, gives a steady steam pressure, which secures an economical point of cut-off, and steam economy, from a proper expansion in the cylinder. When the plant is of such size as to require more than two firemen it will always be good economy to employ mechanical stokers; aside from their saving in labour account, they economise fuel, insure uniformity of steaming, prevent the chilling and straining of crown sheets by in-rushes of cold air through the fire doors, and prevent smoke.

The use of oil as fuel in place of coal is a live question with power and light station engineers and managers. Actual trial of oil, keeping accurate records of costs and results, will be the only absolute answer to the important question, "*Does it pay?*" But as an oil installation is somewhat costly as an experiment, it is best to secure as full outside evidence as possible on the question as to the *probable* economy. Fortunately, several accurate comparisons have been made with sufficient care and accuracy to make them valuable witnesses. Probably the most complete evidence of this kind comes from a recent and exhaustive test of the power plant of the Twin City Rapid Transit Company of Minneapolis and St. Paul (Minn.), made by Messrs. Wm. A. Pike, of Minneapolis, and T. W. Hugo, of Duluth (Wis.). On the comparative value of the two fuels, coal and oil, this test showed that with ordinary Lima oil, weighing $6\frac{3}{10}$lb. per gallon, and costing $2\frac{1}{4}$ cents per gallon, and coal that gave evaporation of $7\frac{1}{2}$lb. of water per lb. of coal, the two fuels were equally economical when the price of coal was $3.85 per ton of 2,000lb. With the same coal at $2 per ton the coal was 37 per cent. more economical, and with the coal at $4.85 per ton the coal was 20 per cent. more expensive than the oil. These results include the difference in the cost of handling the coal ashes and oil. The oil used gave the following as the result of the average of five chemical analyses :—

Hydrogen, 13·03 per cent.
Carbon, 82·38 per cent.

Evaporation, 20·631b. of water from and at 212°F. per lb. of oil.

The average plant is not run at anything like a minimum expense. So long as the cars keep running little attention is paid to the efficiency and economy of the power plant. The obvious and intelligent way to get the most work out of a steam plant at the least expenditure is to ascertain first how the total expenditure, chargeable to power per unit of production, compares with other street railroads ; of course, in making a comparison of this kind, the difference between the surrounding conditions of each plant should be considered. After making the comparison, if the plant is not running as economically as other plants, then such tests and investigations should be made as to ascertain separately the condition of the boilers and engines. To do this it will be necessary to furnish the station engineer with full facilities for testing and maintaining records of each part of the station plant and operation, it being presumed that only an engineer competent to carry out such tests and records will be placed in charge of the plant. If you find the plant is deficient in any part do not adopt haphazard the first idea that suggests itself for its improvement, but study out the cause of the trouble. If the boilers are inefficient it may be because the rate of combustion is too high or too low for the amount of heating surface, a faulty setting, a poor heater, or none at all, a wasteful fireman, or any one or more of a dozen different causes ; the engine may be of inefficient type, underloaded, overloaded, badly set or leaking. Find the trouble and then go systematically to work and remedy it. The standard of maximum efficiency attainable should be ascertained with each portion of the plant, and each part brought up to that standard. With modern appliances and fairly well constructed plants a total station efficiency of 70 per cent. should be set as the standard.

The loss of power between the engine and switchboard terminals is from 15 to 25 per cent., which is attributable to the inefficiency of dynamos, and also to the friction of countershafts, belts, idlers, and attachments, which are simply power consumers, representing a waste of power without any resultant benefit. Besides the loss of power, the expense of maintaining the various arrangements for the transmission of power is quite considerable. This waste of power can be overcome by connecting the generator direct to the shaft of the engine. While machinery of this class is more expensive than the other because it demands a slow speed for the generator, necessarily increasing its size, the saving in power and maintenance of the machinery of transmission will be sufficient to compensate for the slightly reduced dynamo efficiency, due to slower rotation, and will warrant the recommendation of the direct-driven equipment for moderate or large-sized plants. This direct coupling of engine and generator gives also an important advantage, particularly in the large stations in crowded cities, by the considerable saving in floor space.

The Committee look with favour upon compound engines for street railway work, especially so with engines having ranges of cut-off which keep the low pressure cylinders ever from expanding below atmosphere. When this is the case there is no doubt that the compound engine is very economical as it carries the expansion of steam to a greater limit. Where it is possible to condense in connection with the compound engine, there is not the slightest question as to economy. In fact where condensing is possible there is no reason why the expansion should not be carried to a further limit. Ordinary considerations of economy in labour account will dictate the use of labour-saving appliances and methods about the boiler house and engine room. A feature frequently omitted, owing to a lack of appreciation of its value as a labour saving and a safety appliance, is a light overhead travelling crane with differential pulley blocks for handling armatures, cylinder heads, and other parts of machinery.

The practice occasionally followed of placing the generators in the second storey of the power-house, is not to be recommended even where floor space is difficult to secure. The difficulty of securing for the dynamos rigid foundations, and the resulting evil of increased frictional losses and heating, will generally render the disposal of plant inferior to placing the dynamos on rigid ground foundations, even if the problem of floor room has to be settled by direct coupling of generators to the engine or the incurring of considerable outlay for additional ground room. The plan adopted at the power station of the West End Company in Boston of sinking the countershaft into a basement pit, keeping the generators on the same floor with the engines, is worthy of consideration for extraordinarily large plants as securing rigidity of foundations, necessary belt lengths, economy of floor space, without going to direct gearing of generators to engines.

(3) *Greatest Durability.*

When electric traction was first introduced for street railway engine builders were not cognisant of the actual requirements of this kind of service; they did not anticipate fully the extraordinary variation of load and the liability of a short circuit, which so severely test the strength of an engine. They proceeded to build engines from theoretical plans and specifications which have proved by actual practice to be entirely inadequate for this class of work. Engine builders, however, are endeavouring to overcome mistakes which were made at the outset by strengthening and making all of the parts more durable, and to make such improvements as will meet all the demands for this extraordinary class of work.

(4) *Division of Power into Units.*

When electricity was first introduced as a motive power for street railways the largest type of generators were small units as compared with those manufactured at the present time ; and, as a rule, high-speed engines from 100 H.P. to 200 H.P., belted direct to the generator, were in most cases adopted without regard to the size of the plant. In some instances Corliss engines were installed and the dynamos connected to the countershaft. In nearly every installation mistakes of more or less proportion were made, not due, however, to the fault of street railway people, but the lack of knowledge on the part of the manufacturer as to what was actually necessary to properly fulfil the requirements of the new field of traction. The pioneers of electric traction have, as a rule, suffered from these mistakes by the expense of changing to modern, improved, and more economical machinery, or have been financially compelled to jog along with the obsolete outfit and consequent large power-house expense. Local surrounding and conditions will, to some extent, govern the division of power into units, but as a rule, the following principle will be safe to follow :—The size of the proper unit of subdivision should be such as to give th

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required relay or reserve above the maximum power adopted. This will apply equally to boilers, engines, and dynamos. The following table will serve to show approximately the proper proportion :—

Maximum horse-power required to operate road.	Number of engines required.	Horse-power of each engine.
200	2	200
400	3	200
600	3	300
1,000	3	500
1,500	4	500
2,000	4	750

It will be observed from the above table that enough engines are provided to furnish the maximum horse-power required to operate a road and have a surplus of one engine. This is very essential, as it enables the engineer to keep his engines in perfect adjustment and repair, having at all times an extra engine to work on, or in case of a breakdown the extra engine is ready to take the place of the disabled one. The "maximum horse-power required to operate the road," referred to in the table, is not to be taken as the sum of the power needed by each car in service, except in case of small installations, since the maximum power required does not increase in proportion to the number of cars in use, since the line losses are not materially increased with increased traffic, and because as the number of cars increases, the fluctuations of load tend to balance themselves and to reduce the *maximum* load nearer to the *average* load. Thus in a ten-car plant, cases will occasionally occur when all of the cars will require their full power at the same time, and the power plant must be planned accordingly, but there is no probability that all of the cars of a one-hundred car plant will all require their full power at the same time ; from 60 to 75 per cent. of this power, depending upon local conditions, will be sufficient for this plant.

Conclusion.

The Committee sent a list of questions to a number of street railways for such information as would be of service in formulating an intelligent report, by securing an idea of the construction and equipment of the various power plants, and the result of their operation and experience with the various types of engines in service. Only a small number made a reply, from which the Committee would infer that a number of roads are not giving the question of the expense of their power-house much consideration. From the replies that were received, the Committee find quite a variety of types and kinds of engines in use by street railroads, and no uniformity of opinion as to the best and most economical engine for power-house work. Question No. 30 on the list was "What kind and style of engine would you recommend for railway power use (base your opinion on regulation, efficiency and economy)?" In nearly every instance the kind and style of engine which the particular railway had in service was always recommended as the best, showing that the observations and investigations as regards their power were restricted to their own power plant, and the result of its operation was accepted as perfectly satisfactory, perhaps without making comparison with other plants or making such tests and investigations as are necessary to ascertain if they were obtaining a standard of efficiency from their plant. The Committee therefore feel at liberty to express their own convictions as to the best engine for power-house work, based upon the investigations which they have made, and in the line with the progress of the present time.

In selecting a type of engine the size of the plant must largely govern, as well as local conditions, such as water supply and price of fuel, though some consideration may be given to opportunities for station room and arrangement. For small plants to run 10 or 15 cars, simple high-speed engines belted direct to generators are unquestionably the proper choice. For 20 to 50-car plants, compound engines, with condensing apparatus where it is possible ; with tandem compound engines for the smaller plants and cross compound engines for the larger ones, geared direct to generator, will probably be found most economical. While for the larger systems compound or triple-expansion condensing engines, using steam at a high initial pressure, and either driving a countershaft or coupled direct to generator, whichever the conditions of the case will warrant, will be found a proper selection. In every case, except for small plants, where engines are belted direct to generator, the vertical type of engine is recommended.

Royal Institution of Great Britain.—At the general monthly meeting, Monday, November 6, 1893, Sir James Crichton-Browne, M.D., LL.D., F.R.S. (Treasurer and Vice-President), in the chair, the special thanks of the members were returned to Lord Armstrong for his donation of £100 towards the fund for the promotion of experimental research at low temperatures.

THE CHLORIDE ELECTRICAL STORAGE BATTERY.*

BY HERBERT LLOYD, F.C.S.

The electrical accumulator which I will try to describe is known as the chloride cell. It is so called because the plates constituting the element are made up of tablets cast from fused chlorides of lead and zinc, held together by a frame or rim of antimonious lead. When these composite plates are cast, however, they are not capable of use in a storage battery. They do not contain material which is in any sense active material, nor material capable of becoming active in a secondary battery fluid. They are not capable of serving as oxygen plates, as they will not absorb oxygen, nor are they capable of use as hydrogen plates, as not only would their immersion in the dilute sulphuric acid of the storage battery result in contaminating the fluid with chloride of zinc, which would be fatal to its proper action as a storage battery fluid ; but the effect of the hydrogen liberated would be to form hydrochloric acid, with the chlorine of the chloride of lead, which hydrochloric acid would further contaminate the fluid and make it inoperative as a storage battery fluid. Moreover, these tablets are non-conductors of electricity. It is plain, therefore, that a plate consisting of tablets of chloride of lead and chloride of zinc is worthless as a storage battery plate, and cannot be used as such. Its chemical composition must first be radically changed to fit it for use either as an oxygen plate or a hydrogen plate. This chemical change is brought

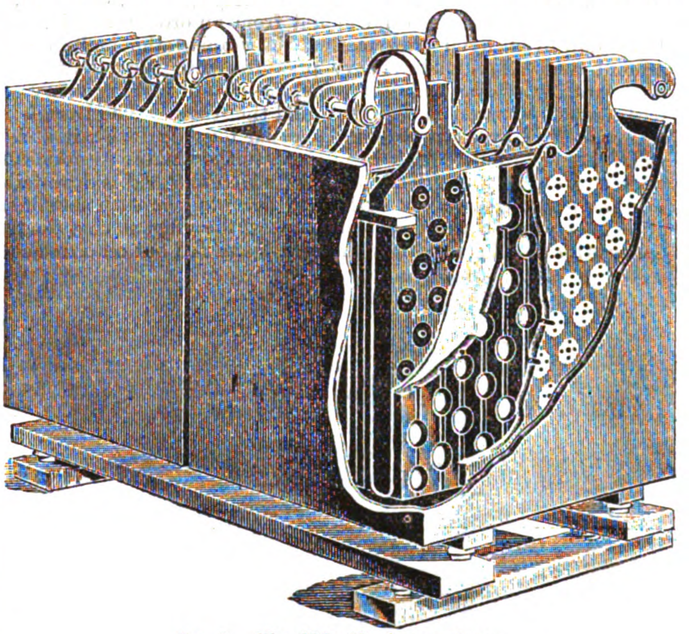

Fig. 1.—The Chloride Accumulator.

about by means of a bath of chloride of zinc or some equivalent substance, in which the plate of tablets is to be immersed in connection with a slab of metallic zinc. This arrangement is, in fact, a primary battery, in which the zinc acts as the positive element, while the tablets constitute the negative element. This operation may be performed with current produced by a dynamo ; but it is a very tedious and expensive process as compared with reduction by means of zinc.

The electro-chemical action in this combination results in withdrawing the chloride of zinc from the tablets by simple solution in the bath, and the withdrawal of the chlorine of the chloride of lead from the tablets, and fixing it in combination with the zinc with the formation of chloride of zinc. It may, therefore, be said that the chloride of lead tablets constitute material which is destined to become active by electrical disintegration, which is brought about when they are connected with the zinc plates in the bath of chloride of zinc. When this process of electrical disintegration is complete, and the chloride of zinc is washed out of the plate, a mass of crystallised metallic lead is left, which is suitable for immediate use in a storage battery, without the tedious forming process of Planté, and without the application of any active material or material about to become active by the processes of Brush and Faure.

To describe in detail the process used in the manufacture of this plate, as it is carried on commercially, I will begin with metallic lead. The first step in the production of chloride of lead is to bring the lead into such a state of subdivision as to make it readily soluble in nitric acid. A process which is satisfactory is to melt the pigs of lead in a suitable furnace, and when the lead is brought to a high state of fusion to convey it through a pipe into closed

* Abstract of a Paper read at the meeting of the Electrical Section of the Franklin Institute, September 26, 1893.

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chamber, where it is delivered in a fine stream into a jet of dry steam, the result being that the lead is blown into a moderately fine powder, and falls on the floor of the chamber. This powder is then shovelled into earthenware baskets suspended in large tanks of dilute nitric acid. When the lead has gone into solution in the form of nitrate of lead, the clear nitrate of lead solution is run off into precipitating tanks, where, on the addition of hydrochloric acid the chloride of lead is thrown down in a fine white powder, nitric acid being set free. This nitric acid is returned to the dissolving pots to be used there again in bringing fresh lead into solution. The precipitated chloride is then washed by decantation and thoroughly dried.

The next step is to mix the chloride of lead so produced with the proper proportion of chloride of zinc, when both are melted together. I will show later on the direct effect produced by the chloride of zinc in the plate. The fused chlorides are next cast into tablets of any desired size or shape, and with a bevelled or V-shaped edge. These tablets are then placed in a second mould, called a framing mould, where they are placed at a fixed distance apart to allow the frame of antimonious lead to be cast around them. In this operation the result most desirable to obtain is to produce this framing lead in as dense a form as possible, so that, unlike the material destined to become active, it will not be attacked by the oxidising current when set up in a cell. The ordinary method of casting storage battery grids is, of course, to pour the molten lead into the mould from an ordinary ladle. We have improved upon this method by forcing the molten alloy around the tablets under heavy pressure, with the result of no only forming a dense metallic frame, but also of making a very perfect contact between the pastille and the frame. The pastille, at the same time, on account of its peculiar form, is dove-tailed, as it were, into the frame. This form obviates the trouble so noticeable with the ordinary red-lead plate, in which the grid is dove-tailed into the plug; that is, the surface of the plug on each side of the plate is of a larger area than the centre of the plug, so that the tendency is for the plug to split in the centre and fall out on either side.

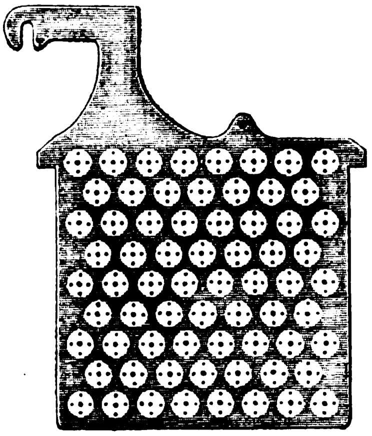

Fig. 2.—Chloride Accumulator Plate.

When the completed plate is taken from the framing mould it is placed in the reducing tank in connection with a plate of zinc, as described in the first instance. This reduction process extends over a period varying from 12 to 24 hours, according to circumstances. When reduction is complete, the plate is thoroughly washed in running water. In order to be sure that the very least trace of chlorine has been removed from the plate, all plates are set up as cathodes in a bath of dilute sulphuric acid, plain lead plates being used as permanent anodes in this tank, and a heavy current is passed through the plates for several hours. If the reduction has been incomplete the chlorine will make itself felt in this operation. Excepting through carelessness on the part of the workmen it is practically impossible for the plate to contain any chlorine at this stage.

When the plates are removed from the hydrogen bath they are next set up in forming tanks in connection with the plain lead permanent negatives, and here they are charged continuously for several weeks, or until the crystalline, spongy lead has been completely converted into peroxide of lead. The theoretical amount of current necessary to form a pound of peroxide of lead is about 200 ampere hours, and owing to the beautifully porous structure of the plate this figure holds out very well in practice; the plates will always be found thoroughly peroxidised after they have received a little over the theoretical quantity of current necessary. The positive plates after formation are then set up with the requisite number of negative plates (the active material of which is in a soft, spongy state as it came from the reducing tank), the lugs or terminals of the plates of each series being burned together with a hydrogen flame, after being insulated. The cells are then charged and discharged a few times until they give their proper capacity, when they are ready for shipment.

Chloride of zinc is used in this plate for two reasons. In the first place, it is impossible to cast plates of chloride of lead without it, as the casting on cooling falls to pieces, so the admixture of chloride of zinc is absolutely necessary on that account. In the next place, it will be readily seen that by the use of chloride of zinc it is possible to so control the density of the plate as to produce any porosity that may be desired, and as within certain limits the capacity of a plate is proportional to the porosity, this use of chloride of zinc is of vast importance. In the manufacture of the ordinary red lead or pasted plate, the density of the material depends mainly upon the energy which the boy uses in pushing the red lead into the grid, and consequently the plates are seldom or ever uniform. In the chloride cell, providing the materials are properly weighed and the mixture thoroughly stirred after fusion, the plates are essentially uniform, as the mixed chlorides become perfectly fluid and every plate cast is exactly like every other plate. It is never necessary to reject any plate for want of capacity. The mixed chlorides, on cooling, crystallise into a hard, stony substance of a peculiar crystalline nature. After reduction the metallic lead is left in the form of fine acicular crystals, running through the plate perpendicular to its surface, and the elimination of the chlorine and the chloride of zinc provides minute cell spaces around these crystals, so that an immense surface is offered for the absorption of oxygen in the forming process.

Having arrived at the proper amount of chloride of zinc to use, there is no danger of buckling or warping of the plates from undue expansion, as this expansion can be accurately provided for in the tablets.

The capacity of cells of this type is from five to six ampere hours per pound of plate. The capacity for weight could be materially increased, but at the loss of durability. At a discharge rate equal to one-half an ampere for each pound of plate, which is a higher rate than is recommended for any other lead element, this capacity of between five and six ampere hours per pound can be obtained. At this rate of discharge the efficiency of the cell will be very high, the loss in current being less than 10 per cent. and the watt-hour efficiency from 75 to 85 per cent. At the rate of one-half ampere per pound, over three-fourths of the capacity can be obtained above two volts. This is, in my opinion, a very desirable feature.

An examination of the complete element will show the special care that has been given to the insulation of the plates. It is well known that the liability of a storage battery to short-circuit has been one of the main causes of trouble. To overcome this, we envelop the positive plate in a piece of woven asbestos cloth. Between this positive so protected and the negative plate we place a perforated, grooved board of insulating material, the perforations in this board being made opposite the pieces of active material in both plates, leaving free circulation of the electrolyte between the plates, at the same time keeping the asbestos cloth pressed against the face of the positive plate, causing it to form a tight covering over the face of the active material, and while making the plate absolutely safe from short-circuit, it also adds very wonderfully to the life of the cell, since the peroxide is held in position where it can perform useful work instead of being deposited on the bottom of the cell. The channels in the board provide for the free circulation of the electrolyte, and also allow for the escape of the gases. In traction work this form of insulation is found very beneficial, as the cell is vastly more durable than anything that has been before produced, and at the same time there is no unnecessary liquid to be spilled over the car.

It may be of interest to state that the Company manufacturing this type of cell in France has supplied batteries for nearly two years to the North Paris Tramway Company, who operate two or three roads with battery cars, about 40 cars in all, I believe. I was on these cars about a year ago, and they certainly were doing good work. The cars are about 22ft. long, and have seating room for 54 passengers. The Paris factory has for some years turned out over five tons of plates a day. They equipped the Popp stations in Paris with these accumulators some three years ago, which have been in constant use ever since. There are 24 substations all charged in series, the lighting being done entirely from the batteries, there being two sets in each station, one being discharged, while the other one is charged. There are in the neighbourhood of 100,000 lamps run daily from these cells, the result obtained being very satisfactory, since, in addition to the benefit derived from the batteries as a store, they also act as transformers, as the batteries are charged in a 3,000-volt circuit, each station turning out current to its immediate vicinity at 110 volts. The plates in some of these cells weigh 100lb. each, the complete cell weighing over a ton, and discharging at a rate of from 1,000 to 2,000 amperes each. A company has recently been formed in England for manufacturing these cells, which has just completed works near Manchester capable of a very large output. That company is controlled by Messrs. Mather and Platt, and the business is to be managed by Dr. Hopkinson. Under such management there can be very little doubt about the success of the business.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *October* 27, 1893.

The American Street Railway Convention.—The twelfth annual meeting of the American Street Railway Convention, recently convened at Milwaukee, was one of the most successful yet held. The principal Paper read was that of Mr. C. O. Mailloux, on the use of storage batteries as auxiliaries in power stations, in which it is shown that in many cases it will be profitable to add a battery plant. This subject has been much neglected in America, and Mr. Mailloux's Paper will perform a good office by bringing discussion to bear on it. Another Paper advocated the use of multiphase expansion engines for large plants. Direct connected power generators were strongly advocated, which is another indication of the disfavour with which belted plants are beginning to be viewed in the United States.

The Brooklyn Bridge.—The Brooklyn Bridge authorities are beginning to investigate the subject of electric traction, with a view to its adoption on the bridge, in which at present the cable system is used for running the cars. It is thought by some, however, that there is little likelihood of the electric system being adopted, on account of its expense, and less safety from accidents through collision.

The General Electric Company.—This Company has fared somewhat better in the Stock Market recently, its shares now standing at 49 (par, 100). There are many rumours of an entire reorganisation, and a still greater reduction in its salaried *employés*.

American Institute of Electrical Engineers.—Dr. Bedell has described a new method of instantaneous contact in the measurement of alternating currents, and some experiments on a Hedgehog transformer. The conclusion was favourable toward this type of transformer and toward using condensers to reduce the line current, which latter method is employed in the Stanley-Kelly two-phase system. The Paper of Mr. Pope considered the subject of local meetings of the Institute, which is now a subject under much discussion.

THE CITY COMMISSIONERS OF SEWERS.

Mr. H. H. BRIDGMAN (the Chairman) presided at the fortnightly meeting of the Commissioners at the Guildhall on Tuesday last.

Mr. GORDON moved the following resolution standing on the agenda paper in his name: "That it be referred to the Streets Committee to consider the question of appointing an inspector or inspectors under the Electric Lighting Acts."—Mr. McCARTHY having seconded the motion,—Mr. Deputy Cox pointed out that the gas light inspector, whose office he had always thought was a useless one, might be utilised for the purpose.—Mr. GORDON thought that would not be possible, because it was evident that the inspector must be a competent official. For instance, the Committee had recently received a complaint from a firm in the City stating that there were serious defects in their electrical arrangements, and asking that an inspector should be sent. He considered that the Commissioners should have had an inspector to send without delay, instead of which there was none.—The motion was then adopted unanimously.

Mr. JOHNSTON, in moving "That it is expedient that Crutched Friars be lighted by electricity, and it be referred to the Streets Committee to carry out," said in consequence of what was stated at the last Court to the effect that Crutched Friars was not included in the list of the main thoroughfares he had consulted the engineer, who had confirmed that opinion. But although it was not scheduled as one of the main thoroughfares, it was very necessary that a street which was so greatly used by all kinds of traffic should be thoroughly lighted, which was not the case at the present time.—Mr. C. T. HARRIS expressed a hope that the street in question would be lighted by arc lights. [Mr. JOHNSTON: "Oh! certainly."] He preferred also that some statement should be furnished to the Court on the question of cost. He was not sure that the electric light would prove the most effective means in so dark a thoroughfare where there were few shops to assist in lighting the street. The reason why London Bridge was not lighted by electricity was because the dark shadows thrown by the light and the absence of supplemental radiance from shops interfered with the traffic. He would prefer, therefore, and would move as an amendment, that the question should be referred to the Streets Committee to consider. With regard to the cost of lighting the eastern district of the City, he found it was nearly 20 per cent. in advance of that for the main thoroughfares of the City. In the eastern district there were 233 arc lights, which at £26 per annum, cost £6,058; adding to that the cost of maintaining disused gas lamps, about £450, the total would be £6,500. The previous cost of lighting by gas the whole (three districts) of the City with 1,730 lamps was £5,550. To light the district by electricity thus cost £1,000 in excess of the expenditure required to light the whole of the City by gas. And yet they were told that the cost of the new light would not be more than double that of the gas, while it was actually three and a-half times the cost in the eastern district.—Mr. JOHNSTON said he was prepared to accept Mr. Harris's suggestion. The motion was then adopted.

The report of the Streets Committee contained a copy of a communication from the City of London Electric Lighting Company on the subject of the laying of tubes for telephone purposes in the trenches with the electric lighting tubes. The Company, in reply, stated that except for purposes of their own the tubes were not being used for telephone purposes.

Mr. PANNELL called the attention of the solicitor to a communication which had been addressed to him (the speaker) on the subject of the National Telephone Company. The letter ran as follows:—"I desire to remind you of the impending consideration of the telephone communication which will be submitted to the House in all probability within a few days. You will remember that Mr. Arnold Morley claimed to have the right of signing the agreement with the National Telephone Company before laying the agreement on the table of the House. After a great deal of effort by various members of public bodies, he consented to lay it on the table before signing it. It is most important this agreement for 18 years should be examined very carefully, as it is almost certain to allow of encroachments on public rights, and for the purpose of taking action in regard to it the Association of Municipalities has appointed a Special Committee. I now beg to suggest that, in addition to taking an active part in the House, you should use your influence to induce the Commissioners of Sewers to appoint a committee to take what steps they may deem necessary, as it is all too certain that the agreement will contain provisions that will call for strenuous opposition." Mr. Pannell added that he would like to know why the subject had not been reported to the Commissioners, because otherwise the Court might have been placed in a very serious position, and he desired to move that the Streets Committee should work in accord with the representatives of the Association of Municipalities, and that the Committee should be empowered to do therein as they might be advised by their officers.—The SOLICITOR replied that it was understood that the agreement would be submitted to the judgment of the House, and that the Commissioners would have an opportunity of expressing an opinion upon it.—The CHAIRMAN said he understood also that the Remembrancer would obtain a copy of the agreement in question. Mr. Pannell's motion having been seconded, it was adopted, and the name of the mover was ordered to be added to the Committee.

The ENGINEER submitted an interesting report on the subject of the number of failures which had taken place during the past six months in connection with the electric light. The total number of arc lamps in use was, he reported, 475. The number of gas lamps disused, but maintained ready for lighting, was 1,219. The total number of failures of the electric light during the period in question was 301. The most serious failure was on May 7th, when 42 lamps were not lighted until nine o'clock. The explanation given by the Company was that the switch was defective. On June 17th 65 lamps went out for a considerable period, but the gas was not lighted. The explanation given by the Company was that there was negligence on the part of the stoker at Wool Quay. On July 27th 96 lamps went out, and the reason given was the breaking of a belt. The 475 arc lamps, at a cost of £26 per annum each, gave a sum of £12,350. The length of streets lighted was 13 miles. The fines for these defects would be deducted from the next account of the Company. The information regarding these failures was received from the police force, and the returns were sent to the Company's office and filed in his office.—On the motion of Mr. MALTHOUSE, it was resolved that this return should be printed and circulated.

BOOKS RECEIVED.

"Les Courants Polyphasés." By J. Rodet et Busquet. (Paris: Gauthier-Villars.) 1893.

"Experimente mit Strömen hoher Wechselzahl und Frequenz." Zusammengestellt von Etienne de Fodor. Revidirt und mit Anmerkungen versehen von Nikolas Tesla. (Vienna, Pesth, Leipzig: A. Hartleben.)

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LEGAL INTELLIGENCE.

Ives and Baker v. Willans.—The Liverpool Overhead Railway.

This action came before Mr. Justice Kekewich on Tuesday last. It was an application on behalf of the defendant to stay all proceedings in the action under the Arbitration Act, the matter being covered by the arbitration clause in the contract sought to be enforced.

Mr. Warmington, Q.C., M.P., and Mr. Bramwell Davis appeared for the defendant, and Mr. Renshaw, Q.C., and Mr. Peterson appeared for the plaintiffs.

Mr. WARMINGTON said that, except that the plaintiffs scattered charges of fraud against persons who certainly up to now held a high position in the commercial world, there was very little to answer. Mr. Willans entered into a contract, called the principal contract, for the construction of the Liverpool Overhead Railway. That was a very considerable work, and Mr. Willans entered into a series of sub-contracts for various parts of the work. Amongst these sub-contracts was one dated August 24, 1889, between the defendant and the plaintiffs. Clause 9 of that contract provided that all questions arising from that agreement should be settled by the engineers in the manner mentioned in the principal agreement. The clause in the principal agreement was to the effect that if any question, difference, or dispute should arise between the Company and the contractor the matter should be referred to the engineers, whose decision should be final, and that neither of the parties thereto should commence or prosecute an action. The plaintiffs issued their writ on July 1, 1893, claiming the sum of 3d. per ton for removing the decking, a declaration for specific performance, and for a declaration that the defendant was not entitled to charge a toll in respect of plaintiffs' bogies running over the swing bridge, and for an account between the plaintiff and defendant. The charge for removing the decking was some £83 odd, and although the plaintiff might be entitled to sue for that there could be no doubt from the documents that he was entitled to a stay under the Arbitration Act respecting the other matters. The defendant set out the arguments in his affidavit. The affidavit of the plaintiff Baker, he being the only plaintiff who had sworn an affidavit, stated that the plaintiffs objected to the gentlemen (the engineers) who were named in the contract, who, they said, were likely to be prejudiced against them. These gentlemen were Mr. Barry Fox and Mr. James H. Tracey, who were two of the best known engineers in the country. The plaintiff further said that he had suffered damage in respect of the non-execution of the defendant's contracts of some works which in some way were connected with the plaintiffs, and that this delay injured the plaintiffs in the performance of theirs. If that was so it was damage for which he could obtain the relief. There was also some point about production. If they were entitled to that the arbitrators would give them it.

Mr. Justice KEKEWICH: It is a question whether this is the tribunal or whether he should go to the engineers.

Mr. WARMINGTON: Precisely. With regard to the decking, he did not think he was entitled to restrain the plaintiffs, but in all other matters he submitted he was. All the authorities were in favour of his contention. The documents showed that all matters with the exception of the decking were covered by the arbitration clause, and he had to ask his lordship to grant the order asked.

Mr. RENSHAW submitted that defendant had taken a step in the proceedings, and was therefore debarred from making the present application. His clients were willing to have the matter referred to independent gentlemen, but they strongly objected to having matters in which they were so deeply interested referred to the engineers.

His LORDSHIP made an order under the Arbitration Act staying proceedings excepting the claim for decking and the claim for damages for delay, the plaintiffs to have liberty to amend their writ.

Upon the application of Mr. RENSHAW, each party was ordered to pay their own costs.

Pollard v. Rust.

This was an action tried on Monday last before Mr. Justice Cave without a jury, and brought by Mr. E. H. Pollard, a barrister, to recover damages for breach of an agreement dated May 19, 1885, or, alternatively, to recover the sum of £1,333. 6s. 8d., money alleged to have been received by the defendant for and on behalf of the plaintiff. In 1884 Mr. C. Langdon Davies obtained protection for an invention entitled "Improvements in Telephony," of which he was the inventor, and had had advanced to him by the defendant £2,000 for the purpose of perfecting his patents. On May 19, 1885, an agreement was entered into between Mr. Davies and the defendant, whereby the defendant was to advance to Mr. Davies a further sum of £2,000 upon the signing of the agreement, and a further sum of £6,000 under certain conditions embodied in the agreement; it was also provided that should a sale of the inventions be effected without the payment of the £6,000 then there should be paid to the defendant out of the moneys received as purchase-money the sum of £4,000, and after a like sum had been received by Mr. Davies he was to pay a bonus of £4,000 out of the next moneys received as purchase-money, but in the event of no sale being effected before December 31, 1885, then the defendant was to be paid the sum of £4,000, with a bonus of £2,000. By a memorandum of agreement made between the plaintiff and defendant, the plaintiff agreed to guarantee the repayment of £2,000 advanced by defendant to Mr. Davies, and the defendant agreed to pay the plaintiff two-thirds of all bonus he got in respect of the first £2,000 paid by him to Mr. Davies as soon as he received the same. On July 20, 1887, an agreement was entered into between Mr. Davies and the defendant, which recited that £2,000 bonus was due to the defendant, and it was agreed that the defendant should purchase from Mr. Davies certain patent rights, and that as to £2,000, part of the purchase-money, the same should be paid by the defendant releasing his right to the said bonus. The plaintiff now claimed two-thirds of the £2,000 under the agreement of May 19, 1885.

After hearing counsel for the parties,

Mr. JUSTICE CAVE, in giving judgment, said that the bonus in respect of £2,000 was £1,000, and two-thirds of that sum became due to plaintiff, which he was entitled to have paid to him when the money was actually received from Mr. Davies. Had it been received from Mr. Davies? He was of opinion that it had. The position was this. Mr. Davies had got the patent rights subject to repaying Mr. Rust the money, but plus the bonus. Mr. Rust had put it out of their power to say whether the £2,000 would have been received, so the Court must consider that it had been received. There had been what was equivalent to payment of the whole bonus payable. The plaintiff was therefore entitled to judgment for £666. 13s. 4d.

Wilkinson v. Medical Battery Company (Limited).

This action came before Mr. Justice North, in the Chancery Division of the High Court of Justice, on Saturday, as a short cause, the points on which judgment was asked having been agreed upon between plaintiff and defendants. The action was brought by the plaintiff on behalf of herself and all other holders of the defendant Company's debentures for the purpose of enforcing their security, as the debentures expressed that the principal moneys which they acknowledged to be advanced became payable immediately on a meeting being called to consider a resolution to wind up the Company. The meeting was called for, and held on, Friday last, when it was resolved to wind up voluntarily.

Mr. Tanner appeared for the plaintiffs, Mr. George Henderson for the Company.

Mr. JUSTICE NORTH gave judgment as asked, declaring that the debentures were a first charge on the assets of the Company, and directing the usual accounts and inquiries.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1893 Edition of "'THE ELECTRICIAN' ELECTRICAL TRADES' DIRECTORY AND HANDBOOK" contains over 1,000 pages, several new and handy features having been added. Price 7s. 6d., post free 8s. 3d.; abroad 8s. 10d. *Comparison with any similar electrical publication is specially invited.*

The 1894 Edition is in preparation, and will be published in January next. New names, alterations of addresses, &c., are received at any time, but the Directory blanks and circulars are not sent out until later in the year, in order that the most recent, and consequently the *correct*, **addresses** *only* **shall appear in the book. Full printed particulars can be obtained, post free, from "The Publisher,"** *Electrician* **Office.**

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, which has a special interest at the present time, is now ready, and will be forwarded on receipt of the published price, 7s. 6d. (abroad 8s.), or it may be obtained from any bookseller. A prospectus can be obtained on application to the Publisher.

TENDERS INVITED.—The Corporation of Dublin invite tenders for the extension of the buildings and the supply and erection of additional plant at their central station in Fleet-street. Plans may be seen, and specifications and forms of tender obtained, at the offices of Mr. Spencer Harty, the city surveyor, at the City Hall, and tenders are to be forwarded to Mr. H. Campbell, the town clerk, at the City Hall, by 5 p.m. on December 14th. Further particulars appear in our advertisement columns.

——— With regard to the tenders invited for the Newport plant, these tenders can be for portions of the plant, and should be sent in by the 20th inst.

——— The Directors of the Waterhouse Electrical Manufacturing Company (Limited) invite tenders for the supply of electric arc lamp-posts. Specifications, &c., can be obtained on application to the Secretary of the Company, and tenders must be sent in not later than November 18th.

——— The Midland Railway Company invite tenders for a variety of stores, including castings, copper and brass tubes, brass engine fittings, telegraph instruments, stay-rods, belts, &c., telegraph and signal wires, English timber, fog signals, indiarubber brake pipe, washers, &c., all to the Company's patterns. Tenders have to be in not later than 9 a.m. on the 16th inst.

——— Tenders are invited for the establishment of a central electric lighting station, with a capacity of 4,000 incandescent lamps at Davos-Platz, Zürich. Water power is to be utilised. Tenders must reach the Municipal Authorities by December 20th.

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SALE BY AUCTION.—Mr. J. C. Stevens announces in our advertisement columns that he will include in his sale at his rooms, King-street, Covent Garden, on Friday next, the 17th inst., the stock and plant of an electrical engineer, comprising dynamos, electroliers, electric light fittings, lathes, tools, &c.

AMALGAMATION OF MESSRS. ELLIOTT BROS. AND MESSRS. THEILER AND SONS.—We understand that the business of Messrs. Theiler and Sons, which has for some time past been managed by Mr. G. K. B. Elphinstone, is being amalgamated with that of Messrs. Elliott Bros. Messrs. Elliott Bros. were established in the year 1800, and Messrs. Theiler and Sons in 1857. A considerable trade in telegraphic and other instruments will thus be added to Messrs. Elliott Bros.' already extensive business. We understand that Mr. Elphinstone is joining Messrs. Elliott Bros. as a partner.

APPOINTMENT.—Mr. Francis Teague has been appointed resident manager of the Scottish House-to-House Electricity Company's new generating station at Coatbridge.

LIQUIDATIONS.—A general meeting of the members of the Pioneer Telephone Company (Limited) is to be held at 1 and 2, Great Winchester-street, E.C., on December 4th, at 3 p.m., for the purpose of receiving the liquidators' account of the winding-up.

——— Messrs. Max Binswanger, Edmond Kahn, and William Watts have been appointed a Committee of Inspection to act with the Official Liquidator in the matter of the Art Workshops, Limited (in liquidation).

——— The petition for the compulsory winding up of the Ipswich Electricity Supply Company (Limited) came before Mr. Justice Vaughan Williams on Wednesday, when a decision was postponed in order that a meeting might be held to endeavour to settle the dispute that had arisen as to who was entitled to use the name of the Company. It appeared that Mr. Shorrocks, the petitioner, held 50 shares out of 58, and did not wish the receiver to sell the property under a certain contract.

BANKRUPTCY.—An application was made at the London Bankruptcy Court on Thursday for an order of discharge on behalf of Henry Bury, formerly carrying on business as electrical engineer in Manchester; but after hearing evidence in support of the application, the Registrar suspended the bankrupt's discharge for two years.

MR. L. P. CASELLA.—Mr. Casella has been appointed agent for the sale of automatic recording instruments (*système* Richard), and is preparing a complete illustrated catalogue.

PERSONAL.—Mr. W. F. Taylor, consulting electrical engineer, of Boswell-court, Croydon, was elected to the County Council of the Borough of Croydon on the 1st inst.

O.-E. METERS.—Mr. Joseph Edmondson has received orders for two 750-ampere O.-E. meters, to be used for registering the total output from the whole of the electric lighting station at Hull. These meters are to be coupled to the two outside conductors of the three-wire system.

LUBRICATORS.—Messrs. O. Berend and Co. forward us their latest revised list of grease and oil lubricators, syringes, oil filters, &c. The list is fully illustrated with a variety of tools and appliances sold by the firm.

ELECTRIC COOKING AND HEATING.—The General Electric Company have sent us their catalogue, Section H, with full illustrations and descriptions of their kettles, steamers, ovens, grillers, laundry irons, and other utensils and apparatus. The current required, and the time of heating, are given, together with estimates of the cost of use. The appliances are all marked with the necessary current in amperes. The wire resistances used are embedded in an insulating cement. An efficiency of nearly 90 per cent. is claimed.

SWITCHBOARDS.—We have received from Messrs. Mavor and Coulson, of Glasgow, a photograph of a set of cast-iron switchboards. The centre portion consists of three separate cast-iron panels, each panel carrying a 700-ampere fuse, switch and ampere gauge, also a regulating switch for dynamo shunt resistance. The panels are mounted in an angle iron frame and surrounded by a polished oak moulding. The distributing boards mounted to the right and left of the dynamo switchboard consist of 24 100-ampere fuses and switches. These switches are mounted in groups of three in an angle iron frame, and surrounded with polished wood moulding. Any number of additional panels may be added as required. The cast-iron panels on which the switches are mounted have planing strips upon which the contact blocks, &c., are fitted, the insulation being effected by mica. The surface of the cast-iron is finished with a smooth black enamel. These switchboards, which are for a concentric installation, are provided with omnibus negative bars, carrying cable sockets, by means of which the negative connection is effected.

EXTENSION PLATFORM LADDERS.—Messrs. Heathman and Co. have recently supplied a number of their patent extension platform ladders for use in tending the arc lamp-posts at Liverpool-street and Bishopsgate-street Railway Stations. These posts are 21ft. high, and the ladders (which will pass through a doorway 6ft. 6in. high) have a spacious platform, with guard rail, enabling the lamp trimmer to work in safety. The same firm have recently supplied ladders to reach to the top of the 40ft. posts at the Battersea New Town Hall, and have in hand street ladders built on high wheels for the Kingston-on-Thames installation, where the lamps are 26ft. high.

STEAM-POWER.—We have received from the New York Safety Steam Power Company a well-printed catalogue illustrating and describing various engines and boilers manufactured by the Company. Included in the list are several vertical high-speed engines specially designed for electric lighting, and a number of tables and prices of the machines are given.

RATING OF MACHINERY.—The Machinery Users' Association are advised that the time is now ripe for obtaining a legal decision which would probably be entirely favourable to their contention as to the interpretation of the Tyne boiler judgment. Two recent cases have resulted in decisions favourable to the position taken up by the Association.

MESSRS. PYKE, HARRIS AND CO. (LIMITED).—With reference to the law-suit, Newman *v.* Hall, this Company ask us to state that neither Mr. L. S. M. Pyke nor Mr. Edward S. Harris have any knowledge of, or connection with, the Mr. Pyke or Mr. Harris therein mentioned.

TELEPHONE ATHLETIC ASSOCIATION.—This Association gave a smoking concert at the "Haunch of Venison," Bell-yard, Fleet-street, E.C., on Friday last, at which Mr. Dane Sinclair, engineer-in-chief to the National Telephone Company, presided. An enjoyable evening was spent.

CHICHESTER.—Mr. Councillor Prior has submitted a report to the sub-committee of the Lighting Committee of the Town Council, on the probable cost of lighting the city by electricity. He estimates the initial cost of lighting the principal streets would be £12,500 to £14,000, and the annual outlay (including repayment of loan and interest) £2,791. The probable revenue from private consumers would be £3,000, and as there would be a saving over gas for public lighting of £300, the works would earn an annual surplus revenue over expenses of £500.

DUBLIN.—On Thursday last Mr. C. P. Cotton, Local Government Board Inspector, held an inquiry at the City Hall in reference to an application by the Corporation for a loan of £24,400 for the purpose of extending the electric lighting of the city. In supporting the application, Mr. Harty, the borough surveyor, said that the present works, which cost £37,000, had proved so successful, and there had been such a large demand on the part of the citizens to obtain the advantage of the electric light in areas not now served by the present supply, that the present application had become necessary.

EAST HAM.—The Local Board have recently opened an infectious diseases hospital on their sewage works, and have lighted it by electricity, the motive-power for generating which is supplied by the pumps.

ELECTRIC LIGHTING FOR CARRIAGES.—Messrs. Slatter, of Long-acre, the builders of the state carriage for the Lord Mayor of London, have made a special study of carriage lighting by electricity, and their latest form of lamp is fitted to this splendid coach. It is placed inside, in the centre of the roof. At the back of the lamps is a domed enamelled reflector. Experiment having shown that when the platinum wires become hot they droop downwards, in order to obviate this drawback a little glass stilt is now added, which is not to be seen in the ordinary incandescent lamp, as in order to economise space the lamps are not hung vertically in the reflector, but lie horizontally. In the first attempts to light carriages in this manner the vibration of the travelling was apt to jar the lamps, often causing a breakdown, and steel springs were not found sufficient to prevent this. The plan now adopted is to suspend the complete lamp in a sheet of rubber, which is attached to the interior of the carriage, and neutralises the vibration. The accumulators are carried in the boot, under the coachman's seat, and are easily accessible. Mr. James Pitkin's carriage accumulator has been found in actual use to supply current to keep a lamp alight for eighteen hours, which is sufficient to last the owner of a brougham for three weeks to two months.

GLASGOW.—At the last meeting of the Town Council the Gas and Electric Lighting Committee reported that Mr. Arnot, electrical engineer, had submitted the statement of cost which he had been instructed to prepare regarding the lighting of the tramway cars by electricity. The Committee were of opinion that it would be more convenient and expedient to make arrangements for charging the accumulators required for lighting the cars at one or more of the car depots now being erected by the Corporation instead of having them charged at the central electric lighting station. This course was approved by the Town Council. The Council also resolved that the Corporation Art Galleries should be lighted by electricity.

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KENDAL.—The Town Council at their last meeting had under consideration the advisability of applying for a Provisional Order empowering them to supply electricity, but it was decided to defer the matter for the present, as the Corporation were already proposing to acquire the local gas and water works.

LECTURES.—Mr. W. W. Haldane Gee is giving a course of six weekly lectures upon "Fire Risks of Electric Lighting" to the members of the Municipal School of Electrical Engineering, at Winkworth-street, Manchester.

——— Dr. Fleming delivered his Gilchrist lecture on "Magnets and Electric Currents" at Bournemouth, on Friday evening before a large and appreciative audience.

LONDONDERRY.—The Corporation have given the contract for the supply of lamp pillars for street electric lighting to Messrs. Alexander Brown and Son, of Derry, at £9 each.

TUNBRIDGE.—Mr. Arnold Taylor, Local Government Board Inspector, held an inquiry at the Town Hall, on Thursday last, in regard to the application made by the Corporation for a loan of £13,000 for the purpose of lighting the borough by electricity.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

October 14, 1893.

19,363. A. K. VON BIEBERSTEIN and E. FROST. London. Electrical, viz., pneumatical or mechanical, apparatus for automatically indicating the names of railway stations or stopping places (and to be eventually employed for advertising purposes and indicating the time).

October 23, 1893.

19,884. M. BINSWANGER. London. Improvements in electrical indicators or annunciators.

19,921. H. Y. DICKINSON. London. Improvements in time apparatus for automatically switching gas and electric lights.

19,934. C. D. ABEL. London. Improved electricity meter for continuous and alternating currents. (Compagnie Anonyme Continentale pour la fabrication des compteurs à gaz et autres appareils, France.)

19,936. H. C. BRAUN and G. E. MEYRICK. London. A new and improved electro-medical belt or bandage for curative purposes.

19,967. W. PETSCHEL. Berlin. Improvements in secondary electric batteries.*

October 24, 1893.

19,989. J. J. HUSSELBEE. Birmingham. Improvements in the mode of, and means for, operating electric bells.

20,011. G. BINSWANGER. London. Improvements in electric lampholders and switches.

20,023. W. P. THOMPSON. Liverpool. Improvements in the method of heating, welding, or working metals electrically, and in apparatus therefor. (C. L. Coffin, United States.)*

20,045. R. MACKIE and ELECTRIC SELECTOR AND SIGNAL COMPANY. London. Devices for selecting and operating mechanical apparatus.*

20,046. S. S. BOGART and ELECTRIC SELECTOR AND SIGNAL COMPANY London. Electric selecting devices.*

20,047. M. B. LEONARD and ELECTRIC SELECTOR AND SIGNAL COMPANY London. Improvements in electrical apparatus for controlling semaphore and other signals.*

20,059. N. MITCHELL. London. An improvement connected with medico-electric bands and belts.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d. each.

1892.

18,066. DEJARDIN. Electric meters.

21,376. EDMUNDS. Electrical resistances.

21,377. EDMUNDS. Electrical conductors.

2?,187. BELFIELD. (Westinghouse Electric and Manufacturing Company.) Lightning arresters.

22,473. BROWN. Dynamo electric machines.

23,007. WALKER and WILKINS. Galvanic batteries.

23,051. DAVIS. Electric induction coils.

23,902. BROWN. Alternate-current motors.

1893.

12,662. ANDREOLI. Electrolysis.

15,681. ROE and SUTRO. Electric accumulators.

COMPANIES' MEETINGS.

Western and Brazilian Telegraph Company (Limited).

The following is the Report of the Directors to be presented at the twenty-sixth ordinary general meeting of the Company, to be held at Winchester House, E.C., on Thursday, the 16th inst., at noon :—

The total earnings for the half-year ended June 30, 1893, amount to £79,353. 10s. 4d., as against £84,021. 16s. 9d., a decrease of £4,648. 6s. 5d., compared with the half-year to June 30, 1892. The working expenses amount to £43,424. 1s. 3d., as against £39,140. 16s. 8d., an increase of £4,283. 4s. 7d.

The above comparisons are made, as usual, with the corresponding period of the preceding year, but the expenses for the two periods necessarily differ because of the extra staff and arrangements required to work efficiently the duplicated and duplexed line, completed in 1892. At the meetings held in November, 1892, and May last, the Chairman pointed out that the duplicated and duplexed Cables would have to be worked to the best advantage to enable the Company to hold its own with the traffic. The expenses, therefore, for the past half-year under Abstract "A" should be compared with those of the half-year ending December, 1892, when the additional circuits were being manned and worked, and it will be seen that as regards the main items, notably "salaries in Brazil," no real increase occurs, the amount under this head being almost identical. Following upon the measures taken the volume of traffic has increased 12½ per cent., which is satisfactory. Notwithstanding, however, the substantial increase in the number of words carried, the revenue derived owing to various causes, unavoidable alterations in tariff, changes in locality of traffic, and so on, shows the reduction already pointed out in paragraph 2.

The shareholders were also informed as to the arrangements for the ultimate employment of one ship instead of two, as heretofore. The half-year under review was a transition period, during which the two former vessels and the new substitute were necessarily all three in commission, two on the coast and for a time coming home, and the new ship on her way out. The "Norseman" No. 1 and the "Viking" have now been laid up pending sale or employment, and the Directors are glad to say that the policy of the Board has so far been successful, both as to the value of the new steamer in the matter of speed during the present critical time in Brazil (where she has just rendered special and important service) and as to future expenses. The economy insured under this head will become apparent in the accounts for the current half-year.

Including the amount brought forward from 1892 (£2,829. 15s. 6d.), the balance to the credit of the revenue account is £38,779. 4s. 7d., from which has to be deducted £12,093 for debenture interest, and £7,007 for the debenture redemption fund, leaving £19,679. 4s. 7d., of which £12,000 has been placed to the reserve fund. This leaves £7,679. 4s. 7d. to be carried forward.

The shareholders are aware of the exceptional state of affairs in Brazil, and the great uncertainty as to what the outcome may be. Under these circumstances the Board are unable to recommend a dividend at this time. With the restoration of tranquility, and an adequate increase in exchange consequent upon it, coupled with the improvements effected in the Company's arrangements, the financial position would be again satisfactory.

The Directors have to notify that the conversion of Ordinary shares into Preferred Ordinary and Deferred Ordinary shares (after January 1, 1894) will be suspended.

West India and Panama Telegraph Company (Limited).

The following is the report of the Directors for the half-year ended June 30th, to be submitted to the thirty-third ordinary general meeting, to be held at Winchester House, E.C., on Wednesday, the 15th inst., at noon :—

The amount to credit of revenue for the six months ended June 30th is £46,687. 4s. 3d. against £44,148. 17s. 7d. for the corresponding half-year of 1892, and the expenses for the same period have been £24,794. 6s. 11d. against £28,589. 6s. 4d., leaving a balance of £21,892. 17s. 4d., which, with £1,430. 3s. brought from last account, makes a total of £23,323. 0s. 4d. Of this sum the Directors have placed £3,000 to reserve, leaving an available balance of £20,323. 0s. 4d., with which it is proposed to deal as follows :—

	£	s.	d.
First Preference Shares—			
Dividend, six months to June 30th, 6s. per share	£10,368	18	0
Second Preference Shares—			
Dividend, six months to June 30th, 6s. per share	1,400	14	0
Ordinary Shares—			
1s. per share (free of income-tax)	4,416	1	0
Balance to current half-year's account..............	4,137	7	4

The traffic receipts for the six months show an increase of £4,170. 13s. 4d. as compared with the corresponding period, this increase being largely due to an interruption of the French Company's cable to Hayti, which lasted about seven weeks, and diverted traffic to this Company's line. It will be remembered that the traffic receipts for the first six months of the last year showed a decrease of £3,762, attributable to the reductions in tariff made the year before. If the exceptional revenue derived from the interruption above referred to is left out of account, the traffic proper of this

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Company's system shows a decrease of £2,391, in comparison with the traffic prior to the reduction made in 1891. Since the close of the half-year the Directors regret to have to report a further falling off of 15 per cent. in the estimated traffics up to date in comparison with the corresponding period of 1892.

The expenses of repairs to cables amounted to £10,520. 18s. 11d., being £12,358. 1s. 11d. less than those for the corresponding period. This decrease is due to fewer repairs, and to the smaller quantity of cable used.

The Company's repairing steamer "Duchess of Marlborough" has been brought home to be surveyed, in accordance with Lloyd's requirements. She has, after the completion of certain repairs, passed her No. 2 survey, and is now in London ready to be commissioned when required.

The Directors have to report, with much sorrow, the death of another member of the Board that was elected by the shareholders in 1874. Mr. Henry Weaver, whose name has been prominently connected with the telegraphic service of the country almost from its inception, died on September 20th last. His loss is deeply regretted by his colleagues. Under the powers given to them by the Articles of Association they have elected Mr. Gerald W. Balfour, M.P., to fill the vacancy thus created.

The Directors desiring to recognise the long and faithful services of some of the *employés* and to strengthen the good relations that exist between the Company and its staff, propose to follow what has become a very general practice, and to offer to bear one-half the expense of life or endowment insurances for some of those who have been in the Company's service a certain number of years. They trust that this measure will meet with the approval of the shareholders.

NEW COMPANIES, STATUTORY RETURNS, &c.

[In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, *pages* 320-348, *&c., &c.*]

ADVANCE BOILER COMPANY (LIMITED).—This Company was registered on October 31st, with a capital of £100,000, in £5 shares, to carry on the business of boiler makers, iron and brass founders, and mechanical engineers.

WILLIAM BANKS AND CO. (LIMITED).—This Company was registered on November 2nd, with a capital of £4,000, in £5 shares, to enter into an agreement with Mrs. Sarah J. Banks, of Bolton, for the acquisition of the business carried on by her at Bolton under the style or firm of "William Banks and Co.," and to carry on the business of electrical and mechanical engineers, opticians, manufacturers and vendors of mechanical, electrical, optical, photographic, and scientific apparatus and appliances, tool makers, metal workers, machinists, smiths, &c.

PIONEER ELECTRIC CARRIAGE COMPANY (LIMITED).—The statutory returns of this Company, made up to August 7th, was filed on August 10th. The capital is £20,000, divided into 400 shares of £50 each, and 36 of these have been subscribed for and allotted. Upon each of these a call of £10 has been made, resulting in the payment of £340, and leaving £20 in arrears.

RAINBOW ENGINEERING COMPANY (LIMITED).—The statutory return of this Company, made up to September 21, 1893, was recently filed. Out of a nominal capital of £20,000, in shares of £5 each, 1,776 shares have been taken up, of which 1,500 were issued as fully paid to Charles H. Bosher, of Thornton Heath, in consideration for certain patents and the business of mechanical and electrical engineers, electricians, &c., carried on by him at Westminster, under the style of Rainbow Engineering Company. Upon the remaining 276 shares a call of £1 per share has been made, resulting in the payment of £234, leaving £42 in arrears.

SPERRYN, McDONALD AND CO. (LIMITED).—Although this concern was registered in August, 1892, no registered office, returns or other information has been filed, and the officials have sent the usual warning notices, to which no reply has been sent. The Company will, therefore, be struck off the register unless an explanation be given.

TAYLOR AND TUCKER ART METAL COMPANY (LIMITED).—The usual return of this Company was filed on October 17th, when the full amount had been called and paid on 4,400 £1 shares, the remaining 600 being unissued.

VEALE AND CO. (LIMITED).—The first annual return of this Company, made up to September 29th, has been filed. 4,904 shares, out of a total of 10,000 £1 shares, have been subscribed for. Of these, 3,839 were issued as fully paid to John E. Veale, of St. Austell (Cornwall), and the remaining 1,065 have had the full amount called and paid on them. Messrs. Crompton hold 2,000 shares.

NEW BRANCH TELEGRAPH OFFICES.—The Direct Spanish Telegraph Company and the Eastern Telegraph Company announce that they have opened branch Telegraph Offices in the Foreign Auction Hall, Covent Garden Market, London, W.C., for the exchange of telegrams with Spain, the Azores, and the Companies' general systems of submarine telegraphs.

CITY NOTES, &c.

ALLDAYS AND ONIONS (LIMITED).—The report to June 30th shows a net profit of £11,544. 15s. 11d., to which is added the sum of £105. 17s. 5d. brought from the last account, making together £11,650. 13s. 4d. The Directors recommend a dividend of 10 per cent. on the Ordinary shares. It is proposed to issue 5,000 additional Ordinary shares.

CHATHAM, ROCHESTER, AND DISTRICT ELECTRIC LIGHTING COMPANY (LIMITED).—A meeting of the shareholders was held on Wednesday week, when it was decided to issue £12,000 in debentures, £4,000 only to be taken up before another meeting of shareholders is called.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended November 5th were £871, as against £891 for the corresponding period of last year, being a decrease of £20. The total receipts for the half-year amount to £14,637, against £14,400 in the corresponding period of 1892, being an increase of £237.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The gross receipts for the month of October were £2,121, as compared with £2,307 for the corresponding period of last year.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company for October amounted to £23,200 and from January 1st to October 31st to £226,800. In the corresponding months of 1891 and 1892 the amounts were £237,800 and £223,600 respectively.

MEDICAL BATTERY COMPANY (LIMITED).—A meeting of the creditors of this Company was held on Tuesday last at the offices in Oxford-street, London, to discuss the position of the undertaking, at which Mr. C. B. Harness presided. He said he was sorry to have to meet the creditors under existing circumstances, but he thought, as a preliminary, that it would be best if the Press were not allowed to be present. The Chairman's resolution to this effect was, however, immediately negatived. The Chairman alluded to the attacks made upon the Institution and himself by "a small body of persons." These attacks had caused a considerable damage to the Company, from which it was recovering, when the further attack by the *Pall Mall Gazette* was made. The result of the attack was that a writ was issued against the Company, and the debenture-holders had taken possession of the Company. The shareholders (of whom there were 28) had decided to put the Company into voluntary liquidation, with Mr. Davis as liquidator. In the meanwhile Mr. T. B. Browne (advertisement contractor, and creditor for about £1,000) had presented a petition for compulsory winding up, and the business was now being conducted under the order of the Court of Chancery. The business had been a rich one from the beginning. The liabilities were estimated at from £14,000 to £20,000, and the assets, as a going concern, were valued (he did not say by whom) at £60,000 or £70,000. As a dead concern it was comparatively valueless. They had got a princely business together, which had been pulled down by a "few dissatisfied persons." The only fault that was found with him was that he was not a qualified electrician; but he had never represented himself as such. The debentures only amounted to £8,000, and the other liabilities to something like £14,000. Their turnover had amounted to £16,000 or £17,000 a year, out of which there was a large profit. He believed the business had been injured 75 per cent. by the recent attacks. The action against the *Pall Mall Gazette* [to which reference was made in our last issue] would be fought to the death, and he had every reason to believe that he would get substantial damages. He defied the proprietors of the paper to prove a single statement they had made. In reply to a creditor, the Chairman said that if they offered him the position of Managing Director (which he had so recently resigned) under the suggested voluntary liquidation, he should take it without any remuneration whatever. He had lost a great amount of money over the transaction, and he intended to have it back again. The Solicitor to the Company said Mr. Harness had brought his action for libel against the *Pall Mall Gazette*, and if he succeeded there was no doubt the creditors would be paid in full, because the business of the Company would rise, Phœnix-like, from the ashes (loud laughter). Ultimately a resolution was moved, authorising the winding-up to be conducted under the supervision of the Court, and not compulsorily, and another that a committee of six creditors should be appointed, and obtain an expert to advise them. Several other amendments were also moved, and the Chairman appealed to the meeting to conduct the proceedings in an orderly manner, in the midst of which a creditor moved that the Company be wound up compulsorily. The Chairman pointed out that all he wished to do was to prevent the assets of the business from being destroyed by "a few interested persons," and the proposal for the compulsory winding-up was put to the meeting and lost by a large majority. The motion for winding-up under the supervision of the Court, and not compulsorily, was declared carried. Several creditors declared that the Chairman had not acted fairly; but he strongly defended his action, claiming that his only object was to act fairly by all concerned. It was then moved that a committee of six be appointed to represent the creditors at the Court; but the Solicitor pointed out the difficulty of getting six representatives of the creditors prepared to stay at the offices of the Company until midnight to decide upon their action. After further discussion the Chairman declared the last resolution lost; but a count was insisted upon, and it was found that the motion had been carried. [On Wednesday, in the Chancery Division, Mr. Justice Williams ordered that Mr. T. B. Browne's petition should stand over for the production of evidence as to whether or no creditors would be prejudiced by the voluntary liquidation. Mr. Cornelius Bennett Harness was arrested on Wednesday morning at Potter's Bar, near Barnet, and charged, with others, at Marlborough-street Police Court, on four counts, with false pretences and conspiracy to defraud. Prisoners were remanded on bail for a week.]

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WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended November 3, 1893, after deducting 17 per cent. of the gross receipts, payable to the London Platino-Brazilian Telegraph Company (Limited), were £2,994.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the two weeks ended November 3rd were £2,160, as compared with £2,040 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Divi-dend	Name	Previous Week's Price, Oct. 31		Price Wednesday, Nov. 8		Rate per Cent. Yielded (£ s. d.)	Dividend Due	Business Done During Week Ending Nov. 8, Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	12/6	Anglo-American	46	47	46	47	5 17 0	Jan., Apr., July, Oct.	46½	..
£2,932,680	Stock	25/0	Do. Preferred	83	85	84	85	6 9 5	" "	84¾	83⅝
£2,932,680	Stock	5/0	Do. Deferred	7¾	8¼	7¾	8¼	..	..	8¼	8¼
£195,100	100	4%	African Direct Telegraph 4% Deb. (Reg. & Bearer)	100	103	100	103	3 17 8	January and July	100½	..
130,000	£10	4/0	Brazilian Submarine xd & bonus	11¾	12¼	11¾	12¼	5 6 1	Mar., June, Oct., Dec.	12¼	11⅞
£36,400	£100	5%	Do. 5 per Cent. Bonds	100	103	100	103	4 17 1	January and July	101½	—
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	..	—
$7,716,000	$100	7%	Commercial Cable Capital Stock	136	140	140	150	4 13 4	April and October	..	..
16,000	10	8/0	Cuba Submarine	11½	12½	11½	12½	6 8 0	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	..	..
60,710	20	3/6	Direct United States	10⅞	11⅜	11⅛	11⅝	6 3 4	Jan., Apr., July, Oct.	11 3/16	11
400,000	10	2/6	Eastern	14¾	15	14¾	15	5 4 0	" "	15¼	14 13/16
70,000	10	6%	Do. 6 per Cent. Preference	15½	16½	15½	16½	3 12 9	" "	16 1/16	15⅞
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock xd	113	116	113	115	3 9 7	May and November	115⅝	114
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	108	111	108	111	4 10 1	February & August	..	..
250,000	10	2/6	Eastern Extension	15	15½	15	15½	4 11 10	Jan., Apr., July, Oct.	15 3/16	15
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113	116	113	116	3 9 0	February & August	115	..
£70,600	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	102	105	102	105	4 15 3	January and July	103½	102
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	101	104	101	104	4 16 2	" "	102	101½
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101	104	101	104	3 16 11	February & August	101½	..
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs. xd	104%	107%	103%	106%	3 15 6	May and November	104¾	
180,227	10	1/6	Globe Telegraph and Trust	8⅝	8⅞	8½	8¾	5 2 10	Jan., Apr., July, Oct.	8¾	8½
180,042	10	6%	Do. 6 per Cent. Preference	14¾	15	14¾	15	4 0 0	" "	15	14¾
150,000	10	5/0	Great Northern	20	20½	20	20½	4 3 0	Jan., April, and July	20½	20½
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	103	106	103	106	4 14 4	March & September	..	..
17,000	25	12/6	Indo-European xd	40	43	40	43	5 16 3	May and November	42	..
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	3 6 8	" "	..	—
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	105	108	5 11 1	March & September	..	—
£100,000	£100	4%	Pacific European Telegh. 4% Guar. Debs. "Red' 1942	102	105	102	105	3 16 11	..	..	—
11,802	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	..	..
3,381	£100 Cert.	35 0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	" "	116½	116½
15,609	10	5/0	West African Telegraph	5½	6½	5½	6½	7 13 10	January and July	..	..
£260,900	100	5%	Do. 5 per Cent. Debentures	98	101	98	101	4 19 0	March & September	..	..
30,000	10	2/0	West Coast of America	2	3	2	3	..	January and July	..	—
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	103	99	103	7 15 4	June and December	..	..
83,321	10	6d.	West India and Panama	1⅛	1⅜	1⅛	1⅜	..	..	1⅜	1½
34,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10	10½	5 14 3	May and November	10⅛	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9	10	9	10	6 0 0	" "	9⅜	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	106	109	107	110	4 10 11	June and December	109	..
64,242	15	4/6	Western and Brazilian	5½	6½	5½	6½	5 15 7	May and November	6	5¾
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5¼	5¾	5¼	5¾	..	..	5½	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1	1½	1	1½	..	..	..	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	103	106	103	106	5 13 2	February & August	..	..
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	103	106	103	106	5 13 2	" "	..	..
$1,214,000	$1,000	7%	Western Union 7 per Cent. 1st Mtge Building xd	115	120	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	105	102	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	—	..	—
22[illegible],800	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/32	3/32	1/32	3/16	..	May and November	..	—
220,000	£1	4·76d.	Oriental (11s. paid)	3/16	5/16	3/16	5/16	7 18 2	Yearly	..	
458,867	5	2/6	National	4½	5	4¾	5	5 0 0	June and December	4 13/16	4¾
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	13½	14½	13½	14½	4 2 9	" "	14⅜	..
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	13½	14½	13½	14½	4 2 9	" "	..	..
90,950	5	2/0	Do. 5% Non-Cumulative 3rd Pref.	5¼	5½	5¼	5½	4 10 11	..	..	..
726,477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully paid)	113	115	113	115	3 18 3	January and July	113⅜	113½
58,000	5	1/0	United River Plate	2	2½	2	2½	—	January and July	..	—
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11¼	11¾	11¼	11¾	—	—	11 11/16	11½
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	12¾	13¼	12¾	13¼	..	—	13	12¾
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	—	—	—
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	—
8,322	£5	..	House to House Electric	..		..		..	—	—	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		—	—	—	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		—		..	January and July	..	—
30,000	£5	3/4 '92	Liverpool Electric Supply (£3 10s. paid)	4½	4½	4½	4¼	..	—	..	—
15,000	£5	5/0 '92	Do. (fully paid)	6 5/16	6 7/16	6⅜	6½	..	—	—	—
111,000	5	..	London Electric Supply	¾	1	¾	1	..	..	..	—
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	7¼	7¾	7½	8	2 10 0	..	8⅜	7 5/16
£100,000	Stock	5%	Do. 5 per Cent. Debs. (Bonds of £10, £20, & £40)	104	107	104	107	4 13 6	June and December	..	..
6,452	£10	..	Notting Hill Electric	5	6	5	6	—	—	..	..
19,980	£5	9½%	St. James' and Pall Mall	6	6½	6	6½	..	—	6 7/16	6¼
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	—	8 5/16	8¼
59,900	5	1/6	Westminster Electric Supply (fully paid)	5	5½	5½	6	2 18 4	—	5⅝	5 7/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
77,978	3	2/1	Brush Electrical Engineering	2¾	3	2¾	3	6 0 0	—	3	2⅞
75,000	2	6%	Do. 6 per Cent. Preference	2⅛	2⅜	2⅛	2⅜	5 1 1	—	2 5/16	2¼
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	107	109	106	108	4 3 4	March & September	107¼	106
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	3½	4½	4	4½	..	January and July	..	—
12,139	5	..	Edison and Swan United	—		—		—	—	—	—
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	—	—	—
49,900	10	12/0	Electric Construction	1¾	2½	1¾	2½	..	—	—	..
91,195	2	10/0	Elmore's Patent Copper Depositing	⅜	⅝	⅜	⅝	—	—	—	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	—	—	—
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21½	22½	21½	22½	5 11 1	February & August	22¼	21¼
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	101	103	102	104	4 6 7	March & September	..	—
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	..	—	—
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	—	—
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/0	4/0	3/0	4/0	..	—	—	..
78,949	5	1/9	Swan United (£3. 10s. paid)	2	2½	2	2½	13 19 8	May and November	2⅜	2 3/16
37,350	12	12/0	Telegraph Construction and Maintenance	32	34	33	35	5 2 9	March and July	34½	32½
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101	104	101	104	4 16 2	January and July	—	..
39,639	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		—	—	—	..
41,098	£5	..	Do. Preference (fully paid)	..		..		—	—	—	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	¾%	City and South London Railway	28	33	28	33	2 5 5	May and November	..	—
87,500	£10	..	Liverpool Overhead Railway	5⅛	5⅝	5⅛	5⅝	—	—	—	—

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THE ELECTRICIAN:

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NOTES.

As we only received a copy of Prof. Forbes' Paper on "The Electrical Transmission of Power from Niagara Falls" in the course of yesterday (Thursday), we can only print a portion of it this week. The chief point of interest appears to be the remarkably low frequency which has been chosen. In a later portion of the Paper Prof. Forbes relates that Mr. Brush once said to him in discussing this matter, "Really, your best plan would be to lower the frequency so much that you get a direct current." The advantage of low frequency for starting up is obvious, but the use of this expedient to improve the efficiency of the motors seems to be a confession of weakness in design. All sorts of other excuses can be brought forward, as is done by steam-engine builders who cannot run their engines fast without knocking and vibration, and demonstrate that, entropy being a function of the piston speed, the number of revolutions given in their catalogues is the best possible. Some further information about the Niagara plant will be found in our "Notes."

Up to the present, the expiry of the lamp patent offers many promises of high efficiency and one guarantee, but no novelties. Central station engineers are looking forward to the use of economical lamps for basements, passages, &c., where gas is often used, although electric light is used elsewhere. Such lighting would help to swell the day load. But hitherto, many consumers, aware that the all-day use of glow lamps in kitchens, sculleries, &c., would cost as much if not more than the whole of the ordinary domestic lighting, have allowed gas to remain in these places. Taking an 8-c.p. lamp at 2·5 watts per candle, used for 300 days in the year for 14 hours a day, the annual cost would be about £2. 19s. 6d., allowing the lamps at 1s. 6d., and current at 6d. per unit. But for stairs and passages, 4-c.p. lamps might often be used, if they could be obtained. We expected to see four or five candle lamps offered for sale, but have not yet come across any. There should, however, be no difficulty in making 4-c.p. 50-volt lamps. For passages and stairs these could be wired in series without any difficulty, unless from Insurance Offices, who have some times made obscure objections. Two 4-c.p. lamps would consume the same amount of energy as in the former case, costing £2. 2s.; and another 17s. 6d. must be added for renewals, making £3. 17s. for the two, or £1. 18s. 6d. each per annum. For passages and stairs in the upper part of a house light is wanted, say, from dusk till 11 p.m., that is, about 1,800 hours. A 4-c.p. lamp would then cost only about 16s. 6d. per annum.

Had we known that the loud-speaking telephone to which we alluded a fortnight ago was being made by Messrs. Muirhead and Co., and was to be seen at their showroom at Princes Street, S.W., we should not, of course, have commented on it without trying it. Though we are unable to trace the source of the information on which we based our remarks, we have but little doubt that the Graham Loud-Talking Telephone is the one of which we had heard. The fact that it is made by Messrs. Muirhead and Co. is in the first place a sufficient guarantee of excellence, and that it is the invention of Mr. Graham is a further promise of practical value. The proof, however, is in the use, and we can only say that having had an opportunity of testing the apparatus it equals any loud-speaking telephone that we have tried, and surpasses all but an instrument in the possession of the late L. J. Crossley, of Halifax, Yorks. At present the instrument is adapted only for short lines, without induction coils, but a receiver for use on exchange circuits is occupying Mr. Graham's careful attention. No bell is needed, for the caller need only speak into the transmitter in his ordinary tone, and he can be heard many feet away from the receiver at the other end. The voice is all but natural, and is entirely free from buzzing. A resonant trumpet is fixed in front of the receiver, and the voice is not more modified than if the speaker were actually speaking through the trumpet.

The question naturally arises, How is it done? The transmitter is an ingenious modification of the Hunnings, and presents nothing fresh in principle, but is only remarkable for excellent workmanship in details connected with the prevention of clogging of the powder. The inside of the receiver is rather a surprise, for it appears to be nothing whatever but a rather large Gower. The magnet is, of course, strong, and the coils are of very low resistance. The secret seems to lie in the careful design and proportion of parts. These are almost as indistinguishable by mere inspection as the design of an armature of a dynamo. An interesting feature of the apparatus is a commutator, by which any room in a building can communicate direct to any other room, without possibility of over-hearing or cross-talk.

The recent report of the engineer to the City Commissioners of Sewers in regard to the number of failures of the arc lighting in the City needs a word or two of explanation.

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In our last issue we gave an account of the report, in which it will be found that during the past six months there have been 301 failures of light; and many of these were but for a minute or two. It is interesting to know that out of the 787,245 lamp-hours of possible running only 370 lamp-hours were lost.

A CORRESPONDENT of *The Times* has recently made a valuable suggestion which, it is to be hoped, will receive all the attention it deserves from the authorities in our London and other city hospitals. He suggests that all the hospitals in each town or city should be connected up on a special telephone circuit, just as it is intended to connect lighthouses and lightships. The importance of such a step is great, and the benefits to be derived from it are very numerous. At the present time each hospital is a detached and insulated institution, the staff of which is generally in perfect ignorance of the number of surgical beds or medical beds which are vacant in the neighbouring institutions. It is not an uncommon thing for a patient, often in a critical condition, to be carted round from Bart.'s to Guy's, St. Thomas's, Westminster, and perhaps the London or St. George's as well, finally being deposited, *pro tem.*, in some infirmary or taken home again. Medical men in one suburb often require to communicate with a hospital in a remote suburb: to telegraph is to lead to waste of time, and to ambiguities of all kinds; to cab it takes up time and money; to attempt to telephone is to find that the hospital, in many cases, is not even on the public telephone circuit. A private telephone circuit between all the hospitals, and a wire from each to the public exchange would greatly add to the harmonious integration of these institutions, and would increase their utility.

A Paradox.—A "dry" cell, says the *Electrical World*, is so called, because from its very nature it is always "wet," in order to distinguish it from the "wet" cells, which, if not attended to, may become "dry."

Cable Interruptions:

	Date of Interruptions.
Cayenne-Paramaribo	October 25th, 1893.
Perim-Obock	November 10th, 1893.

Royal Institution.—The annual Christmas course of lectures for children will this year be delivered by Prof. Dewar, his subject being "Air: Gaseous and Liquid." The first of the course will be delivered on Thursday, December 28th.

Compensation for Hysteresis.—We have received, too late for insertion this week, a communication from M. Abdank-Abakanowicz, commenting on Mr. Vignoles' article on this subject, together with some interesting diagrams, which we hope to reproduce in our next issue.

Lady Engineers.—Miss Bertha Lamme, of Springfield, Ohio, who recently received the American degree of electrical engineer at the Ohio State University, is said to be the first woman in the world to obtain this distinction. Miss Lamme has already accepted a position with the Westinghouse Company at Pittsburg.

Lecture.—A popular lecture on "The Supply and Measurement of Electricity" was delivered on Thursday, November 9th, by Prof. S. P. Thompson, F.R.S., at the Victoria Rooms, Bristol. Bristol people have been a long time waiting for the supply, and are growing impatient; we hope they will find the measurement satisfactory when it comes.

Manchester.—A short circuit occurred, at eight o'clock yesterday morning, on the mains of the Manchester electric power supply, which are laid on the five-wire system. An explosion ensued, resulting in the cover of one of the junction boxes being blown into the air. It was found necessary to switch off the current from the section on which the accident took place.

Personal.—In the list of honours conferred by H.M. the King of Portugal given in our issue of the 3rd inst. the following should have been included:—To be Chevalier of the Military Order of S. Bento de Aviz, John Seymour, Commander of the s.s. "Seine"; to be Chevalier of the Ancient Most Noble and Enlightened Order of S. Thiago, for scientific, literary and artistic merit, Francis Robert Lucas, Engineer-in-Chief of the Expedition on board the "Seine."

The New Atlantic Cable for the Commercial Company.—Messrs. Siemens Bros. and Co. (Limited) have received instructions from the Commercial Cable Company to proceed forthwith with the manufacture of a new cable to be laid between Ireland and Nova Scotia. This cable, which will be over 2,000 miles in length, is to be built to a specification ensuring higher speed than the Company's present cables, and is to be of special strength to resist the action of ships' anchors in fishing waters.

Magnetism and Contact Potential Difference.—In a Paper on the electric conveyance of heat, says the *Engineer*, M. L. Houllevigue mentions that the difference of potential between a conductor and iron is different accordingly as the iron is magnetised or not. One joint of a copper-iron couple was brought into a magnetic field, and the other left out. Since this arrangement could not give rise to a steady current without creating energy, an opposing E.M.F. was to be expected between the variously magnetised parts of the iron. Such a difference of potential was, in fact, found, the balance being in favour of the less magnetised portions.

Dynamos and their Prime Movers.—A feature of some interest regarding the relative sizes of dynamos and the engines which are used to drive them, says the *Electrical World* of New York, is shown quite nicely in some exhibits at Chicago. In all cases where there is direct driving, or where a single engine drives a single dynamo, it may be assumed that the dynamo and its prime mover are practically of the same horse-power; when the prime mover is a steam engine it will be noticed that the difference between the sizes, floor space, &c., of the dynamo and the engine is very greatly in favour of the former, the proportions being, perhaps roughly, about as one to three, or at least as one to two.

Plane of Polarisation of Hertzian Oscillations.—A recent number of *La Lumière Electrique* contains an article on this subject by M. Righi, in which he draws the following conclusions: his experiments with the metallic reflection of the oscillations tend to show that the plane of polarisation of electric oscillations is perpendicular to the direction of the magnetic forces, that is, parallel to that of the electric forces; but the experiments with reflection and refraction in dielectrics, on the contrary, tend to show that the plane of polarisation is perpendicular to the direction of the electric forces; the second being in accord with theoretical results, he thinks it is preferable to consider it as the true conclusion.

Huddersfield.—The electric lighting station was officially opened, and the supply of energy commenced last July. The number of consumers then connected was 33, or equivalent to 2,200 8-c.p. lamps. Since that time the number of consumers now connected has increased to 84, equivalent to 6,800 8-c.p. lamps, and many more premises are being fitted up, and will immediately require connecting with the supply mains. The total length of conduit laid for high-pressure mains is 12,000 yards, into which 5,420 yards of cable have been drawn. The total length of low-pressure mains laid is 5,305 yards. The number of junction boxes fixed is 127. The generating plant at the electric supply station is being increased by the addition of one engine and alternator, capable of supplying 6,600 8-c.p. lamps, which, with the existing machinery, will be ample to meet all demands during the coming winter.

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West of Scotland Iron and Steel Institute.—The second ordinary meeting of the West of Scotland Iron and Steel Institute was held on Friday evening last, in the Technical College, Glasgow, Mr. James Riley presiding. Mr. E. J. Duff, manager, Blochairn Steelworks, read a Paper on "Electric Welding," in which he described various electrical processes in use for the welding of metals. He predicted a useful future for these processes, and said that they would admit of the accomplishment of many things that had in the past been impracticable. The processes were yet but little known in this country amongst engineers and ironworkers. He hoped that the information imparted by the lecture might in some degree be the means of calling attention to a subject well worthy of the consideration of all engineers and metallurgists.

Coupling Alternators in Parallel.—M. Staner, in some recent numbers of *L'Electricien*, gives a mathematical discussion of this subject, which is intended to determine the conditions which should be complied with in order that the coupling of the alternators may be as stable as possible; he treats the subject algebraically and graphically, and comes to the following conclusions:—That the external circuit should have as small a self-induction as possible, a condition which is at the same time a favourable one for the transmission of the energy; that the alternators should have as low an internal resistance as possible, which is also a condition favourable to efficiency; that the coefficient of self-induction of the alternators should have a certain value for which he gives the equation; where the self-induction of the external circuit is negligible, this equation reduces to $m\,l = \sqrt{r\,R'}$, in which m is equal to $2\,\pi$ divided by the time of the duration of one period, r the internal resistance of the alternator, and R' equal to the sum of the internal resistance and twice the external.

Inspection of Telegraph Messengers.—Nearly 900 telegraph messengers paraded at the Tower by 9 a.m. on Monday last for inspection by the Postmaster-General. The boys carried carbines, and presented a very workmanlike appearance, wearing gaiters and great coats with waist-belt and buckle outside. Every London district was represented by at least one company of 25 file. In addition to this the Central Telegraph Office sent two and the Indoor Boy Messengers one company. The parade was under the command of Lieut.-Col. J. P. MacGregor, and was mainly composed of those boys who have been selected as prize-winners for proficiency at drill and for general good conduct during the current year. After the customary salute with presented arms, the battalion marched past in column and quarter-column, music being provided by the massed bands of the Central Telegraph Office and the various districts. The Postmaster-General and Mr. Spencer Walpole (the new Secretary) were present; as were also several of the Metropolitan district postmasters.

A Gallant Savant's Definition of Electricity.—Prof. Galileo Ferraris was recently asked by a young lady what electricity was, but, unlike most others when asked that question, he ventured to answer it, and according to "Cosmos," wrote in French in her autograph book the following, of which we venture to give a translation, even though the English language hardly does justice to the original in French:—

"Maxwell has demonstrated that luminous vibrations can be nothing else than periodic variations of electromagnetic forces; Hertz, in proving by experiments that electromagnetic oscillations are propagated like light, has given an experimental basis to the theory of Maxwell. This gave birth to the idea that the luminiferous ether and the seat of electric and magnetic forces are one and the same thing. This being established, I can now, my dear young lady, reply to the question that you put to me: What is electricity? It is not only the formidable agent which now and then shatters and tears the atmosphere, terrifying you with the crash of its thunder, but it is also the life-giving agent which sends from heaven to earth, with the light and the heat, the magic of colours and the breath of life. It is that which makes your heart beat to the palpitations of the outside world, it is that which has the power to transmit to your soul the enchantment of a look and the grace of a smile."

The Yorkshire College Engineering Society.—The first ordinary meeting of this session, says the *Engineer*, was held on Monday, October 30th, when Prof. Hele-Shaw gave an address on "The Methods of Graphical Calculation." The lecturer showed that the chief uses of graphical workings were:—Firstly, the interpolation of unknown values from known values of a like kind; and secondly, the graphic representation of the rate of changes of two variable quantities. The elaboration of these two statements form the groundwork for the theory and application of all graphical methods. It was also pointed out that the limit of usefulness of graphical work was reached in dealing with two variable quantities of unlike kind, and that if it was required to depict graphically the rate of change between three variables of unlike kind it would be necessary to have not only area enclosed by the diagram, but volume. This was clearly shown by a plaster cast, which served to illustrate the uselessness of attempting to deal adequately with three variables of unlike kind by graphical methods upon plane surfaces.

Intensities of Lighthouse Lights.—Last Friday the second meeting of a Conference of the General Lighthouse Authorities of the United Kingdom and their engineers, together with representatives of the Admiralty and Board of Trade, was held at the Trinity House, at which it was decided to publish in the Official List of Lights, the candle-power of each light as determined by the engineers. By this means mariners will be informed of the relative illuminating powers of all the principal lights on the coast. The members of the Conference were Sir Sydney Webb, Deputy Master of the Trinity House, in the chair; Vice-Admiral Sir George Nares, of the Board of Trade; Captain Wharton, R.N., Hydrographer to the Admiralty; Sir Robert Ball, scientific adviser to the Irish Lighthouse Board; Captain Burne, Elder Brother, and Mr. Charles A. Kent, secretary of the Trinity House; Sheriffs D. B. Hope and R. N. Campbell, Northern Lighthouse Commissioners; Messrs. W. Watson and G. B. Thompson, Commissioners of Irish Lights; with Mr. T. Matthews, Mr. D. A. Stevenson, and Mr. W. Douglas, the engineers of the English, Scotch, and Irish Lighthouse Boards respectively. Mr. E. Price Edwards acted as secretary to the Conference.

Modification of the Violle Standard of Light.—The Reichsanstalt, at Berlin, has published a report on the use of fused platinum as a standard of light. It is well known that M. Violle has proposed to use a square centimetre of surface of glowing platinum at the point of solidification, for this purpose. The chief objections to this standard are that it is necessary to have the metal absolutely pure and, in order to have the surface absolutely smooth, that there should be a considerable quantity of metal in a molten state. An error of 10 per cent. is very frequently present. The Reichsanstalt has, says the *Revue Scientifique*, ventured to standardise the temperature of the platinum quite independently of its melting point. It has been proved that at a certain fixed temperature the proportion of the total radiation which is transmitted through a layer of pure water of a definite thickness is always equal to 2 per cent., whatever the thickness of the platinum. This might have been expected. In order to measure the amount of luminous radiation, a very sensitive volometer has been constructed, the parts being composed of strips of platinum of one millimetre width and of extremely small thickness, said to be one-thousanth of a millimetre.

Electricity in Sugar Refining.—An account has been given by Von Lippmann of his observations when inspecting a certain sugar factory. The purification of beetroot juice was done, says the *Engineer*, by means of electricity. The warm diffusion juice is subjected to a current of 30 to 40 amperes at a pressure of 4 to 5 volts from a Siemens dynamo machine between electrodes of sheet zinc. A thick, muddy precipitate, which gradually sinks to the bottom of the vessel, separates at the anode. The electric current effects the coagulation of the albumen, which carries down many other substances; the zinc oxide which is formed combines also with numerous organic substances; and, as a matter of fact, the mud which separates at the electrode contains zinc oxide to the extent of one-third of its weight, but the juice is quite free from zinc. As, however, the diffusion juice does not contain much albumen, and the zinc plates are said to last for eight days and longer, it is impossible that the chemical effect can be great. It is, therefore, difficult to say, in the absence of analytical data, whether the excellence in purity of the sugar turned out at the factory in question is due to the application of electricity, or whether a judicious coagulation of albumen before purification would not lead to equally good results.

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A Seismic Photochronograph.—In *L'Elettricista* for November, Dr. A. Cancani describes an instrument for recording photographically the precise time at which an earthquake shock is felt at the observing station. This is done by obtaining a photograph of the face of a chronometer at the instant of the shock. In the apparatus in question the chronometer is illuminated for an instant by an incandescent lamp thrown into circuit by any one of the seismic instruments in the observatory. The mechanism, which is rather complicated, consists essentially of a horizontal lever carrying a pan with nine potassium bichromate pots on one arm, while the other is provided with weights, and is kept in position by the raised armature of an electromagnet. When the circuit of the latter is completed by one of the seismoscopes, the armature is attracted, the bichromate pots are raised, and the zinc-carbon couples fixed above them are immersed in the liquid, thus supplying the current for the lamp. After about a quarter of a second the lamp circuit is broken by one of the weights sliding off the lever, and the whole apparatus is automatically readjusted for the next shock. It has been in use at the Rocca di Papa Observatory, and has worked well.

The Junior Engineering Society.—Last Friday evening, at the Westminster Palace Hotel, the inaugural meeting of the thirteenth session of this Society took place, and was largely attended. The retiring President (Dr. John Hopkinson, F.R.S.) took the chair at the commencement of the proceedings, and, after some formal business had been disposed of, presented the Society's premium to Mr. R. W. Newman for his Paper on "The Sanitary Engineering of Dwellings." A vote of thanks having been cordially passed to Dr. Hopkinson for his services as President, the new President (Mr. J. Wolfe Barry, Vice-President Inst. C.E.) was then introduced, and proceeded to deliver his Presidential Address, an abstract of which will be found in another column. The hearty thanks of the Society having been expressed to the President for his address, the meeting terminated with the announcement of the ensuing meeting, when a Paper will be read by Mr. S. Cutler, jun., on "Coal Gas Manufacture and Recent Improvements in the Plant Employed therein." Other Papers on the session's programme are "Boiler Incrustations and Deposits," by Prof. V. B. Lewes; "The Construction and Working of Electromotors," by Mr. A. H. Dykes; "The Design and Construction of Boilers for Locomotive Engines," by Mr. G. F. Burtt; "Lubricants: their Use, Testing, and Analysis," by Mr. W. F. E. Seymour; "The Industries of Devon and Cornwall," by Mr. F. R. Taylor; "Marine Engineering Repairs," by Mr. T. P. Hosegood. Visits to works take place between the meetings, the Papers and reports of visits being printed in the Society's record of transactions. We may add, for the information of any of our readers desiring particulars of membership, that the address of the Secretary is 47, Fentiman-road, S.W.

Toronto.—The electric companies of Toronto, says the *Canadian Electrical News*, are brought face to face with a difficulty which threatens to make serious inroads upon their profits, if indeed it does not in some instances wipe them out altogether. We refer to the action of the city assessment department in placing an assessment for the first time this year on the plant of these companies. In the case of the Toronto Electric Light Company, this assessment amounts to about $300,000, and calls for the payment of $7,000 yearly in taxes, or about one-fifth of the Company's total income. It is not difficuit to realise what a tremendous burden this would be on almost any class of business, and on none perhaps would it fall more heavily than on electric lighting companies, as it is a well-known fact to all who are familiar with the conditions, that excessive competition has reduced the profits of the business to a minimum. Electric lighting companies are under contract with the municipalities to furnish light at a certain fixed price for a definite number of years, and therefore it will be impossible for them to make good their loss by increasing prices, at least so far as street lighting is concerned. Even were this not the case they are obliged in many instances to maintain a price which will compete with gas. A most serious injustice with which the electric companies have to contend in competition with gas companies is, that under the assessment law the underground mains of the gas companies are exempt from taxation. Thus even in cases where, as in that of the Incandescent Light Company, of Toronto, the distribution of current is done by means of underground conduits, the electric light company's mains will be taxed while those of the gas company's will escape assessment. In a variety of ways, therefore, the electric companies are placed at a serious disadvantage, and unless in some way they can be relieved of this latest burden their already slender profits will as already stated in many instances be wiped out altogether. Another hardship is that there is but one appeal from the decision of the Court of Revision, viz., to the county judge, whose decision is final. Should the efforts which will be made by the electric companies in Toronto to be relieved of this method of assessment prove unavailing, then a united effort on the part of all the electrical companies of the province should be made at the next session of the Ontario Legislature to have the matter remedied.

The Niagara Electric Plant.—After protracted and exhaustive examination of many plans submitted by various electrical companies in America and Europe, the Niagara Falls Power Company announces, says the *Electrical World* of New York, that it has awarded to the Westinghouse Company, of Pittsburgh, Pa., a contract covering the construction and erection of three alternating current dynamos of 5,000 H.P. each, after designs originating with the engineers of the Cataract Construction Company, and especially adapted to the particular requirements of the hydraulic works of the Niagara Falls Power Company. The system adopted involves the use of two-phase current, with a frequency of 25 periods per second, generated at a voltage of 2,000 and the use of transformers for long distance transmission at higher pressure. The officers of the Cataract Construction Company include the following well known business men: Edward D. Adams, who is president; Francis L. Stetson, Edward A. Wickes, William L. Rankin, and Dr. Coleman Sellers as engineer, with Prof. George Forbes, of London, as consulting engineer. The Cataract Construction Company has been conducting negotiations with the principal electric manufacturing companies, including the Westinghouse Electric and Manufacturing Company, the Siemens and Halske Company and the General Electric Company. Early in the spring of the present year bids were received based upon specifications advocated by the individual companies, in which the different companies were at liberty to advocate the different systems and class of machines which they preferred. The system finally adopted was the two-phase alternating current, Tesla system. After a careful study of the conditions under which the apparatus had to operate, the engineers of the Cataract Construction Company prepared a complete set of specifications calling for the employment of the two-phase system, new proposals were submitted, and the contract was awarded to the Westinghouse Electric and Manufacturing Company, as above stated. The machines will be built in units of 5,000 H.P. The revolving field of the generator will be constructed with inwardly projecting poles, and will revolve in a horizontal plane, being mounted upon the vertical shaft of the turbine. The weight of the shaft, turbines, and armature is to be carried by the upward pressure of the water columns producing the heads for the turbines. The electromotive force generated will be 2,000 to 2,400 volts, and will be increased by step-up transformers for long-distance transmission, and lowered by reducing transformers for distribution. The motors will be the two-phase Tesla motors, which have been found to be well adapted for power purposes although this question is not definitely settled. The system adapts itself readily to the use of motor generators or rotary transformers, so that it is possible to develope either single-phase alternating currents or continuous currents of any desired electromotive force, as may be required for the use of individual customers. It is expected that a large amount of power will be employed for manufacturing purposes, arc and incandescent lighting, electrolytic work and power purposes generally. It is also understood that the Company contemplates sending currents at high pressure to Buffalo and greater distances, to be used for lighting and power purposes. The work upon the apparatus has already been begun, and it will be erected at the earliest possible date.

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ELECTROMAGNETIC THEORY.—LIX.

BY OLIVER HEAVISIDE.

(*Continued from page 7.*)

§ 219. In any electromagnetic combination the effects of electric and magnetic energy are antagonistic in some respects. Or we may say that magnetic inductances tend to neutralise electric permittances. Or, more generally, that the effects of elastic compliance and of inertia tend to neutralise one another. Thus, when a coil is under the action of a simply periodic voltage, the current lags, owing to the self-induction. But if a condenser be introduced in sequence with the coil, the lag is diminished, and may be reversed or converted into a lead. The result on the current is the same as if we substituted for the coil another of the same resistance and of reduced inductance, or even of negative inductance. Thus, the resistance operator of the coil being $R+Lp$, where R and L are its resistance and inductance, and p is the differentiator d/dt; and that of the condenser being $(Sp)^{-1}$, where S is its permittance, when the two are in sequence the resistance operator of the combination is

$$Z = R + Lp + (Sp)^{-1}, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

which, in a simply periodic state of frequency $n/2\pi$, making $p^2=-n^2$, or $p=ni$, becomes

$$Z = R + Lp - \frac{p}{Sn^2}$$

$$= R + \left(L - \frac{1}{Sn^2}\right)p. \quad . \quad . \quad . \quad (2)$$

This shows that the effective inductance of the condenser, which is $-(Sn^2)^{-1}$, is additive with real inductance when in sequence therewith, and being negative, reduces the effective inductance of the combination from L to $L-(Sn^2)^{-1}$.

But when the condenser and coil are in parallel, it is more convenient to use the conductance operators. Thus

$$Y = (R+Lp)^{-1} + Sp \quad . \quad . \quad . \quad . \quad . \quad (3)$$

is the conductance operator of the coil and condenser in parallel, being the sum of the conductance operators of the coil and condenser taken separately. And when $p=ni$, we convert Y to

$$Y = \frac{R-Lp}{R^2+L^2n^2} + Sp$$

$$= \frac{R}{R^2+L^2n^2} + \left(S - \frac{L}{R^2+L^2n^2}\right)p, \quad . \quad . \quad (4)$$

from which we see that the combination is equivalent to a condenser of conductance $R(R^2+L^2n^2)^{-1}$ and of permittance $S-L(R^2+L^2n^2)^{-1}$. The steady conductance being R^{-1}, we see that the effective conductance is reduced by the self-induction. At the same time the effective permittance is reduced, and may become negative. Remember that in (3) and (4) the standard of comparison is a condenser, not a coil; whereas in the former case (1), (2) the standard of comparison is a coil, not a condenser. For further information regarding resistance and conductance operators *see* "Electrical Papers," Vol. II., p. 355, and elsewhere. The present remarks are merely definitive and introductory to the theory of waves sent along a circuit, either naturally, or partly controlled by subsidiary arrangements. The comparison with a coil is, I believe, more generally useful. Then we imagine any combination to be replaced by a simple coil whose resistance and inductance are those (effectively) of the combination. But there are cases when the other way is preferable. Then we imagine the combination replaced by a condenser whose conductance and permittance are those (effectively) of the combination. And in the following it will be convenient to use both ways in the same investigation.

§ 220. Now imagine the permittance of a submarine cable to be concentrated in lumps at a number of points. Let S be the permittance of one of the equivalent condensers. If it be shunted by a coil of such R and L that $S=L(R^2+L^2n^2)^{-1}$, we know by the above that the state of the cable, when simply periodic, will be the same as if the condenser and coil were removed and replaced by a simple leak of conductance $R(R^2+L^2n^2)^{-1}$. This reasoning applies to every condenser, if it have its appropriate coil, or to any selected group we please. But if the frequency be changed the permittance will come into sight again, of the real or positive kind, or of the fictitious negative kind, as the case may be. We have, therefore, the power of reducing the effective permittance of a cable under simply periodic forces, by means of numerous auxiliary inductive shunts or leaks, and of practically cancelling it at a particular frequency. How will this work out in the transmission of telephonic currents through the cable?

From the purely theoretical point of view one may be somewhat prejudiced against the system at first. For, obviously, it is not a distortionless arrangement. That is got by balancing the self-induction of the main circuit against the lateral permittance, which can, subject to practical limitations, be done perfectly. That is, there is a balance at any frequency, or the idea of periodic frequency does not enter at all. I doubt whether there can be any other distortionless circuit than that which (in the absence of another) I always refer to as *the* distortionless circuit. With inductive shunts we produce a partial neutralisation of the permittance, the amount of which may vary very widely during the transmission of telephonic currents. Remember, too, that during the change from one frequency to another there are other phenomena than those concerned during the maintenance of a simply periodic state of variation.

Nevertheless, we should be careful not to be prejudiced against an imperfect plan merely because it is so manifestly imperfect. It may perhaps be more easily applied than a theoretically perfect system, and may possess practical advantages of importance. Now this is a matter for practical experiment and experience. But it is just here that there is an almost complete dearth of information. For although Prof. Silvanus Thompson has mentioned that he has made many experiments, yet he has only described one case in which an inductive shunt was found good. It was an artificial cable of 7,000 ohms and 10 microfarads. Presuming that there was a fairly good spreading of the permittance, we see that the permittance is that of about 40 kilometres of a submarine cable, whilst the resistance is more like that of 1,000 or 2,000 kilometres. The inductance would probably be very small. We see that the example does not well represent a submarine cable. We should rather compare it with a very long overland circuit of very much smaller permittance per kilometre than the cable. Only, such a circuit, if properly put up, would have a large inductance, so that there is a failure here. However, it is mentioned that one shunt of 312 ohms and a time-constant of 0·005 sec. rendered telephonic transmission possible except for shrill sounds. I cannot help thinking that Prof. Thompson has been much too reticent on the experimental side. He will perhaps furnish us with fuller information later on. At present there is little to judge by.

§ 221. In the meantime the following theory and formulæ may perhaps be useful to those who may desire to go into the matter. I put the theory into such a form that it may be applied to various other cases of auxiliary arrangements. Let V and C be the transverse voltage and the current, at distance x, at time t. Let their connections be

$$-\frac{dV}{dx} = ZC, \qquad -\frac{dC}{dx} = YV, \quad . \quad . \quad . \quad (5)$$

where Z is a resistance operator, and Y a conductance operator, as described in § 219, only now belonging to unit length of circuit. In the simplest case Z reduces to a resistance, and Y to a conductance, per unit length. But in general Z and Y may have various forms, in unlimited number, being then functions of electrical constants and of the time differentiator p. When there are no auxiliary devices, and the natural resistance R, inductance L, leakance K, and permittance S (all per unit length) are constants, then we have

$$Z = R + Lp, \qquad Y = K + Sp, \quad . \quad . \quad . \quad (6)$$

as before, § 201—4. But whatever the forms of Y and Z may be, in finite terms or transcendental, we may reduce them to the simple standard forms (6) when the simply periodic state of vibration is maintained, by employing the transformation $p=ni$, or $p^2=-n^2$. We see from this that we can practically examine cases of simple periodicity which might at first seem

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beyond all bounds of practicability. Note, however, that "forces" and "fluxes" should be in constant ratios, so that such phenomena as hysteresis, magnetic or electric, are excluded.

From equations (5) we see that the characteristic equation of V is
$$\frac{d^2V}{dx^2} = YZV = q^2V, \text{ say}, \quad . \quad . \quad . \quad . \quad (7)$$
provided Y and Z are independent of x. This restriction is not a necessary one, but, of course, it makes an important practical simplification to have uniformity along the circuit. In (7) q^2 represents the operator YZ, and in passing we may notice an interesting matter connected with partial differential equations of the type (7), or of the more general type
$$\nabla^2V = q^2V, \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$
appropriate to three dimensions in space. This type of equation occurs in all sorts of physical problems, V being some variable which is propagated through a medium in a manner depending upon the nature of the operator q^2, which involves the time-differentiator. It is usually a very simple rational function of p, such, for example, as to bring in only the first and second derivatives of V with respect to the time, and, so far as I know, no physical problems have presented themselves which involve an irrational partial differential equation for characteristic, as, for example,
$$\nabla^2V = (a + bp + cp^2)^{\frac{1}{2}}V. \quad . \quad . \quad . \quad . \quad (9)$$

It might, indeed, seem at first sight that a characteristic of this form was physically impossible, being meaningless. Nevertheless, it is quite easy to see by the way equation (7) was constructed out of the components (5), that real physical problems may involve irrational characteristic equations, such as are exemplified by (9). For if either Y or Z be irrational, so is YZ. And we can easily (in imagination, not so easily in execution) choose auxiliary devices making Y or Z irrational. Similar remarks apply to (8). It results from the union of two distinct equations involving two variables, one of which is then eliminated to make the characteristic. If either of the component equations involves an irrational operator, the characteristic resultant will be irrational. It must not be imagined that the solutions of such equations obtained by physical reasoning are impossible or beyond the range of mathematics, or that the results are physically meaningless. Some partial characteristics of the form (8), with irrational right members, I have examined and solved. I should imagine that there will probably be a field for equations of the kind in the future study of the complicated influence of matter upon phenomena which occur in their simplest manner in the ether away from matter, as in the theory of dispersion of light, for example, of electric absorption, and in similar subjects.

Returning to equation (7), the general solution involves two arbitrary functions of the time, as in the form
$$V = \cosh qx.V_0 + \frac{\text{shin}\, qx}{q} ZC_0. \quad . \quad . \quad . \quad . \quad (10)$$
But it is preferable to take the case of disturbances propagated from a source into an infinitely long cable, in order to eliminate complications due to reflections and terminal apparatus. Then
$$V = \epsilon^{-qx}V_0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$
is the solution representing V at x, t due to V_0 given as a function of the time at $x = 0$, the origin. And the current is given by
$$C = \frac{q}{Z}V = \left(\frac{Y}{Z}\right)^{\frac{1}{2}}\epsilon^{-qx}V_0, \quad . \quad . \quad . \quad . \quad (12)$$
by using the first of (5).

To see the final state due to the continued action of constant V_0, give q, Y, and Z in (11), (12), the values they assume when p is put $= 0$ in their general expressions, viz., for Y the steady leakance and for Z the steady resistance per unit length, and for q their geometric mean. To find how this state is arrived at, and, more generally, to interpret (11), (12) where V_0 is any given function of the time, demands the conversion of these equations to proper algebraical form by execution of the analytical operations implied in q, Y, and Z. This we are not concerned with here, except as regards the case arising when V_0 is a simply periodic function. Then put $p = ni$, and reduce Z to R + Lp, and Y to K + Sp, as before stated, equations (6), making (11), (12) become
$$V = \epsilon^{-qx}V_0, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$
$$C = \left(\frac{K + Sp}{R + Lp}\right)^{\frac{1}{2}}\epsilon^{-qx}V_0, \quad . \quad . \quad . \quad . \quad (14)$$
where
$$q = (R + Lp)^{\frac{1}{2}}(K + Sp)^{\frac{1}{2}}. \quad . \quad . \quad . \quad . \quad (15)$$

These expressions have next to be reduced to the form $(A + Bp)V_0$, which is a matter of common algebra. When done we shall find that if
$$P \text{ or } Q = (\tfrac{1}{2})^{\frac{1}{2}}\left[(R^2 + L^2n^2)^{\frac{1}{2}}(K^2 + S^2n^2)^{\frac{1}{2}} \pm (RK - LSn^2)\right]^{\frac{1}{2}}, \quad . \quad (16)$$
then the V solution is
$$V = e\,\epsilon^{-Px}\sin(nt - Qx), \quad . \quad . \quad . \quad . \quad . \quad (17)$$
due to $V_0 = e \sin nt$ at the origin. From this, by the use of the first of (5), giving
$$C = \frac{-\dfrac{dV}{dx}}{R + Lp} = -\frac{R - Lp}{R^2 + L^2n^2}\frac{dV}{dx}, \quad . \quad . \quad . \quad . \quad (18)$$
we may derive the C solution. Or we may derive it by developing (14). The result is
$$C = \frac{e\,\epsilon^{-Px}}{P^2 + Q^2}\left[(KP + SnQ)\sin + (SnP - KQ)\cos\right](nt - Qx), \quad (19)$$
where the value of $P^2 + Q^2$ is given by
$$P^2 + Q^2 = (R^2 + L^2n^2)^{\frac{1}{2}}(K^2 + S^2n^2)^{\frac{1}{2}}. \quad . \quad . \quad (20)$$

It may be only necessary to consider the amplitudes of V and C, and, of course, C is most important. That of V is obviously $e\,\epsilon^{-Px}$, by (17). That of C may be got from (19), and is expressed by
$$(C) = e\left(\frac{K^2 + S^2n^2}{R^2 + L^2n^2}\right)^{\frac{1}{2}}\epsilon^{-Px}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (21)$$

The wave speed is n/Q, the wave length $2\pi/Q$, and the periodicity $n/2\pi$. Another convenient form of (21) is
$$(C) = \frac{e}{Lv}\epsilon^{-Px}\left(\frac{1 + K^2/S^2n^2}{1 + R^2/L^2n^2}\right)^{\frac{1}{2}}, \quad . \quad . \quad . \quad . \quad . \quad (22)$$
where $v = (LS)^{-\frac{1}{2}}$.

§ 222. The above simply periodic solution is discussed in my "Electrical Papers," Vol. II. (especially p. 396 and p. 339) where R, L are the natural effective resistance and inductance and K, S the leakance and permittance per unit length, the latter pair being supposed to be the same at all frequencies (A Paper by Prof. Perry, *Phil. Mag.*, August, 1893, may als be consulted, but I do not think he is right in some of hi conclusions.) But the same formulæ are applicable whei auxiliary devices are employed, if they are numerous enough by a process analogous to the obvious one of representing large numbers of separate leaks by uniform leakance.

Thus, in the case of inductive shunts, if we treat them as a set of separately located shunts, the full theory is very complicated, because it requires a separate formula for every section of the line. The best course to take is to distribute the inductive leakance uniformly, in imagination, of course. The result will represent the fullest possible carrying out of the principle concerned, and more. Thus, let ρ be the resistance and λ the inductance of the leak belonging to the unit length of cable. The reciprocal of ρ is of course the steady leakance per unit length. But it does not operate fully when the stat is changing, owing to λ. We shall now have
$$Y = \frac{1}{\rho + \lambda p} + \sigma p, \quad . \quad . \quad . \quad . \quad . \quad (23)$$
where $(\rho + \lambda p)^{-1}$ is the leakance operator, taking the place c ρ^{-1}, whilst σ is the steady permittance per unit length. W have to use this special Y in the above formulæ to represen the effect of inductive leakage. In the simply periodic cas Y develops to
$$Y = \frac{\rho}{\rho^2 + \lambda^2n^2} + \left(\sigma - \frac{\lambda}{\rho^2 + \lambda^2n^2}\right)p. \quad . \quad . \quad (24)$$
The first term is the effective leakance, and the coefficient of p the effective permittance per unit length.

In the developed formulæ (16), (17), (19) to (22), therefor we must give K and S the values
$$K = \frac{\rho}{\rho^2 + \lambda^2n^2}, \qquad S = \sigma - \frac{\lambda}{\rho^2 + \lambda^2n^2}, \quad . \quad (25)$$

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to suit the case of inductive leakage, whilst R and L remain as before, the effective resistance and inductance per unit length of line. The solutions should be examined through a wide range of frequency in order to arrive at a good knowledge of how the circuit would behave to telephonic currents, with different values of λ and ρ. It is, of course, necessary that ρ should not be so small as to produce too great a loss in transit.

Notice that λ and ρ are immensely big when the unit length is a centimetre. Remember that m equal coils in parallel behave like one coil of one m^{th} the resistance and inductance of the individual coils. Thus, when ten shunts at the rate of one per kilometre take the place of one shunt per ten kilometres, each of the ten should have ten times the resistance and inductance of the one. This leads to physically monstrous results when we do as was done above, and make the action uniform, as it implies infinitely large inductance of an infinitely small section of the leakance. But that need not cause any alarm when we are employing the ideal case for calculating purposes. What is more important is that a stop would soon be set to the multiplication of the shunts.

At the particular frequency making the effective permittance vanish, the solution may be obtained simply from the fundamental formulæ, since Y reduces to a constant, viz., the value of K in (25), S being zero; and only the rationalisation of Z has to be attended to. If, further, we assume that L = 0, then Z is also constant, viz., R, and the solutions are simply

$$V = \epsilon^{-x(RK)^{\frac{1}{2}}} V_0, \quad . \quad . \quad . \quad . \quad . \quad (26)$$

$$C = \left(\frac{K}{R}\right) V. \quad . \quad . \quad . \quad . \quad . \quad (27)$$

These represent a very remarkable state of affairs throughout the cable. But it is thoroughly deceptive, because even if the inductance of the line were quite unimportant under normal conditions, the effective cancellation of the permittance would make it important under the present circumstances; that is, L cannot be neglected. Including it, when S = 0, the value of P reduces to

$$P = (\tfrac{1}{2})^{\frac{1}{2}} \left(\frac{\rho}{\rho^2 + \lambda^2 n^2}\right)^{\frac{1}{2}} \{R + (R^2 + L^2 n^2)^{\frac{1}{2}}\}^{\frac{1}{2}}, \quad . \quad (28)$$

and the current amplitude, according to (21), becomes

$$(C) = \frac{\rho^{\frac{1}{2}} \epsilon^{-Px} e}{(\rho^2 + \lambda^2 n^2)^{\frac{1}{2}} (R^2 + L^2 n^2)^{\frac{1}{4}}}, \quad . \quad . \quad . \quad (29)$$

in which, of course, ρ and λn are not independent, having a relation fixed between them by the vanishing of S in (25). By giving a suitable value to σ, for instance, $\frac{1}{4}$ microfarad per kilometre (which is a suitable unit of length to employ), and also fixing the frequency, we may readily apply the formulæ to estimate the attenuation with different values of the insulation resistance or its equivalent.

(To be continued.)

PHOTOMETRIC FANTASIES.

Under this title M. Hospitalier comments in *L'Industrie Electrique* on the discussion which has recently appeared in our columns on power of search lights, or intensity, as Mr. Steinmetz calls it. The discussion arose out of a remark made in Prof. S. P. Thompson's article on the Chicago Congress (*The Electrician*, September 20, 1893). M. Hospitalier quotes the remark, together with Mr. Steinmetz's letter and our Notes on the subject, in full, and continues :—

"The discussion which we now resume proves as far as the evidence goes, that the photometry is on a fundamentally wrong basis, and that it is absolutely impossible to compare and to express as the function of one and the same unit, the luminous intensity of a *source* of light reduced theoretically to a mathematical point, and that of a luminous beam of which the rays are parallel or sensibly so. Indeed, in the first case, the illumination diminishes directly as the square of the distance; in the case of parallel rays, the illumination remains constant, neglecting the absorption of the atmosphere. The more the source of light is withdrawn, of which the rays have been made parallel, the greater the luminous intensity, calculated in the ordinary way, increases; it increases, too, beyond all limit, which is physically impossible.

"To take analogy from phenomena familiar to electricians, a luminous *source* is comparable to *magnetic pole*; the field which it produces varies inversely as the square of the distance: a parallel luminous beam is comparable to a uniform magnetic field. But the intensity of a magnetic pole is equivalent to the flux of magnetic force, while the intensity of the field is the quotient of a flux of force by a surface. These two physical quantities of different nature are incommensurable.

"The expression of the intensity of a magnetic pole capable of producing a magnetic field of a given intensity has not any physical meaning, and this is the corresponding photometric expression which is used by the inventors and constructors when they speak of a lighthouse or of a projector producing so many millions of candle-power. Even taking into account the divergence of the rays, and of the imperfection of the projector, the photometric measurement loses all meaning, because of the want of physical identity between the magnitudes purported to be measured in the two cases.

"We conclude, then, against Mr. Steinmetz, and with our contemporary *The Electrician*, that the values of the luminous intensities attributed to lighthouses and to projectors have not any physical meaning.

"On this point, as well as on many others, photometry must be entirely revised. This conclusion allows us to dispense with the objection of Prof. Silvanus Thompson about the surface of the crater, which should give an arc of 180,000,000 candle-power, an objection which we have not reproduced because it only begs the question."

After so lucid an explanation such as M. Hospitalier is wont to give, especially upon subjects on which others are be-fogged, it is hardly necessary to add another word. The analogies which he draws between candle-power and the strength of a magnetic pole, and between illumination and the intensity of a magnetic field, are very apt. The importance of magnetic poles is merely due to the fact that they are associated with lines of force, the number of lines being proportional to the strength of the pole. An ordinary source of light diverges its rays uniformly in all directions, just as a magnetic pole emits lines of force. When these lines or rays cease to diverge and become parallel, it is useless to speak any longer of the former being due to a magnetic pole, or the latter to a light source fixed at a finite distance. It is far better to consider the density of these lines or rays, *i.e.*, the induction density of the magnetic field, in the one case, and the density of the rays of light, or the illumination of the optical field in the other. Rays of light can in fact be treated in exactly the same way as lines of force. A ray of light can always be supposed to represent a definite quantity of light just as a line of force always denotes a fixed quantity of magnetic induction.

We may mention, however, that another discussion has been going on in the *Electrical World* of New York. Prof. S. P. Thompson's remark found its way into the "Digest" of the *Electrical World* of New York, and was accompanied by a comment by Mr. Carl Hering. To this Mr. Steinmetz replied in much the same terms as his letter which appeared in our columns, and to this Mr. Carl Hering makes a rejoinder, demolishing the fallacy. "If Mr. Steinmetz," he concludes, "can describe how calculations of the candle-power of search lights from photometric measurements are made in practice by those well up in the subject, the matter would, doubtless, be of great interest to many; I have inquired of the United States Naval Department, as also have several of the most prominent makers of search lights in Europe, but without obtaining any satisfactory replies."

We should not have called attention again to the subject but for an official announcement which has been made regarding the photometry, or at all events the designation, of the power of British lighthouses. In this announcement, which will be found in our Notes, it is promised that "the candle-power of each light, as determined by the engineers," will be published in the Official List of Lights. "By this means mariners will be informed of the relative illuminating powers of all the

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principal lights on the coast." If the "relative" illuminating powers be adhered to there need be no confusion. The sizes of lighthouse lanterns have long been designated as "first order," "second order," &c., a classification as unfortunate as that of levers in text-books on mechanics. The sizes would be much better expressed simply by the diameters. For the illuminating power, some such arbitrary system would probably be the best. The sailor would, probably, prefer to call a light "a No. 3," than a "14,000 candle-power," especially as it is clear that the 14,000 candle-power is quite fallacious. The most powerful light might be called No. 1, and the lesser ones 2, 3, &c., as the magnitudes of stars are described. When the time comes for bigger lights they can be called No. 0, No. 00, &c., as in the wire gauge. The effect of atmospheric absorption, however, will seriously interfere with the apparent brilliance of the lights, and if, as there is every reason to suppose, electric lights suffer more than oil lights in thick weather, the advantage of designating the power of lighthouses is considerably reduced.

NODAL SYSTEMS OF ELECTRIC WAVES OBTAINED BY LECHER'S METHOD.*

BY DOMENICO MAZZOTTO.

This Paper gives the results obtained in an investigation of the various wave systems produced in a Lecher wire system† on varying the lengths of the primary and secondary wires, and the round india-rubber tubes sliding on the secondary wires, and approaching each other to within a distance of 2cm. When the apparatus was worked in the dark, and the fingers were brought near the platinum tips of the wires, two small luminous stars appeared at these tips when the bridge was in the vicinity of a node, and on further approaching the node these stars became very bright and conspicuous sparks, even without the presence of the fingers. This "explorer" has the advantage over Lecher's tube of showing more decided maxima and minima, being less fatiguing to the eyes, and less capricious in its action.

The condenser plates used by Signor Mazzotto were of zinc, 40cm. square, and 0·25cm. thick. The primary and secondary wires were soldered to the upper extremities of their near edges, 12cm. apart, and consisted of copper wire, 1mm. thick. The distance between the condenser plates could be easily varied between 1cm. and 15cm. The maximum length of the primary wires was 2·42m., and that of the secondary wires 25m.

The main object of the investigation was to find a ready way of unravelling the multitudinous nodal systems formed when the induction system—*i.e.*, the primary wires and the condenser—was kept constant, and the secondary wires bridged in different places. The multiplicity of these nodal systems was found to be greater than what would appear from Lecher's work. The "harmonics" of the fundamental system were not the only higher systems that were produced; but it was possible, by altering the disposition of the bridges, to produce any system intermediate between two harmonics. It was also found, however, that when the second bridge was placed in a certain position, the nodal systems obtained by shifting the first bridge were independent in position and intensity of the state of the system beyond the second bridge and behaved just as if the wires were cut off and joined by the second bridge. In order, therefore, to find all the possible nodal

Fig. 1.

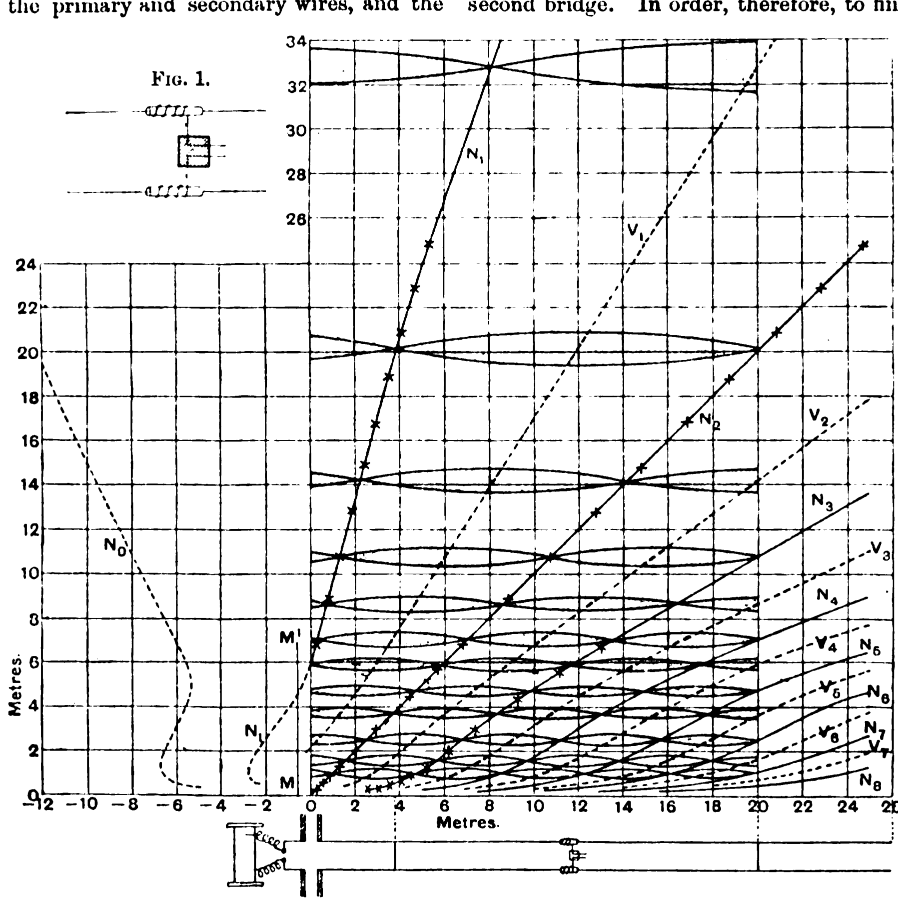

Fig. 2.—Distance between Plates, 5cm. Length of Primary Wires, 62cm.

distance apart of the plates of the condenser. The wire system in question is sketched at the bottom of Fig. 2. It consists of two metallic plates, joined by means of metallic wires (primary or adductor wires) to the knobs of a spark-gap, which are further connected with the terminals of an induction coil. In front of the primary plates are two equal and parallel plates connected with secondary wires. Two opposite points in the latter can be connected by a "bridge" capable of being shifted along the wires.

The points of maximum difference of potential along the wires were indicated, not by a Geissler tube, as in Lecher's experiments, but by an "explorer," consisting of two wires (Fig. 1) passing systems, it sufficed to find them for all possible positions of the second bridge. Each system is sufficiently defined if two of its nodes are known, since all the nodes are equidistant. Taking then, any one system, and noting its development as the second bridge is moved away from the zinc plates along the wires, and plotting the "nodal lines," we obtain Fig. 2, where the distances from the plates are taken as abscissæ, and the distances of the second node (N_2) of each system as ordinates.

In practice, points along the nodal lines are determined as follows: The second bridge is placed at the end of the secondary wires, and the first bridge is shifted from the vicinity of the plates towards the second, keeping the "explorer" always half way between the bridges. They are shifted until the maximum effect is obtained at the explorer, showing that the system of waves producing it h

* *Atti della R. Accademia delle Scienze di Torino*, Vol. XXVIII., June 11, 1893.

† *Wiedemann's Annalen*, Vol. XLI., p. 850, 1890.

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the greatest possible wave-length. This is usually accomplished at the first trial, and tested by the gradual extinction of the glow on approaching the explorer to either of the bridges. The position of the first bridge is noted, and the second is shifted by a convenient amount in the direction of the plates. The corresponding position of the first bridge is determined as before, and the process continued until the bridges are inconveniently close to the plates. When that happens they are shifted by one wave-length, and then the second bridge will indicate the position of the third node (N_3), and its successive positions will trace a third "nodal line."

Other nodal lines (N_4, N_5, &c.) are easily obtained by cutting off equal segments along the abscissæ, and joining the points of section, and lines denoting the centres of ventral segments (V_1, V_2, &c.) are obtained by joining points midway between the nodes.

To determine all the possible systems for any given position of the second bridge, cut off its distance along the axis of abscissæ, and draw an ordinate, cutting the various nodal lines. From the points of intersection draw horizontal lines towards the left. These will represent the various systems, and twice the distance between two successive nodes will be the corresponding wave-lengths.

The dotted lines (N_0 and a portion of N_1) are obtained by cutting off corresponding segments beyond the first bridge towards the inductor. The lengths of abscissæ cut off by these lines may be taken as the equivalent lengths of the inductor system.

Besides this system of nodal lines others were determined with the plates at distances apart of 1, 2, 5, and 15cm., and

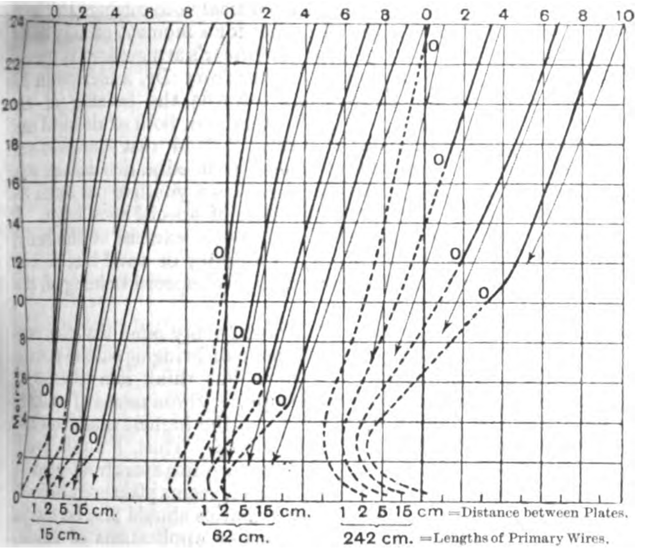

FIG. 3.—The Thick Lines represent Curves Found, the Thin Lines Curves Calculated.

with lengths of primary wires of 4, 15, 32, 62, 122, and 242cm. The results are shown graphically in Fig. 3. It was found that the condensers had the greatest effect in lengthening the waves when disposed symmetrically with respect to the exciter on the one hand and the first bridge on the other.

The wave-lengths found were compared with those given by the formula published by Salvioni,* and found to agree fairly well with their general character, as seen in the figure.

But this formula, like that published by Cohn and Heerwagen, gives only the nodes of the fundamental system. It is easily seen from Fig. 2 that the superior systems are not "harmonics" of the fundamental system in the acoustical sense, as the nodal lines do not meet in a point. Signor Mazzotto inclines to the view that these wave systems are the harmonics of the system comprised between the spark-gap and the first bridge.

THE JUNIOR ENGINEERING SOCIETY.

PRESIDENTIAL ADDRESS.†

BY JOHN WOLFE BARRY, ESQ., VICE-PRESIDENT INST.C.E.

I have been somewhat perplexed in the choice of a subject on which to speak to you this evening, bearing in mind the eloquent and instructive addresses with which my predecessors have inaugurated their various terms of office. These addresses have ranged from specific subjects of practice to the education of an engineer. I at length decided to devote myself to the subject of engineering considered generally as a calling or profession, including a few words on the subject of education for it. I propose to add a retrospect of what has been done by us engineers during my own memory, and some slight forecast of the future of the profession, in which last division those whom I have the honour and pleasure of addressing are more interested than the speaker can be.

First, then, what is the profession of civil engineering? The founders of the Institution of Civil Engineers well defined it as being the art of directing the great sources of power in nature for the use and convenience of man; and this surely is not only true now, but has been abundantly shown to be justified by the history of the years which have elapsed since the year 1828, when the words were inscribed in the Royal Charter of the Institution. The Chancellor of the Duchy of Lancaster, Mr. Bryce, in an after-dinner speech lately, humorously said that he had observed in modern novels, whereas the villain is usually a baronet, that the virtuous and clever man is almost invariably an engineer. This is putting the matter somewhat broadly, whether for the baronets or engineers, but it amusingly illustrates my thesis that our profession is one which gives scope for great characteristics, both moral and mental. Seriously, then, let us consider this question further and we shall see that among the moral qualities which engineering demands we should certainly number courage or bravery, constancy, loyalty and uprightness. I am sure that we can point to many examples of these within the recent history of our profession no less than in the past. With regard to courage, what finer examples of gallantry can we point to in any profession than that of the engineering staff of the ill-fated ship "Victoria"; when all the rest of the ship's company were mustered on the deck of the sinking ship, the engine-room staff carried on their duties below unflinchingly, and perished, I believe, to a man, among horrors which one can scarcely realise, much less attempt to describe.

Again, how necessary to an engineer is the sentiment or quality of loyalty. Loyalty to his employers, which will enable him to give advice unpalatable to them, and often contrary to what seems to be his own interest, but which is necessary for the good of the undertaking under his charge. Loyalty again to the subordinates of his own staff, or to contractors or others, whom in his position as engineer he is bound in all honour to protect against injustice or unmerited blame. How necessary also, on the other hand, is loyalty between the juniors of an engineering staff to their chief; keeping his secrets, and obeying orders without thought of their own supposed interest; giving their help ungrudgingly and doing their very best. I am happy to think that we can all think of examples of such qualities in the career of most of our profession, and I repeat that such loyalty is an essential part of an engineer's qualifications. Uprightness is of course a necessity of any honourable man, whatever walk of life he may follow. But I think that the amount of confidence which is given to engineers is perhaps greater than in any other profession.

But apart from mere honest administration of funds, there is another form of uprightness which is a necessity for a true engineer, and this brings me to the rather thorny subject of scientific evidence. I utterly repudiate the idea that any trifling with facts, or figures, or opinions is justifiable or properly attributable to engineering witnesses as a class, or, indeed, can fairly be made an accusation against them. A barrister whose whole business and theory of life is not to attain to truth, as to win cases, may accuse scientific witnesses of obscuring truth because he finds different theories advanced on the same subject. But I venture to think that when evidence of opinion is given it is almost impossible to avoid such conflict, and that the most contradictory opinions may yet be perfectly *bonâ fide*. On what subject of science can it be said that opinion is so consolidated as to be axiomatic, so that there is no room for honest difference of opinion, and how easy it is to reach different conclusions from the same data. Indeed, if such matters were absolutely clear, no evidence could be wanted about them. I am sure we must all know numberless cases where engineers have refused to support or attack by evidence when they are not themselves convinced. But the public does not perhaps know that the solicitor, often fortified by the "opinion of counsel," then seeks for someone else whose opinion whilst being *bonâ fide* happens to suit the case which the lawyers wish to advance.

The way in which evidence is thus sought for reminds me of an old friend of mine who was fond of bitter beer with his dinner, and who was urgently ordered by his doctor not to continue to drink it. I condoled with him on the deprivation, and asked him what he would do. He replied, "I shall consult another doctor, and continue to do so until I find one who recommends me my favourite beverage." I do not know whether he succeeded in finding a doctor to his mind; but if he did, it would be scarcely fair to say that either the doctor who thought beer to be harmful, or he who thought it beneficial, were one or other guilty of falsehood. Scientific testimony, then, being largely the expression of opinion, must be frequently, indeed one may almost say generally, contradictory; but that is no reason why it may not be perfectly

* *Atti R. Accademia-Lincei*, Series V., Vol. I., p. 208 (1892).
† Delivered November 10, 1893.

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honest, and it is absurd to rail against it, because on any specific subject it may point in different directions. Such being the views I take of the subject, I may say that I consider that engineers should devote the greatest care to any matter on which they may be called on to give evidence, so as to make certain of their facts, and that they should endeavour to form their opinion upon the facts without advocacy of any particular view. I look upon giving evidence as a very serious responsibility, and it is a hundred times better to refuse to appear as a witness than to allow oneself to drift into the position of supporting views of the truth of which one is not convinced, or of twisting facts to suit a theory.

Leaving now the question of qualifications for the profession and its responsibilities, let us glance shortly at its utility as evidenced by its record for the past 50 years. Look at the improvements attained during that period in every branch of engineering. The power of locomotion by land has not so much increased in the speed of railway trains as in their weight, and in the safety and comfort of travelling. Thanks to the improvements in railway appliances, an English railway carriage is now perhaps the safest place in the world, and the percentage of accidents has fallen enormously. At present the statistics averaged for the last three years, compared with the three years 1874-75-76, are as follows :—

Passengers Killed or Injured from Causes beyond their own Control.

Average per annum.	Killed.		Injured.	
	No.	Proportion.	No.	Proportion.
For 1890-1-2......	15	1 in 56 millions	657	1 in 1,280,000
For 1874-5-6.....	47	1 in 10 millions	1,368	1 in 370,000

The number of accidents to railway *employés* in the United Kingdom (who are 381,000 in number) is still considerable, but it must be remembered that the calling is in itself one which must have attendant risks. The following are the comparative statistics :—

Employés Killed or Injured.

Average per annum.	Killed.		Injured.	
	No.	Proportion.	No.	Proportion.
For 1890-1-2.....	527	1 in 723	3,066	1 in 127
For 1874-5-6......	742	1 in 347	3,007	1 in 86

I think that these satisfactory statistics of improvement are very much due to the action of the Inspecting Officers of the Board of Trade, who from the first introduction of the block system, and of interlocking signals, took every opportunity of urging their adoption on the railway companies. The companies were for some years by no means willing to adopt these and other useful appliances ; they did not realise how much these inventions were in their own interest, not only in diminishing accidents and consequent compensation, but also in immensely increasing the carrying capacity of their lines. I believe that on the chief lines of railway not a third of the present traffic could be carried if we had not had the two inventions to which I have specially referred, the former of which has not been practically adopted for more than three years, and the latter for more than 25 or 30 years.

What achievements, again, we are proud to recall in electricity during the period under my survey. You can scarcely realise a world of only 50 years ago, which was without a telegraph, or telephone, electric light, or electric motors. We all thoroughly realise the infancy of this most attractive branch of engineering, and look forward to immense developments, considering the strides which have already been taken. Electric locomotives for underground railways are an accomplished fact, and it may well be that their use on railways generally may be largely extended. I suppose ere long that from any ordinary dwelling a telephone will be no more absent than a front door bell, and it is obvious that an immense field for improvement lies open in telegraphy. The battle between gas and electric light is, I think, already in a fair way of settlement, by which gas will remain the light for houses in which it has a value in heat, apart from light, and for domestic cooking, gas engines, and the like, and electricity will be the light of the more well-to-do houses. Our electrical brethren will perhaps scarcely admit that electricity will not hereafter supply both warmth and light, and I see no impossibility in the suggestion, though at present it seems premature.

In machinery, again, it must be difficult for you to imagine the smallness of the amount of machinery 40 years ago, and the enormous developments which have taken place in this respect in every branch of industry. The vast advantage of the single, double and triple expansion steam engines, in diminishing the consumption of coal by 50, 60 or 80 per cent., and so rendering machinery available where it was formerly unavailable, have all occurred within my memory; while the application of hydraulic power to machinery of almost every description only dates from about 1845, when Lord Armstrong—then Mr. Armstrong—had the greatest difficulty in getting his invention adopted.

This glance of mine at the progress of 40 or 50 years is merely intended as the slightest of sketches. It is not for a moment meant as a history of engineering progress, which would be far beyond the possibilities of such an address as this. But I am bold enough to ask what profession can point to such a record of progress and utility. It shows that our profession, at any rate, has been in full vigour, and it indicates also how much remains to be done. For myself, I am persuaded that there will be no halting, that the progress to which we can point is now as rapid as ever, and that the next 50 years will have as great steps to record as those of the past half-century.

I have entered on this subject, as I have said, not in the spirit of boasting for the past history of our profession, but rather to indicate its dignity and worth. As a corollary let me point out the necessity for an education which will fit men for it. One of my predecessors, Dr. William Anderson, in his Inaugural Address, entered fully on the special training which is necessary for an engineer, and I am not going over the ground which he has so occupied. He points out how indispensable a mathematical training must always be, and the special importance of modern languages, together with the necessity for knowledge of the various sciences of Chemistry, Physics, Geology, Physical Geography, Botany, and Electricity. He claims also an important place, I am glad to say, for Political Economy, on which science so many political vote-catchers are ready now-a-days to pour contempt. I do not for a moment gainsay those views of what may be said to be an engineer's armour for his special position in life, but I venture to differ from Dr. Anderson in his somewhat depreciatory expressions towards the training of the mind, which the ordinary study of literature, both of classical and modern times, most assuredly gives. I hold that education and instruction are not convertible terms ; that education means that general exercise of the mind which enables a youth to put forth his best qualities in the further acquisition of special knowledge. It is thus somewhat like gymnastics or athletic exercise of the body, which fits it for the work of, say, a military or naval life, or any calling requiring special instruction in, and special training of, the capabilities of the human frame.

If this be the correct view, it follows to my mind that the first thing in education is to use the best mode of bringing out the powers of the brain, and accordingly, I cannot but think it a mistake to despise, or even relegate to a second place, those means of making the best of a man which what we term the highest education has been found by long experience to afford. Thus, I think, every man is the better for a training in classics, quite apart from what he is to do after 18 or 20 years of age, just as it seems plain even to those who depreciate the classics that mathematics should first be taught as a general science before the particular applications of mathematics are entered upon. It is said, "Oh ! there is not time for such a course, and one must cast aside everything which one cannot see at a glance to be wanted in an engineer's career." I venture to dissent from this view, and to say that a man who has had a classical training has taken the most useful step towards not only the acquisition of all modern languages, but also of knowledge of the general literature of his own tongue, and of the special literature which he has to study for use in his profession. With respect to the various sciences I cannot but think that if a man has had a general mathematical training and has been given at school that general introduction to Chemistry, Geology, Botany, and Electricity which is now-a-days given at all good schools, the special acquisition of further knowledge of those sciences and their practical application will be better and more soundly acquired subsequently to the school age. Consider also the charms of such knowledge of the past that the study of general literature gives, and of the resource it affords for the future development of the mind during the work of life and for relaxation when leisure is available. One cannot begin these studies when once one is plunged in active business, and it appears to me that a very strong case should be made out before such advantages are lightly thrown aside. As a man who left school too early, and who had not any university training, I can truly say that I highly prize even the classical training of my old school, and such knowledge of literature that I then acquired. I only wish that it had been more, and should deeply regret if it had been less.

I think also in considering this subject we may be guided by what is done by other professions. I have already said that I hold the engineering profession as second to none, and I confess I heartily dislike the idea of our being content with one whit less of education and culture than the profession of law or medicine, or the Royal services. Let us take our proper position, and educate our young engineers thoroughly as men first, and we shall find the rest will follow. If you look at the qualifying examination for a

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barrister, or physician, or surgeon, or for the army, you will find that in all cases classics and general literature is required; and why not for an engineer? I do not see that the special education of an engineer, including his practical training, or else a stay on the Continent for the acquisition of French or German, need occupy any more time than that of the other professions. Indeed, a man need not go to the Continent; a good colloquial knowledge of French or German can be attained by a young engineer without any interruption to his other work, by boarding in this country with some French or German family, of which there are so many resident in our large towns.

The Council of the Institution of Civil Engineers have of late years insisted on an examination by some public examining body of candidates for studentship, and I rejoice that they have insisted on the subject of general literature. For my part I wish that Latin or Greek had also been made obligatory. I hope as time goes on that the present qualification will rather be raised in the direction of general and classical literature, so that the curriculum of an engineer's education may be as high as that of any other profession. It may be said—"Oh, but you may keep out the poor natural or heaven-born engineer." I do not believe one word of such an argument. If a man is such a natural genius, he will not be kept back in these days of national education by any such requirements as the qualifying examination for any of the sister professions present. Again, if such a risk existed, which I deny, it is a risk which attaches to every other profession, and it had better be borne by ours as it is by others, for the general good of the profession at large. But in truth, the risk does not exist. A youth of genius, if poor, can now attain to a very high level of general education, without more than the merest pittance, or, indeed, if necessary, gratuitously, and we need not fear that an examination, which an ordinary 5th form boy at a public school can pass, will keep back the George Stephensons or Brindleys of the future, who would in our day have been in the highest standard of the Board School at 14 years of age.

I have said this much from jealousy of the position of my profession, and because I think there is a tendency which I hold to be mistaken in many leading men to take an opposite view. I have only the desire now to again refer you to what was said so admirably by Dr. Anderson on the subject of the special instruction of an engineer, bearing witness most strongly to the advantage of a training in some handicraft. In the case of a young man who is going to follow the business of a mechanical engineer, it is obvious that he must acquire an exact practical knowledge of the tools of his trade, and be thoroughly acquainted with the possibilities of the manual labour of fitters, erectors, pattern makers, moulders, and the like. This cannot, of course, be acquired in less than some three years, but in the case of an engineer who is to devote himself to works of construction, the case is different. It is not necessary for him to know intimately any manual trade, but rather to attain to a general idea of construction, and to know the value of an artisan's time. Thus for a young man as last described, I think it does not greatly matter whether it be the handicraft of a fitter who works in iron, or of a carpenter who works in wood. I confess, having been in a carpenter's shop, I have a predilection for that trade, and think that more knowledge of the principles of construction and of strains can be gained in carpentry than in other trades within the same limits of time, and that the trade of a carpenter includes within it a great deal of all other artificer's work.

Let us now glance at some aspects of the career which may lie before many of my hearers. It would be futile for any one to attempt to predict the distant, or even the near, future of engineering, but we can all see that various and numerous parts of engineering thought are at present only partially explored, and that vast fields exist for the exercise of our present or future knowledge. When we consider how very far we are at present from being able to realise the potentialities of heat, even with our most improved steam engines or gas engines, or when we think how new is the science of electricity and magnetism, we see how immense a field for investigation and adaptation is open to us in these two directions, which will affect every department of engineering. What a promising subject for improvement and extension locomotion still presents, so that enthusiastic investigators promise us railway trains at 150 miles an hour, and that road traction will soon be mainly independent of animal power. But quite apart from such fascinating anticipations of unknown developments, let us consider the more hum-drum future, and the extension of well-known works and appliances. Within the past 40 years the capital of the British railway companies has increased from 248 millions sterling in 1851 to 919 millions in 1891, or by 270 per cent. and the number of passengers from 85 millions to 845 millions, or by 900 per cent., while the mileage has only increased by 4,500 miles, or 29 per cent. In the meantime, our population has increased from 27 millions to 38 millions, a difference of 11 millions, or of 37 per cent. You will notice from the above figures that the tendency to travel far exceeds the rate of increase of population, and is also out of all proportion to the increase of railway mileage. The increase of railway capital is somewhat more proportional, but the above statistics appear to me to show what is borne out by observation, viz., that the volume of passenger traffic is continually and rapidly increasing, and that railway companies must continually add to their means of carrying it by doubling their lines, making relief lines, rebuilding their stations, and adding to their rolling stock and plant. In fact, our population and our wealth are still increasing, and this being so, there will be a constant demand for more railways, more docks, more harbours, more bridges, more roads, and the like. I can see no reason to suppose that this increase will be any less than in former years, on an average though, as heretofore there will be ups and downs.

If these be the facts about our own islands, how much greater a field also exists for engineers in India and in the Colonies with which we all hope to be more closely united, looking to a great confederation of English-speaking people in every latitude and longitude, bound together by common ties, and by mutual interests for advancement and defence. In our great Empire of India we have at present but some 17,500 miles of railway; in South Africa only about 3,000 miles; in Australia, New Zealand, and Tasmania, about 13,000 miles; and in Canada 14,000 miles. It is obvious from such figures that only the fringe of the subject of railway development has been already touched in these huge countries, while in the vast virgin fields of China, and the remainder of Africa, these problems have not even been reached. In foreign countries, also, so long as England remains the financial power in the world which it now is, and so long as English enterprise remains what it has been, English engineers will continue to be called upon to propound and superintend the various works for which English capital is provided.

Let us, therefore, have confidence and patience in the future of our calling, remembering what has occurred before, and being sure that so long as civilisation exists the civil engineer must be to the front. The progress of the future must depend very largely upon him and upon his ability to keep abreast of all knowledge of the various phases of science, and to lead the way in their application for the use and convenience of man.

ELECTRO-MAGNETIC VOLTMETERS ON ALTERNATING CURRENTS.

In a recent number of the *Elektrotechnische Zeitschrift*, M. Szapiro, of Warsaw, has an article on variations of the reading of electromagnetic instruments with the shape of the E.M.F. curve of the alternator. He works out general equations from the curves of a sinusoidal and non-sinusoidal E.M.F. for the value of the current in the two cases for given resistance and self-induction, and from the resulting formulæ deduces the following conclusions:—

1. Where the self-induction is relatively small, as in a Cardew voltmeter, the effective current, and therefore the reading, is independent of the shape of the curve of E.M.F.

2. If the resistance is relatively small, and the deviation from a sinusoidal E.M.F. curve not large, the effective current is not appreciably affected.

3. Should resistance and self-induction be of the same order of magnitude, the differences in the reading may be large for certain deviations of the E.M.F. from a sine function. Taking a concrete instance, the author takes a Ganz machine, a voltmeter of resistance = 3,000, and coefficient of self-induction = 1; then, for the same periodicity, the effective current will vary 8 per cent. from its value on a sinusoidal E.M.F. of the same effective value. These considerations, says the author, make it necessary in accurate work to calibrate the voltmeter on the alternator with which it is to be used, and not only at the right frequency.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

THURSDAY, November 23rd.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary General Meeting. Discussion on the Paper: "The Electrical Transmission of Power from the Niagara Falls," by Prof. George Forbes, F.R.S., member.

FRIDAY, November 24th.

PHYSICAL SOCIETY.

5 p.m. (1) "The Magnetic Shielding of Concentric Spherical Shells," by Prof. A. W. Rücker, M.A., F.R.S., President.
(2) "The Action of Electromagnetic Radiation on Films containing Metallic Powders," by Prof. G. M. Minchin, M.A.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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AMERICAN ELECTRICAL ENGINEERING AND I LESSONS.

According to a correspondent of the *Daily Chronicle* PREECE has been rash enough to declare that "England nothing to learn from America in regard to electrical applianc It is unlikely that Mr. PREECE has publicly declared anyth of the kind. It is quite true that we all think somethin the sort, but we do not say it. Mr. PREECE keeps the ri side of everybody, and being essentially a public man a constant visitor to the States, would say nothing so r whatever he may think. We have, indeed, some recolle of a more or less opposite statement by him at a scien meeting. The theme of the correspondent who makes accusation is that "in America inventions are being ca out on a great scale, and with a rapidity greatly in exce Europe," and he proceeds to state briefly the facts, in o to give the English people an idea of how far behind the in the application of modern science to the needs of mo life. One of his first batch of facts relates to long-dis telephony, and calls for a remark. "At this moment prob hundreds of people in New York are talking freely and perfect distinctness in Chicago, 1,000 miles away."

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suggests one of three things: either that there are "hundreds" of pairs of wires between New York and Chicago, which is, indeed, news; or that, owing to the "great scale" and "rapidity" with which inventions are applied to the needs of their modern life, some apparatus has been devised to allow four or five dozen people to talk independently on one circuit—if this is so, we have much to learn from America; or, that there is no independent talking, but that the "hundreds of people" are all chanting together in chorus, through one transmitter, the Praises of the Almighty Dollar, the Transcendant Superiority of The Nation, or some such theme on which they can all agree. No more than ten circuits were contemplated, and no definite report has reached us that more than one has been erected. We venture to suggest that, electrically, the London-Paris, or the Glasgow-Belfast telephone cables are each a "bigger thing," except in mere pounds of copper and hundreds of miles, than the New York and Chicago line.

Of course, after long-distance telephony comes electric traction, or transit, as Americans have it; and by way of a big thing the insane St. Louis and Chicago line is solemnly described as if it were on the point of completion. "The capital is practically subscribed." How often have we heard this statement about schemes which never got beyond the flaunting prospectus stage. There are big things across the Atlantic; but why should one-sixth of a long article be devoted to the glorification of a project which is less likely to come off than the "lightning express" of a certain enthusiast on this side of "the water." Then come electric street railways, as they are called. With the exception of a line in connection with the Chicago Exhibition, and one or two doubtful cases, all these so-called railways are what we call tramways. If we wish to point to real electric railways we should name the Bessbrook line, the City and South London line, and the Liverpool overhead line. These, particularly the last two, are not only essentially railways in the English sense, and have no American characteristics whatever about them, but are a long way in advance of anything that had been done in America at the time of their respective openings. Turning to electric tramways, it is said that we are far away behind our American cousins. Let us see where they are. It was the late Mr. Reckenzaun who first opened our eyes to the fact that these tramways are in many cases not started to supply a demand, but are promoted by speculators in land for the purpose of inducing builders to run up suburban residences. But let that pass; it is not possible to judge of financial results yet. Here are a few details: "It must be admitted that the addition to the immense quantity of wires which make an average city street in America look like a long vista of gigantic spiders' webs is not desirable, but there seems no other method at present quite practicable. . . . Besides the wires there are two drawbacks . . . one is the peculiar noise, . . . it is as the sound of a low hissing wind moaning along the street, and this curious sound and the humming of the perpetually moving cables is one of the lasting reminiscences of a stay in any great American city." As far as cables go, a lesson or two might perhaps be learned in Edinburgh or Birmingham, where there is no such nuisance. "The other drawback consists in the danger to life. One has to be very careful in crossing the streets at certain points. . . . I was told at Pittsburg that for several weeks two lives per day had been sacrificed on the average to the cable and electric cars. In Chicago three persons per day are killed or maimed. In many cases these are children who are playing in the streets. . . ." The *Daily Chronicle* enthusiast, then, so far forgets himself as to say that grade crossings are a disgrace to American cities, "and are permitted to disfigure and render dangerous the streets and country roads of this great land. . . ." We gather from all this that we have much indeed to learn from America, and that there are many matters which our engineers will do well to study, lest through carelessness they might make similar blunders.

Then follows the doubtful statement about Mr. Preece, and immediately after:—"America is as much ahead of England in this respect as England is ahead of Norway and Sweden." Ahead, indeed? Everyone who knows anything whatever of telephony is aware that England is indeed far behind Norway and Sweden in telephony, and is likely to be for many a year. The last confession, before a peroration of superlatives, is that "no city here that I know is so brilliantly illuminated as the City of London by night, yet electric lighting is far more general." We gather from some of these statements (passing by the confessions which quite spoil the article) that one country is very much "behind" the other. By this is meant that, as measured by the advance of civilisation, one is in a more rudimentary or savage state. We can only say that such barbarities as those described as common in America would not have been tolerated here fifty years ago when railways were introduced. These tramcars, we understand, spin along in the suburbs, where perhaps human life is still cheaper, at ten or fifteen miles an hour. We do not want "advance" of this sort, and are thankful for sensible public opinion and the firm hand of the Board of Trade to stop it. The rudimentary ideas about steam railways in America afford some excuse for such recklessness. But even Americans seem to be beginning to realise the danger. Our American correspondent called attention to the increasing number of accidents on "electric street railway lines," and to the proposed action of the city authorities at Brooklyn and at Cincinnati, in our issue of October 13th, and again this week. The American technical journals teem with accidents. A fortnight ago a shocking accident occurred at Oregon, when a tramcar with thirty passengers dashed through an open drawbridge into the river, killing, it appears, twenty-five people. Last month a flywheel burst at Brooklyn, wrecking the engine-house, stopping all the cars in the city driven from this station, and injuring three persons. Two days later the whole of the street lighting plant of Baltimore was destroyed by fire, together with plant for running 12,000 glow lamps.

But besides all this, electric lighting seems to be "in its infancy" in the United States. The flaring and spluttering arc lamps which satisfied, and in most cases still seem to satisfy, our transatlantic friends, were not tolerated over here. If it were not for the careful design and good construction of one or two thoroughly English arc lamps, arc lighting would have long ago been given up as a bad job in this country. Although we have not heard that anything new was shown at the Chicago Exhibition, this is not altogether a matter of regret; and we are glad to learn that some attention is being paid at last to sound practice rather than to novelties. The Westinghouse Company, we are informed, intend to confine themselves to good work, and this gives hope that no gigantic breakdown of their huge alternators will compete at Niagara for magnificence with the Falls themselves. Perhaps we are mistaken, and we are really behind. It is, however, difficult to find anything to learn about lighting by glow lamps from America. We are quite willing to believe there may be something, but we have not come across it. They are only just finding out in some places that the introduction of meters, where contract lighting has been in vogue, is apt to give rise to a little unpleasantness. The

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main lesson that they have to teach seems to be to avoid doing anything in a hurry, and to accept nothing but really first-rate work. There may be some minor disadvantages; things may go slower and cost more. After all, it is only a matter of opinion, and it is so much more polite to be able to say that we have much indeed to learn from America.

OBITUARY.

ANTHONY RECKENZAUN.

It is with deep regret that we have to record the death of Mr. A. Reckenzaun, whose name will be long remembered in connection with electric locomotion on land and water. Mr. Reckenzaun was a well-known attendant at the meetings of scientific societies and other gatherings of electrical engineers, and his work is well known on the Continent and in America. His health had for some time past been failing, and a recent trip to Chicago did little or nothing to relieve his condition. He died on Saturday last of consumption at his home at Stockwell, at the age of 43 years. Mr. Reckenzaun was born at Graz, in Austria, where he received a thorough technical education. He had early opportunities of gaining practical experience with constructive details in the ironworks of his father, who carried out large contracts for brewery plants, tanneries, buildings, and railway material, especially for the Hungarian railways. Desirous of enlarging his knowledge he came to England in 1872, and obtained employment with the then flourishing marine engineering firm, Messrs. Ravenhill and Miller, of London, where the most powerful engines for the British and various foreign navies were constructed. When Mr. Ravenhill retired the business was transferred to Messrs. Easton and Anderson, of Erith, whither Mr. Reckenzaun followed. In connection with the Erith ironworks he established evening classes for the benefit of the *employés*, and gave lectures during three years on "Machine Construction and Drawing" and "Steam"; but, in order to qualify himself according to the rules of the South Kensington Science and Art Department, he had first to undergo the examinations in those subjects, which he passed with first-class honours. Subsequently he attended the courses of lectures given to qualified science teachers at the Royal School of Mines in 1877 and 1879, when he again obtained first class at the final examination in steam and mechanics. After visiting the Paris Exhibition of 1878 he resolved to devote himself to the study of electrical engineering, and attended Prof. Ayrton's lectures at Finsbury Technical College. In 1881, again, at the great Electrical Exhibition in Paris, he spent nearly every day for three months within the Palais d'Industrie in order to become thoroughly acquainted with all the systems then on exhibition. After his return from Paris he joined the Faure Accumulator Company, which he left, however, soon afterwards, and accepted the post of Engineer to the Electrical Power Storage Company. There he designed the first electric launch, "Electricity," driven by means of E.P.S. storage batteries, in 1882, and soon afterwards he made the electric tramcar which was exhibited on the West Metropolitan Tramway in March, 1883.

Mr. Reckenzaun delivered many lectures and read Papers on "Storage Batteries and Electric Locomotion" before scientific societies, notably the British Association, the Society of Arts, the American National Electric Light Association (when meeting in Boston, Mass.), the American Institute of Electrical Engineers, and the Vienna Electro-Technical Society. The Society of Arts awarded its silver medal for his Paper on "Electric Locomotion"; and the Institution of Electrical Engineers in December, 1892, awarded him the Paris Electrical Exhibition Premium for a Paper on "Load Diagrams and the Cost of Electric Traction." He has also written numerous articles for scientific journals, and is the author of a treatise on "Electric Traction on Railways and Tramways." He started business on his own account in 1885 for the purpose of building boats, cars, and electric motors for various purposes. The most noteworthy of the boats was the "Volta," which made the double voyage between Dover and Calais on September 13, 1886, also the more difficult voyage between London and Dover. Mr. Reckenzaun spent nearly a year in the United States, when he introduced his electric cars on several tramways, and where he built the "Magnet," the first electric launch in American waters. He was an ardent advocate of secondary batteries, and has contributed largely to our knowledge of the subject. Mr. Reckenzaun was vice-president of the Old Students' Association of the City and Guilds of London Institute; a member of the Institution of Electrical Engineers, of the Society of Arts, of the American Institute of Electrical Engineers, and of the Vienna Electro-Technical Society.

For the last few years Mr. Reckenzaun has practised as a consulting engineer, concerning himself with power distribution and accumulators. His private work for some time past has been devoted to the development of a type of accumulator for central stations. The meter which we described in *The Electrician*, Vol. XXXI., p. 8, was the invention, or joint invention, of Mr. Reckenzaun. We were not aware of this at the time, or we should, of course, have had pleasure in recording the fact.

Mr. Reckenzaun was essentially an engineer, and in devoting himself as he did to the use of accumulators for motive power, it is a question whether he did not give them more consideration than they deserved. It must be confessed that he has not lived to see any real success. Time will show whether his work will yet bear the fruit which such honest and thorough work should yield, and whether he was not in advance of his day. Accumulators are in fact at present unworthy of the labour which he expended on their application. Let this be placed on record, lest some inventor should hereafter improve the secondary battery and make it a success for locomotion, and take, or be given the credit for, the work which was so well done by Anthony Reckenzaun.

ELECTRIC MOTIVE POWER.*

BY ALBION T. SNELL.

(Continued from page 493, Vol. XXXI.)

It will be apparent that the laws which govern the determination of the excitation for a given magnetic flux in continuous-current machines are equally applicable to the alternate-current designs, it being necessary, however, to modify the equation for the total electromotive force of the armature, and to arrange suitable current densities in the copper and magnetic densities in the iron. These modifications are of importance, and require elucidation. The total armature impressed electromotive force, V_{imp}, may be expressed in terms of the number of turns, the number of lines of force per pair of poles, and the number of revolutions per minute, as in the continuous-current machine in equation (6), Vol. XXX., p. 624. But since pressure is periodic, and therefore changes in value through each cycle, there will be a maximum pressure considerably greater than either the *effective* or *average* value. It is evident that both the pressure and current have all values between zero and a maximum (one positive and one negative) twice in every period, and it is therefore necessary to define what is understood by the terms alternating pressure and current.

In practice we require to know the *effective*† values, and not the maximum or instantaneous values. The readiest means of comparing the *effective* values of an alternating and direct current is afforded by the several heating effects produced in a wire of known resistance having no self-induction. When the heat caused by the current is the same in either case, then the effective pressure of the alternate current is equivalent to the continuous pressure.

Instruments which depend on the heat waste, $i^2 R$, are calibrated by continuous currents, the effective values of which are proportional to the squares of the uniform currents, and

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† Prof. Silvanus P. Thompson prefers to use the older term, "*virtual* value.

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therefore the readings of the instruments are proportional to the square root of the mean square of the currents (usually written $\sqrt{\text{mean square}}$). For example, the heat produced by a continuous current of 10 amperes is proportional to 10^2, and the readings of an ammeter of the dynamometer type placed in the circuit are proportional to $\sqrt{10^2}$. If the same instrument were placed in an alternate-current circuit and gave the same deflection, the $\sqrt{\text{mean square}}$ value of the current would be as before, 10 amperes, and this is called the *effective* strength of the alternate current. This $\sqrt{\text{mean square}}$ value is independent of the shape of the curve, which, however, determines its ratio to the maximum value.

If it be assumed that the pressure and current are harmonic functions of the periodic time, the curves of either will be sinusoidal, and may be expressed by an equation of the order—

$$y = a \sin t,$$

where y is the instantaneous value of the pressure or current, t is the time of one period (it is most conveniently reckoned in angular measure), and a is a constant numerically equal to the maximum value of y, which occurs when

$$t = \frac{\pi}{2}, \text{ for } \sin \frac{\pi}{2} = 1.$$

Fig. 74 shows a sine curve of wave-length t. The ordinates y_1 and y_2 may represent either values of pressure or current, at the corresponding instants t_1 and t_2.

The arithmetical mean value of the ordinates y_1, y_2, y_3, &c., in Fig. 74 is $\frac{2}{\pi}$ times that of the maximum ordinate; or the average value = 0·637 times the maximum value.

But the total heat generated per second in the wire is a numerical measure of half the square of the maximum ordinate of a simple periodic current; for the mean of the squares of the sine, either for one quadrant or a whole circle, is one-half of the square of the maximum value, or $\frac{i^2_{max}}{2}$. And therefore instruments depending on the estimation of the heat waste ($i^2 R$) will measure $\frac{1}{\sqrt{2}} = 0·707$ of the maximum value of a periodic current or pressure.* And the continuous current which will give the same deflection on the instrument, that is, the same heating effect, is equal to $\frac{1}{\sqrt{2}}$ times the maximum value of the alternate current.

Therefore, an alternating current, if it follow the sine law, will cause a heating effect greater than that of a continuous current of the same *average* strength by the ratio of 0·707 to 0·637, that is, about 1·1 times greater. In these pages when an alternate current or pressure is referred to, unless otherwise stated, it is assumed that effective values are understood, and that pressure measurements are made by hot wire or electrostatic voltmeters, and currents are read by dynamometers. The *effective* value of the total armature electromotive force may be written

$$V_e = k\, N_a\, C_a\, p\, \frac{n}{60}\, 10^{-8} \quad . \; . \; . \; . \quad (26)$$

if all the coils are in two parallels, or

$$V_e = 2k\, N_a\, C_a\, p\, \frac{n}{60}\, 10^{-8} \quad . \; . \; . \; . \quad (27)$$

if they are in one series.

The symbol V_e = the effective pressure in volts,
p = the number of pairs of poles,
n = the number of revolutions per minute,
N_a = the magnetic flux from one pair of poles,
$C_a = 2\,p\,w$, where w = the number of active conductors on one side of one coil; or, briefly, C_a = the number of turns counted all round.

The symbol k requires special explanation.

The quantity expressed by k is a constant for the particular arrangement of pole-pieces and armature coils; it is the ratio between the effective and the average pressures. If the pressure curves obey a sine law—it does very nearly in many types of alternators—$k = 1·1$, and this value may be taken in most rough approximations. The equations for the electromotive forces of alternators, assuming a *sine law* is followed, may be written thus:—

Two parallels: average total volts $= N_a C_a p \frac{n}{60} 10^{-8}$ . . (28)

One series: „ „ „ $= 2\, N_a C_a p \frac{n}{60} 10^{-8}$. (29)

Two parallels: maximum „ „ $= \frac{\pi}{2} N_a C_a p \frac{n}{60} 10^{-8}$. . (30)

One series: „ „ „ $= \pi\, N_a C_a p \frac{n}{60} 10^{-8}$. . (31)

Two parallels: effective „ „ $= \frac{\pi}{2\sqrt{2}} N_a C_a p \frac{n}{60} 10^{-8}$ (32)

One series: „ „ „ $= \frac{\pi}{\sqrt{2}} N_a C_a p \frac{n}{60} 10^{-8}$ (33)

The numerical value of the constant in equation (32) is approximately 1·1. In equation (33) for series coupling the coefficient must be twice as great as that in equation (32), if the same value of C_a be retained, and it is therefore equal to $2 \times 1·1 = 2·2$. In practice it is found to vary between 2·2 and 2·3 when the coils are all in series.

The pitch of the pole-pieces and the width of the armature cores are of great importance in designing alternators, for they affect the shape of the pressure curve, and consequently the effective pressure and the output. Four of the more frequent arrangements are illustrated in Figs. 75, 76, 77 and 78, which it will be necessary to examine carefully before proceeding with the calculation of the output. In these diagrams the field poles are developed horizontally, and the polarity is indicated by capital letters. The winding and bare spaces on the armatures and the apertures of the coils are clearly marked. The pitch of the field poles is equal to half of a wave length, and, therefore, in Figs. 75, 76 and 78, it is equal to the angular width of one pole and one space; whilst in Fig. 77 (which refers to the Brush Alternator) it is equal to that of one pole only, for there the spaces, strictly speaking, act as if they were poles of opposite sign to those hatched in the diagram. It will be noticed in this case that the armature coils are twice as numerous as the field poles.

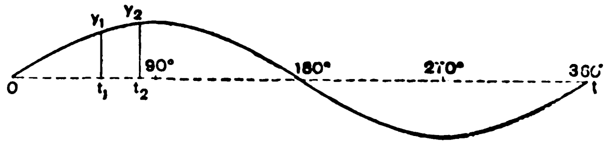

Fig. 74.

Below each figure is the theoretical shape of the pressure curve in full lines, determined on the assumption that there is no magnetic leakage between the poles, and that therefore there is no fringe at the corners of the pole-pieces. This is not the case in practice, and therefore the actual curve will be less angular, and approximate more or less closely to sine curves, as shown in dotted lines. This is easily seen to be the case with Figs. 75 and 76, and practically it is found that the design in Fig. 77 gives an almost perfect sine curve. In tracing the pressure curve for any arrangement of pitch and angular width of poles and coils the zero points may be first determined and marked off on the line $a\,b$, which shows the angular position of the coils. Having found these points the wave-length is known, and the positions of maximum pressure should lie midway between the zero points. If the *winding spaces* are exactly equal to the *width of the poles*, then, assuming no magnetic fringe, the intermediate values lie in straight lines, joining the maximum and zero points as in Figs. 75 and 78. The height of the maximum ordinate depends on the scale selected, but its numerical value can be found from the known magnetic flux and the linear speed of the coils. In these diagrams an arbitrary height has been selected. If the coils be in one series, and a simple zigzag curve be assumed, then

$$V_{max} = 4\, C_a\, N_a\, p\, \frac{n}{60}\, 10^{-8} \text{ volts}, \quad . \; . \; . \quad (34)$$

* For a more complete explanation of the interesting phenomena of alternate currents reference should be made to "The Alternate Current Transformer (in Theory and Practice)," by Prof. J. A. Fleming.

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where the maximum pressure is assumed to be twice the average pressure. If the winding space be shorter than the polar width, then the maximum pressure will be maintained for that

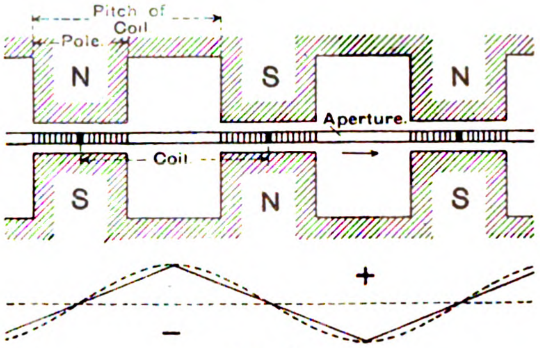

Fig. 75.

period of time during which the coil as a whole is passing under the pole piece. Thus, if the polar arc be 10in. in

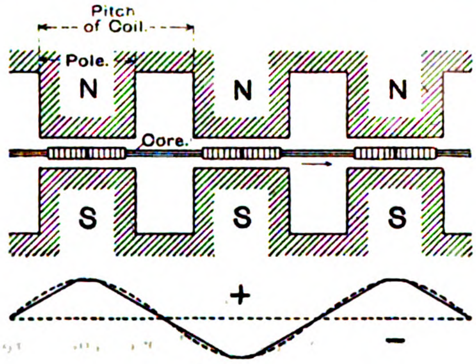

Fig. 76.

width and the winding space only 8in., then for the fraction of time required for the coil to move through the angular distance of $10-8=2$in., the pressure will have the same

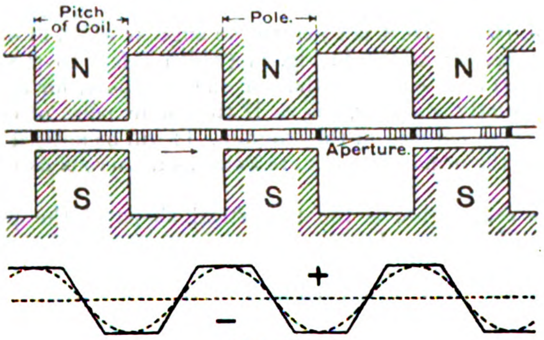

Fig. 77.

value, and hence the top of the crest will be flat, as in Fig. 76, which refers approximately to the design of the Kapp alternator.

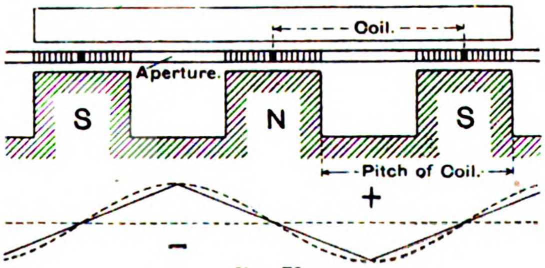

Fig. 78.

In some designs the coils are made to exceed the poles in width by a small percentage, the arrangement being found to give a very close approximation to a sine curve. Prof. Thomson, of the Thomson-Houston Company, is in favour of such proportions.

The Gülcher alternator, designed by Mr. W. B. Esson, also embodies this idea, but the armature coils are only half as numerous as the field poles, and are equal to the width of three and a-half poles. There is a distance piece between the coils equal to half of a pole, the pole being of the same width as the space (*see* Fig. 79). The theoretical curve of pressure is shown in full lines, and a sine curve is indicated by a dotted line. It is evident that this arrangement approximates very closely indeed to the necessary conditions for obtaining a sine function.

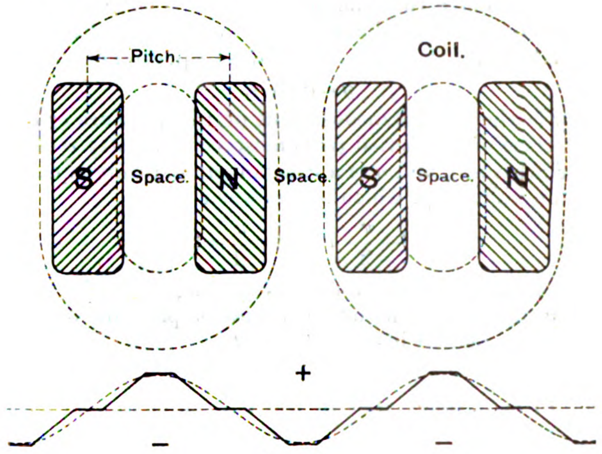

Fig. 79.

The curve of pressure of any arrangement of pole-pieces and armature coils can be traced approximately, and then it is easy to determine the effective pressure with sufficient accuracy for practical purposes. Consider the curve in Fig. 80, the half wave length is equal to, say O X, and V_{max} equals the maximum ordinate. Now, bearing in mind that the instruments used for measuring alternate currents give readings proportional to the $\sqrt{\text{mean-square}}$, it is necessary to square the ordinates

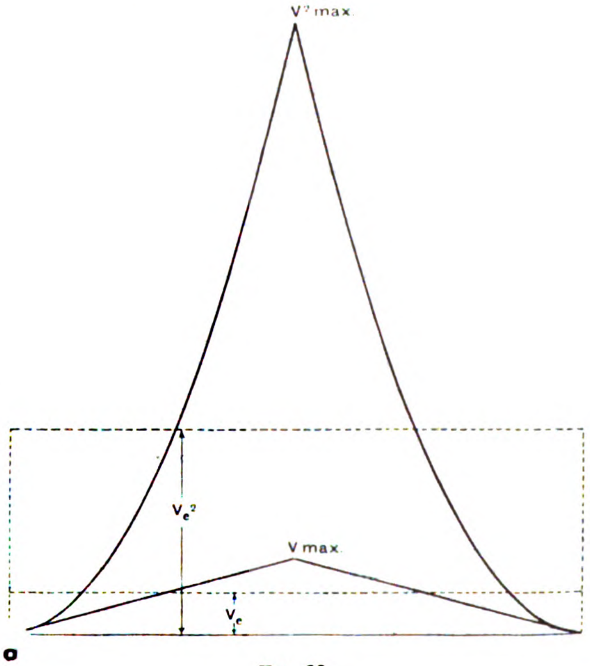

Fig. 80

of O V X and plot a new curve on the same base and then to find the mean ordinate, say V_e^2, of the squares. This can be readily found for most symmetrical figures by integration; but many engineers prefer the graphical method, which is as follows:—Plot the curve to any convenient scale on squared paper and divide the base line O X into any number of equal parts—the more the better. Measure the heights of the

ordinates at the middle of each and divide the sum of their values by the number of parts: the result is the numerical value of the mean square, V_e^2 in the selected units. Next extract the square root and then the effective pressure V_e, is known. This has been done in Fig. 80, for the triangular pressure curve $O\,V_{max}\,X$, and the value of V_e is found to be 0·58 of the maximum pressure ; or

$$V_e = 0{\cdot}58\ V_{max}.$$

In Fig. 81 the same operation has been performed for a semicircular curve, and it is found that

$$V_e = 0{\cdot}7854\ V_{max}.$$

Thus equation (34), which gives the value of the maximum pressure, must be multiplied by 0·58 to equal the effective pressure. Therefore, if the coils be in one series, since

$$V_{max} = 4\ C_a\ N_a\ p\ \frac{n}{60}\ 10^{-8},$$

$$V_e = 0{\cdot}58 \times 4\ C_a\ p\ N_a\ \frac{n}{60}\ 10^{-8}$$

$$= 2{\cdot}32\ C_a\ N_a\ p\ \frac{n}{60}\ 10^{-8}. \quad . \quad . \quad . \quad . \quad (35)$$

And if the coils be coupled in two parallels, then the effective pressure is half as great as the value given by (35).

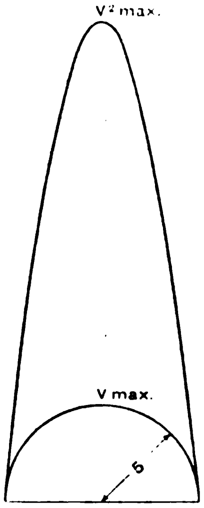

Fig. 81.

The relation between the effective and average values for the more common curves, and the theoretical values of k, are shown in Table J :—

Table J.

Order of curve.	Average value as a decimal of the max. ordinate.	Effective value as a decimal of the max. ordinate.	k = Ratio of effective to average average.
Sine	0·637	0·707	1·1
Semicircle.....................	0·7854	0·835	1·063
Triangle	0·5	0·58	1·16
Rectangle.......................	1·0	1·0	1·0

The above values of k will not be realised in practice, since the magnetic fringe will cause the angles to be rounded. The shape of the curves will also be largely affected by the pitch ratio of the poles and coils.

There is some difficulty in finding the actual value of k in practice, since the exact magnetic density B_a is not easily found without special experimenting. The designer, of course, knows the calculated value of N_a, and consequently B_a, and then from the measured pressure may calculate k with a fair degree of approximation to the truth. But if a small test coil be arranged so as to explain the gap at various places, then the average value of N_a may be readily found ; this, however, is not an easy thing to do in an ordinary shop with workshop instruments with the pressure of commercial routine.

Mr. Kapp has made a special study of the coefficient k, and the following table is based on his researches. The windings are assumed to be in one series, and the width of the poles and coils is expressed in decimals of the pitch.

Table K.—*Proportions of Field-Poles and Armature Coils in Terms of the Pitch, and Consequent Values of k.*

Ref. No.	Pitch.	Pole.	Total breadth of copper in each coil.	$2k$.
1	1	1	1 (covering whole surface)	1·16
2	1	1	0·5 (covering half surface)	1·635
3	1	0·5	1 (covering whole surface)	1·635
4	1	0·62	0·5 (covering half surface)	2·06
5	1	0·5	0·5 (covering half surface)	2·30
6	1	0·33	0·33 (covering third of surface)	2·832
7		Sine Function		2·22

Nos. 4 and 5 approach most nearly to designs found in practical machines.

Having thus determined the total effective pressure of the alternator, it is easy to find the terminal effective pressure.

This will be given as for continuous currents by equation (5). Thus, if v_e be the effective terminal pressure, then

$$v_e = V_e \pm i\,r,$$

where i is the current in the armature and r the resistance of the coils.

(To be continued.)

ELECTRIC LIGHTING AT GABLONZ.

A good deal of attention is paid on the Continent to the subject of the utilisation of water power for driving dynamos, and a somewhat exceptional plant exists at Gablonz, one of the chief industrial towns of Bohemia, inasmuch as the water power is used in the day-time for industrial purposes, and at night for electric lighting.

This plant, which is due to the enterprise of some local manufacturing firms, has been carried out under the direction of Messrs. Kremenezky, Mayer and Co. Power is derived from the River Neisse. There is a fall of about 75ft., the turbine developing about 200 H.P., and in addition there is a 500-H.P. compound steam engine. There are seven dynamos in the machine room, of which four are used for public lighting and the rest for the works of Mr. Hoffmann, the originator of the scheme. They run at 530 revolutions per minute, and furnish current either at 180 volts and 185 amperes, or at 260 volts and 108 amperes. The dynamos are of the Manchester type. Although this plant is at present sufficient for the demand, it has been considered advisable to have reserve power, which is drawn from another part of the Neisse, where a fall of about 50ft. is available. The new turbine will give about 200 H.P., and will be used for driving two dynamos, each of 35 kilowatts. The current from the dynamos is lead to a general switchboard in the machinery room. Current is taken from the generating station in the outskirts of the town to the accumulator station in the centre of the town by means of an underground cable of 200 square millimetres section of copper. There were originally two batteries, each of 86 Tudor cells, possessing a capacity of 630 ampere hours, from which current is distributed on the three-wire system. There has now been added a 172-cell battery of a capacity of 790 ampere hours. The most of the distribution is carried out by underground cables, though there are some overhead wires to outlying districts, the town being built in a very straggling fashion. In addition to private lighting, the plant supplies current to some arc lamps for street lighting. Among the public buildings lighted is the synagogue and the infirmary, the latter having also a pump driven electrically. The current has been found of much utility in connection with the supply of power. Many of the export houses of the town use it for driving their lifts, and it is also employed for lathes and other machinery.

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ELECTRIC LAUNCHES AT CHICAGO.

The following analysis, for which we are indebted to the *Electrical Engineer* of New York, showing the costs of running the electric launches at Chicago, may interest our readers :—

APRIL 13TH TO OCTOBER 1, 1893.

Mileage and Passenger Traffic

Passenger trips of three miles each	47,787
World's Fair special launch trips	6,750
Special trips of regular launches	1,220
Trial trips	270
Experimental trips	180
Total number of trips	56,207
At three miles per trip, total miles	168,621
Average miles per launch to Oct. 1st	3,122
The total number of days the 54 electric launches have been in service on the lagoons of the World's Fair, is	6,594
Therefore, the general average of miles per launch, per day, is ...	25·57
Minimum miles, per launch, per day	14
Maximum „ „ „	37½
Maximum miles, one launch, one day	54
Total number of passengers carried from May 1st to October 1st.	801,0C0
Maximum passengers carried in one day by one launch	464
Maximum number of people carried by one launch for one round trip	40

Operating Cost.

Average cost per launch per day for charging, at 3 cents per electric horse-power hour	55½c.
Average cost per launch per day for care and repair of shafting, propellers, 54 motors, 162 packing-boxes, 3,524 storage batteries, including labour for charging, 54 controllers—all the above being gone over every 24 hours	43c.
Renewals of batteries per launch per day	41c.
Renewals and repair material for all else per launch per day	9c.
Total cost per launch per day	$14. 8½
Average cost per launch mile for labour and material, exclusive of office expenses	5⅞c.

INSTITUTION OF ELECTRICAL ENGINEERS.

THE ELECTRICAL TRANSMISSION OF POWER FROM NIAGARA FALLS.*

Introductory.

I had originally intended the title of this Paper to be "The Transmission of Power by Electricity," but I found on writing it that it was inevitable that the work on which I am engaged as electrical consulting engineer at Niagara Falls should take a very prominent part in its substance ; but the Paper does still deal with the general question.

On December 14, 1892, I read before the Society of Arts a Paper on the utilisation of Niagara Falls, in which the general plan of operations was described. But at that time the electrical developments were not sufficiently advanced to enable me to treat of that part of the subject. A reference to that Paper will prevent the necessity of my wasting time and describing in detail the civil engineering and hydraulic arrangements. The object of the present Paper is to put before this Institution the circumstances under which this great problem has been attacked, and the views which have been arrived at, and also to describe, so far as any work has been done, the electrical machinery to be installed.

The utilisation of the Falls of Niagara has long been a favourite theme of engineers, but it was not until the transfer of power by electricity became feasible that this could enter very satisfactorily into the region of practical engineering. The matter is now in the hands of one of the most powerful combinations of New York capitalists which has ever been formed. Under their auspices the matter was, for the first time, thoroughly investigated from an engineering, financial, and commercial point of view. Rights were then acquired, and companies formed. The Cataract Construction Company does the engineering work, and will then hand it over to the Niagara Falls Power Company. The Land Development Company builds a whole village on the extensive lands acquired. The Niagara Junction Railway Company constructs six miles of terminal railway to connect all the factories, as they are built, with the railways in the neighbourhood. Rights of way are obtained in many directions, and also over the Erie Canal, which connects the Niagara and Hudson Rivers. Allied companies are formed to develop power to all the cities within reach. Roads are made, leases of land granted, factories built, and the engineering works taken in hand by the Cataract Construction Company. It is with this latter that we have chiefly to deal. Mr. E. D. Adams is the president, Mr. F. L. Stetson the first vice-president, and Mr. E. A. Wickes second vice-president ; Mr. W. B. Rankine is secretary and treasurer ; Mr. G. B. Burbank is the chief engineer ; and Dr. Coleman Sellers acts both as consulting engineer to the Cataract Construction Company and president of the Niagara Falls Power Company, while undertaking at the same time many of the duties of resident engineer. The waters from the river are taken in at a point about a mile and a-half above the Falls by a canal, from which it is led, by channels, into a long slot in the ground, going to the depth of 200ft. In this slot are iron pipes, or flumes, down which the water is carried to the turbines, and the waste water is carried through a tunnel for a distance of 7,000ft. to a point a few hundred yards below the American Falls, where it discharges into the lower river. Each turbine is of 5,000 H.P., revolves at a speed of 250 revolutions per minute, and is mounted on a vertical shaft. Above it there is a shaft extending in a vertical direction to the surface of the ground, on which a power house is built, and the revolving part of the dynamo is placed directly upon the top of this shaft. The present Paper may be divided into two distinct parts—first, the plans of working, of which, as their consulting electrical engineer, I have recommended the adoption ; and, second, the design of the machinery which is to be used. In neither of these two parts can I claim to have done anything of great novelty or originality. I have simply collected together the results of experience which are available to all engineers, and in any advice that I have given I have simply followed the logical conclusions that were to be derived from the past experience ; and in this I have been benefited by the courtesy and kind assistance of professional men, inventors, and manufacturers in both continents, who, almost without exception, have put their experiences at my disposal. If I have been the instrument to put before the Company any designs of value, it has been to a great extent as the assembler of ideas which have originated as often in the minds of the engineers and draughtsmen who have given me their assistance, as in my own. I wish especially to express how much the Company is indebted to Prof. Coleman Sellers, one of the most distinguished mechanical engineers in the United States, and who has assisted me throughout with his advice and suggestions, and who may be said to have originated the form of bearings and their supports which are to be used in the Niagara dynamos. I have also received valuable suggestions from my colleagues, Prof. Unwin and Colonel Turrettini, and also from the draughtsmen who have assisted me, and from numerous friends in our profession.* I have been desired by the President of the Company to take this opportunity of stating some of the events which have culminated in the present satisfactory position of the Company with regard to its contracts for machinery.

Relative Advantages of Direct and Alternating Currents.

A few years ago it would have been considered necessary to devote a considerable amount of space to the discussion of the relative merits of direct and alternating currents. During the last two years, however, opinions have advanced so steadily in the direction of preferring the alternating current for the transfer of power to any considerable distance, that it is not necessary to give much time to this question. One of the chief difficulties in connection with using the direct current is that it is necessary for getting the best results, to connect a number of dynamos in series, and also to put the motors at the receiving end in series with each other. This involves the insulation of each dynamo and motor from the earth—a requirement which can in some cases be attained, but which in a general system of distribution is apt to be attended with difficulty, and perhaps with danger. The best case of the kind which has been put in practice is that of Genoa, and we gave it the most serious attention, but came to the conclusion that, for our purpose, it was undesirable.

The facility which the stationary transformers used with the alternating current give for varying the pressure according to the requirements of economy or safety, is one great feature in favour of the alternating current. The question was considered in all its bearings with the utmost care, and it was not until the month of May, 1893, that the Board of Directors passed the resolution to adopt the alternating current both for their distant transmission and also for the works nearer to the power house. It was proposed, indeed, by some manufacturers to distribute the current within a radius of a mile or two at 700 or 800 volts, and one firm proposed to do this by means of a direct current. Had this plan been accepted, we should have arrived at the surprising result that

* Paper read by Prof. George Forbes, November 9, 1893.

* I must mention the names of the following draughtsmen who have worked on the dynamo designs for me. In England, Mr. F. M. Weymouth was chief draughtsman, assisted by Messrs. A. Wilson, R. H. Simpson, G. E. Groom, F. Willby, W. L. Hamilton, W. M. Williams, and W. H. Hudson. In America, Mr. Baumann was chief draughtsman, assisted by Messrs. Steen and Jacobson ; Mr. Vogel also worked for me there.

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by using the continuous current at 700 volts within a mile or two, and high-pressure alternating current for more distant places, it would have cost more to produce a horse-power per annum at Niagara Falls than at Buffalo.

The argument that seemed to me the most important in favour of using the direct current was, that motors for this purpose have been made in much larger quantities than alternators, and that it would be seldom necessary to build special types of machines to act as motors. This advantage seemed to be of great importance, until I realised the value of a low frequency used with the alternating current. So soon as we reduce the frequency low enough, we are able to alter a direct-current motor into a synchronising alternating motor, by the simple addition of a couple of rings placed on the commutator and electrically connected with opposite bars of the commutator, and a brush rubbing on each of these collecting rings. I also took into consideration the question of the possibility of storing up energy in storage batteries during the night-time, when, of course, the demands on our plant would be least, and giving it off during the daytime; but at the present time the cost of the batteries would not repay work in this direction, and it would be cheaper to make another tunnel, with wheel pits, turbines, and all the paraphernalia required to generate current, than to go to the expense of putting down the large amount of lead which is required for these batteries. With the alternating current we have the choice of a considerable number of motors of different types. We have the synchronising motor, the series-wound motor with laminated field and commutator, the multiphase motors, which attracted so much attention at the Frankfort Exhibition of 1891, and a host of single-phase motors which have been developed by various inventors, but which have never been placed on the market because of the high frequency which has been prevalent, and with which they were not altogether satisfied. These motors become immediately available if we use a lower frequency. The generation of an alternating current also permits of the use of a commutator, or rectifier, with direct-current motors.

Number of Phases.

Assuming now that it is generally agreed that the alternating current must be adopted, not only for the distant transmission, but also for the nearer work, the next point to consider is the number of phases—whether the current should be generated in a single phase, in two phases, or in three phases. The possibility, too, of using even a greater number of phases was also considered, but it did not seem to possess advantages.

As already stated, there are many motors which are suitable for use with a single phase at low frequency, and which start without assistance. In the workshops of nearly all the most able electricians which I have visited in the course of the last year or two I have found such motors built upon different plans, and nearly all of them seemed to work fairly well, and promise to be very efficient at low frequency.

For all heavy work, which is going on constantly without stopping the machinery, no motor could be more suitable than the synchronising alternator on a single phase, and its speed is as regular as that of the turbine which is developing the power. It seems, however, that even if single-phase motors are going to be adopted it would be best for the generator to have two phases, because in this way we get a larger output for the same size and price of machine: the circuits may be perfectly independent, and supply separate motors. Also, the two-phase system makes the rectification or commutation of the current more easy to use it for street railways, electro-metallurgy, &c. Again, multiphase motors have a great advantage that they have been considerably utilised already, and even in small sizes have a fairly good efficiency.

With regard to the relative merits of two and three phases, several claims that cannot be supported have been put forward in favour of the latter. First, it is claimed that the saving in the copper on the line is 25 per cent. over a one-phase system, and 25 or 13 per cent. over a two-phase system, according as four or three wires are used for the purpose. I investigated this matter carefully, and arrived at the conclusion that this was not the case, and that the three-phase system had no advantage in this respect over a two-phase system with three wires. Second, it is claimed that there is a greater simplicity of wiring with three phases than with two phases; but this advantage disappears when we remember that the two-phase system can be used with only three wires, although this is not a plan which I would recommend. Third, it is claimed that any pair of the three wires may be used for a distribution of lighting. This is not the case. A two-phase system, where the circuits are completely independent, is much more suitable for the purpose, and maintains the lights at a more constant electric pressure. Fourth, it is claimed that there is a smoother starting and rotating effort with the three-phase than with the two-phase system. This was originally claimed on theoretical reasons only by Dobrowolski, but everyone who has used the type of two or three-phase motors made by the Oerlikon Company, by C. E. L. Brown, and by the Allgemeine Electricitäts Gesellschaft, of Berlin, and others, is convinced that this advantage, which seems probable enough, is purely theoretical; it is not confirmed by actual practice, and, moreover, when the fact is known, the theoretical reason is pretty evident.

No other claims in favour of the three-phase system over the two-phase have ever, to my knowledge, been advanced; and, as shown above, a very full consideration of these claims does not tell in favour of the three-phase.

I will now point out what seemed to me great objections against the three phases, due to the fact that the three conductors are all inter-connected. First, it introduces trouble in maintaining the efficient working of the line, and in testing it; so that a higher type of electrician would be required to make these tests, and even he would have greater difficulty in finding the faults and correcting them. Secondly, when the three circuits are unequally loaded, the electric pressure varies considerably. These difficulties have been thoroughly appreciated by workers in this line. When an inter connected set of circuits such as the three-phase system employs is used, it is found that when the circuits are unequally loaded there are great variations in the electric pressure, and the following tests were made at my request to illustrate this. The three circuits are called A, B, and C. The average electric pressure of the three branches at the terminals of the secondaries was maintained constant. A resistance tending to reduce the electric pressure at the lamps 5·3 per cent. was introduced into each branch. Both the primaries and the secondaries were connected as represented by the form of the letter Y. By varying the connections in different ways, some slight variations were possible; but this general fact remained—that when A is loaded and B and C are not loaded, the pressure of A is less than that of C, and that of C is less than that of B, and the difference may be 12 or 13 per cent.; and when A and B are loaded and C is not loaded, the pressure of A is less than that of B, and that of B is less than that of C. The variations here shown in the pressure of two equally loaded circuits is probably due to the armature reactions, and would be found in a two-phase system also; but the rest of the variation is due to the inter-connection of the three circuits, and is an obvious defect of the three-phase system. In order to get over this difficulty, the Oerlikon Company proposed to devote only one circuit to lighting purposes, which shall be maintained at constant pressure, using the other two circuits for power purposes, where constancy of pressure is not so important. In some cases this would be a suitable method of working, but it was not considered satisfactory for the work at Niagara Falls. Having considered these points, the Board of Directors of the Cataract Construction Company, at their meeting in May, 1893, determined to reject the three-phase system, leaving the single-phase and the two-phase available.

Conditions.	Volts at terminals of lamp mains.				Difference between maximum and minimum volts.
	A.	B.	C.	Avrge.	
A, B and C loaded (resistance out)	108·5	108·6	107·9	108·3	0·7
A, B and C loaded (resistance in)..	103·5	103·6	103·2	103·4	0·4
A loaded, B and C off	102·9	116·0	108·5	108·5	13·1
B loaded, A and C off	104·5	102·5	114·9	107·3	12·4
C loaded, A and B off ... .:	115·1	105·3	101·3	107·2	13·8
A, B and C loaded (resistance in).	103·0	103·4	102·5	103·9	0·9
A and B loaded, C off	98·9	107·8	111·1	105·9	12·2
A and C loaded, B off	101·2	108·0	98·1	102·4	9·9
B and C loaded, A off	110·5	98·0	105·8	104·8	12·5
A, B and C loaded (resistance in)..	103·7	103·0	103·0	103·5	0·7

Frequency of Alternations.

I wish now to say some words on a question which has absorbed my most serious attention, especially since I have been acting for the Cataract Construction Company, and this relates to the frequency of the alternating current. In America a frequency has generally been adopted of 133 complete periods per second for lighting purposes. This was done with the object of reducing the cost of transformers, which were supplied to each separate house, and consequently were always of small size, and therefore expensive. The selection was also approved because American engineers working with alternating currents have generally put forward the view that parallel work is not desirable, and the fact that parallel working is more difficult at high frequency, which is one of the principal objections to high frequency, has not been seriously considered in America. In Europe the usual frequencies are from 70 to 100 periods per second, but a notable exception exists in the case of Messrs. Ganz and Co., of Buda-Pesth, who have adopted 42 periods per second. Some years ago I unwittingly did Messrs. Ganz the injustice to say that I thought it probable that they had adopted this frequency because it suited their particular

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type of machinery and speed of running. I have it in writing from them, and I am thoroughly convinced of the truth of it, that their reason for adopting the frequency of 42 periods per second was that it is the lowest frequency that is available with arc lights so as not to produce any serious flickering, and their desire was to lower the frequency as far as practicable in order to ensure parallel working. Of course it is a matter of common knowledge that parallel working is assisted by lowering the frequency.

With the large units which will be employed in connection with the Niagara Falls scheme, the cost of the transformers is very much diminished; and this does not become so important a matter as it does when all the transformers are of small size—under 10 H.P., as is usual in electric lighting in America. Moreover, although with lower frequency the transformers must be increased in size, the increased cost is not in proportion to the lowering in frequency, because we can use a higher induction. Mr. Steinmetz has shown that the loss due to hysteresis varies as the induction raised to the power 1·6, and it is this loss which must be kept constant when we vary the frequency. I deduce from this law the fact that in any transformer, if the hysteresis loss is kept constant, its power of doing work varies in proportion to the frequency raised to the power 0·4 (but it is probably unwise to increase the induction so much as to saturate the iron). It follows that when we double the frequency we get out of the same transformer 132 units of work instead of 100. If the frequency were quadrupled we should get 174 units instead of 100. I have been informed by Mr. William Stanley, jun., of Pittsfield (Mass.), that without the use of theory, but simply working from his experience in manufacturing and testing transformers, he obtains almost identically the same law; and I have got independent practical testimony in the same direction from other manufacturers. It appears, then, that there can be no doubt that in lowering the frequency we are not proportionately increasing the cost; but at the same time it must be realised that the cost of transformers is to a certain extent increased by lowering the frequency. If the frequency be reduced to one-half, the cost is increased about 50 per cent. The lowest price which has been quoted for large transformers is 3·52 dollars per H.P., at a frequency of 42 periods per second. In halving the frequency the extra cost would therefore only be 1·76 dollars per H.P. It becomes, then, a matter of inquiry whether the benefits to be derived by lowering the frequency in such a proportion would compensate for the extra expenditure as indicated. I am thoroughly convinced that the gain is far in excess of this amount. I shall have occasion to discuss the superior efficiency of motors at low frequency; and in most types of motors I think it safe to say that in passing from 42 periods to 21 periods, or varying the frequency in that proportion, we have a gain of at least 3 per cent. in the efficiency of the motors. Neglecting altogether the increased value of the motors from this cause, there is 3 per cent. more power at our disposal, which, at only 10 dollars per H.P. per annum, would amount to 30 cents per annum, or, capitalised at 5 per cent. represents an increased value of 6 dollars per H.P. of the plant, against which we have the increased cost of transformers—only 1·76 dollars. It appears, then, pretty certain that, from a purely economical consideration of the question, a lower frequency than any which has hitherto been adopted is advantageous.

With regard to the lowest limits at which we can work, since our turbines have been designed to revolve at 250 revolutions per minute, a two-poled dynamo—if such could be satisfactorily constructed—would give a frequency of $4\frac{1}{6}$th periods per second, and none of the synchronising or polyphase motors employed at different factories could run at a higher speed than 250 revolutions. I am not sure that it is desirable that any motors should run at a higher speed than this, but in the few cases where this might be desirable the use of belts would be quite natural in order to give the higher speed. With a four-poled machine we would have a choice of speeds at 500 revolutions, 250 revolutions, and any submultiple of these speeds, for by increasing the number of poles in the motor the speed of the motor can be reduced as much as we please. With eight poles in the generator the maximum speed is 1,000 revolutions per minute, which is as high a speed as would generally be desired in connection with the factories supplied from Niagara Falls. This frequency is $16\frac{2}{3}$ periods per second; and after considering the three points—namely, cost of transformers, speed of synchronising motors, and convenience in the design of the generators—I came to the conclusion that, so far as motive power was concerned, this is the frequency which would be most favourable for use at Niagara Falls.

Another indirect advantage of using a low frequency is of a very practical nature, and lies in the fact that the ordinary continuous-current dynamos of any size that are made may be used as synchronising motors by means of rings attached to the commutator bars in the manner which has been above described. This method of altering and working a direct-current motor so as to make it suitable for an alternating current of low frequency has long been known to electricians, but the attention of those who are not experts was forcibly directed to it by the machines shown by Mr. Schuckert and others at the Frankfort Exhibition in 1891. Owing to this fact, it would be possible for any manufacturer connected with our supply station to procure a motor of low frequency of any moderate power he might require at a day's notice; and this is not true of any other alternating motor, nor is it true of a higher frequency.

(*To be continued.*)

ROYAL METEOROLOGICAL SOCIETY.

The first meeting of this Society for the present Session was held on Wednesday evening, the 15th instant, at the Institution of Civil Engineers, Great George-street, Westminster; Dr. C. Theodore Williams (President) in the chair. Mr. F. J. Brodie read a Paper on

"The Great Drought of 1893, and its attendant Meteorological Phenomena."

After this, Mr. W. Marriott gave an account of the

"Thunder Storms and Hail Storms"

which occurred over England and the South of Scotland on July 8, 1893. Thunderstorms were very numerous on that day, and in many instances were accompanied by terrific hailstorms and squalls of wind. It was during one of these squalls that a pleasure boat was capsized off Skegness, twenty-nine persons being drowned. About noon a thunderstorm, accompanied by heavy hail and a violent squall of wind, passed over Dumfries and along the valley of the Nith; many of the hailstones measured from 1in. to $1\frac{1}{2}$in. in length. At the same hour a similar storm occurred at Peterborough. From about 2 until 10 p.m. there was a succession of thunderstorms over the north-east of England and south-east of Scotland, and at many places it was reported that the thunderstorms were continuous for nine hours. Two storms were remarkable for the immense hailstones which fell during their prevalence over Harrogate and Richmond in Yorkshire. The hailstones were 4in. and 5in. in circumference, and some were as much as 3in. in diameter. Great damage was done by these storms, all windows and glass, facing the direction from which the storm came, being broken. It is computed that within a radius of five miles of Harrogate not less than 100,000 panes of glass were broken, the extent of the damage being estimated at about £3,000. The thunderstorms in the northern part of the country travelled generally in a north-north-westerly direction at the rate of about 20 miles an hour. They appear to have taken the path of least resistance, and consequently passed over low ground and along river valleys and the sea coast. Several storms seem to have followed each other along the same track.

THE STORAGE BATTERY OUTLOOK IN AMERICA.*

The history of the storage battery in America presents phases of such anomalous character that it can be compared to that of no other electrical apparatus of like importance which has yet made its appearance. The readiness with which Americans are known to take up and bring into practical shape and use every invention and apparatus giving promise of commercial success seems, in this instance, to have been entirely wanting, with the result that to-day America makes, perhaps, the poorest showing in the application of storage batteries of any country of similar size and importance. To analyse the causes which have led to this, in many ways to be deplored result, would lead us too far; but we think they can be summarised in the statement that the proverbial American impatience for results, and inadequate attention to details in the early stages of the introduction of the storage battery, will account for many of the failures recorded. The excellent results which have, within the last few years, been attained in Europe with it have, we are glad to say, again forced the storage battery on the attention of our own electrical engineers, and we have of late discerned a reviving, and we hope an increasing, faith in the capabilities of the accumulator when properly applied. In central station practice the economy to be derived from operating engines at full load for a definite period, which the storage battery makes possible, appears to be now no longer a matter of doubt, judging by the results obtained abroad; and the recent trial of a like method of station operation in New York City corroborates this European experience.

But what is shown to be so eminently conducive to economy in lighting work, ought to be not less so when applied to electric railway operation. Much of the discussion which has been held on

* From the *Electrical Engineer* of New York.

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the management of street railways has related to the most economical method of power equipment, and hence it is fair to assume that this item of railway expense is constantly before the eyes of street railway managers. With the usual load factor of railway power plants, and the enormous power fluctuations to which they are subjected, there would appear to be here a field for the storage battery, more extended even than in electric light stations.

But we must not lose sight of the direct application of the storage battery in railway work—the storage battery car. While the trolly system is unquestionably strongly intrenched, and at the time of its introduction confessedly presented the only available and practicable method for this country, no one will deny that it has its shortcomings; we may go so far as to say that street railway managers themselves would welcome a system which, in the first place, would dispense with the overhead system of conductors and all the troubles to which they are subject; and, in the second place, would make each car a self-propelling unit, independent of any other factor in the operation of the road.

The sporadic attempts which have been made to demonstrate the feasibility of storage-battery traction have not, we are sorry to say, proved convincing to the large majority of street railway managers, who are, perhaps, among the most conservative of business men to be found anywhere, and rightly so. Quite recently, however, the subject has again been taken up with energy, and in a manner which bids fair to demonstrate that the storage battery, applied directly to the car, can, under proper local conditions, hold its own against any other method of traction. We base this view upon the very systematic trial which is now being carried out by the Waddell-Entz Company on the Second Avenue surface road in New York, and which has extended over a sufficient lapse of time to enable a fair estimate to be formed of what the system is capable of accomplishing. The result obtained on the Second Avenue line has shown that in practicability and reliability storage-battery traction can be depended upon to fill the needs of the most exacting conditions; but, it will be asked, What does it cost? On this point we are enabled, through the courtesy of the Waddell-Entz Company, to give the cost of operation of their storage-battery cars on the Second Avenue road, as made up directly from the books of the Company. The figures of the actual cost, under the present conditions, with six cars in operation, show that the expense for power, including everything which properly belongs under that head, amounts to 9.32 cents per car-mile. This figure, of course, exceeds that which may be attained with the trolly system, but the cost for the same items of expense when figured on the basis of 18 cars would compare far more favourably with that of the trolly. If, in addition, we take into consideration the cost of overhead construction and its maintenance, the high efficiency at which the engines can be operated, and the other advantages accruing from having the entire operating force constantly under the eye of the superintendent, this disparity is still further lessened. It may take some time yet to heal fully the wounds of the past, but with a better understanding of the nature and capabilities of the storage battery America may yet turn its early storage battery experience to good advantage.

LEGAL INTELLIGENCE.

Thompson v. Cowles Syndicate Company.

In this action, the hearing of which by Baron Pollock occupied several days, the plaintiff was Mr. N. G. Thompson, engineer and agent, Victoria-street, Westminster, S.W., and the defendants are the Company which has been carrying on the process of producing aluminium and aluminium alloys by electrolysis by means of the Cowles electric smelting furnace. The plaintiff claimed £290 for carbon rods supplied; the defendants paid £90 into Court for a proportion of the carbons which were found suited to their purpose, but repudiated liability for the remainder, which they alleged were not suitable, and further brought a counter-claim for damage sustained by reason of this alleged unsuitability.

The plaintiff's case was that the carbons were supplied according to sample, were of good quality, and would have been found suitable for the purpose for which they were required if properly managed.

Mr. THOMPSON gave evidence as to the order for the carbons, which were obtained from the French firm for which he was agent in this country.

M. BERNE (the manufacturer) stated that the carbons were identical with carbons he had supplied to the Swiss Aluminium Production Company at Neuhausen for a similar process to that carried out by the defendants, and which the Swiss Company had found entirely suitable.

Mr. JAMES SWINBURNE said the carbons produced were capable of conveying the current used in the process without wasting, and he attributed the wasting alleged to have taken place to the over-heating of the bath into which the carbons were plunged. There was a slight difference in the hardness of the two sorts said to have been supplied, but not such as to have any material effect.

For the defendants, Mr. ESCHEWARI (manager of the Company) spoke as to the negotiations which took place between the Company and the plaintiff prior to the supply of the carbons. They had previously been using American carbons, which proved satisfactory; but when their stock of these was exhausted they gave plaintiff an order for 10,000 kilos of French carbons. With the American carbons they had been in the habit of producing about 200lb. of aluminium with a current of 3,000 amperes. In June, 1892, they received the first instalment of carbons from the plaintiff. When used the carbons appeared to get hot at the top, and they wasted away. Upon analysis they found 20 per cent. of carbon in the bath, which was rendered unworkable. Some carbons subsequently supplied turned out all right, although worked under identical conditions.

Mr. NICHOLSON said he was an electrical engineer. The wasting of the carbons at the sides, he considered, pointed to over-heating or to bad manufacture. If the carbons were up to the ordinary commercial standard they would not, in his opinion, have showed any signs of wasting with the current said to have been used.

Mr. MOULTON, Q C., for the plaintiff, contended that the whole of the mischief was caused by the over-heating of the bath upon the occasion when the first carbons were tried.

Mr. BOUSFIELD, Q.C., in reply, asserted that the conditions were in no way different from those which prevailed when the carbons were used which worked satisfactorily.

Baron POLLOCK, in giving judgment on Tuesday, held that an inferior quality of carbons had clearly been supplied, and the plaintiff could not, therefore, recover for them; but that there was no warranty and no special damage proved. There would, therefore, be judgment for the defendants, with costs, except as to the counter-claim, in regard to which there would be judgment for the plaintiff.

Mr. TINDAL ATKINSON, for the plaintiff, asked for a stay of execution for a week, pending appeal, and this was granted upon the condition that £100 was paid into Court as security for costs.

Elieson Accumulator (British Patent) Syndicate (Limited) v. The Earl of Galloway

This case, which was part heard before the Long Vacation, was resumed in the Queen's Bench Division on Tuesday before Mr. Justice Kennedy, sitting without a jury.

The plaintiffs in the case are the Elieson Accumulator (British Patent) Syndicate, a Company incorporated October 15, 1892, for the purpose of working an electric patent and plant at Croydon, which the inventor, Mr. C. P. Elieson, had disposed of for £6,000 fully-paid up shares in a Company to be subsequently formed. The plaintiffs alleged that the defendant (the Earl of Galloway) applied for 2,000 shares, and paid a deposit. Application having been made for payment of the balance, the defendant refused to carry out the contract. The defendant denied the agreement, and also denied that shares had been allotted to him. The Earl of Galloway also pleaded that the Company registered on October 13, 1892, was not the Company agreed upon; that subscriptions to the amount agreed upon from the outside public had not been forthcoming; and he was not, therefore, liable, as he had not applied, and had given no authority to the promoter to apply, for shares. Mr. C. Salter appeared for the plaintiffs; Mr. Frank Lockwood, Q.C., and Mr. Pollard represented the defendant.

His LORDSHIP, upon taking his seat, said as he recollected the case the question was whether there was a valid allotment of shares for which Lord Galloway was bound, and certain letters and a verbal promise were relied on to attach responsibility for the shares. The defendant denied agreement to take, and said if there was it was subject to an agreement with Lord Sackville Cecil.

Mr. LOCKWOOD said that was the substance of the case so far as it had progressed; but it was further contended by the defendant that there should be directors approved of by Lord Galloway. There were two prospectuses, one in relation to a storage company, and another in respect to an accumulator company, there being £50 paid in respect to each company, but treated as a deposit upon an additional 1,000 shares in the plaintiff company. The defendant denied that there was any allotment, or that there had been any application by the public to the amount agreed upon; and he further denied that he had paid the £100 as a deposit upon shares in the Company.

Mr. WATSON SMITH, the promoter of the Company, and other witnesses, having given evidence,

Mr. LOCKWOOD, Q.C., addressed the Court for the defendant, and

Mr. ELIESON, the inventor of the accumulator patent, was examined on behalf of defendant, and denied that there had ever been any confirmation of sale given by Mr. Alfred Pallas, his partner, such as that spoken of by Mr. Watson Smith. He denied that he had ever entered into a contract with the plantiff company, and said that his patent had been sold to another and a different company, which is now in existence.

The EARL of GALLOWAY was examined, and generally bore out counsel's statements in his behalf. He denied having given Mr. Watson Smith authority to apply for shares in any other companies than those mentioned in the prospectus. He admitted having signed an application for shares under a certain prospectus of a company which was to be formed, but which never was formed.

After addresses upon both sides, his Lordship reserved judgment.

The Medical Battery Company (Limited).

Mr. C. B. Harness, aged 47, living at Heathside, Potter's Bar, and well known in connection with the Medical Battery Company (Limited), and with what is now known as the Electropathic Belt Fraud, was charged on remand at the Marlborough-street Police-court on Wednesday with unlawfully conspiring, confederating, and agreeing with Dr. J. Montgomery McCully, and other persons, by false pretences and fraudulent advertisements in newspapers and otherwise, to defraud; further, with conspiring with other persons to obtain by a false and fraudulent pretence the sum of

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£52. 10s., and other sums of money from Colonel Jeremiah Braysyer, with intent to defraud; and further with obtaining the sum of £2. 2s. from Frederick Theobald Burbage, and the sum of £2. 2s. from William Hibberdine Manners, in each case with intent to defraud. James Montgomery McCully, 47, a physician, living in Blandford Mansions, East-street, Marylebone, and Charles Beavington Hollier, 37, described as a salesman, of the Headley Arms Hotel, Warley, Sussex, were charged, on remand, with conspiring with Harness in committing the alleged offences.

Mr. Thomas Terrell, barrister, prosecuted: Mr. Horace Avory appeared for Harness, Mr. A. R. Cluer for McCully, and Mr. C. F. Gill for Hollier.

Great interest was taken in the case by the general public, who crowded the court; and Mr. Terrell, in opening the proceeding, detailed a number of cases in support of the action taken by the prosecutors; and evidence was given by a former employé of the Medical Battery Company in support of the prosecution. In the course of his opening statement Mr. Terrell informed the Bench that he was prepared to prove conclusively before the case was concluded, by calling some of the most eminent electricians of the day, that the so-called electrical belts had no possible electrical effect whatever. He described Harness as a "vulgar, ignorant man, with no knowledge of any kind except that of selling goods." The business of the Medical Battery Company was kept together chiefly by advertising, upon which enormous sums were spent annually, reaching in one year as much as £50 000! McCully, who represented that he was a qualified medical man, was some years ago struck off the register. Hollier was a salesman who represented himself on many occasions to be Harness. On one occasion, when Harness was asked a question as to the elements of electricity, he replied that he "did not trouble himself about the groundwork of science, but went straight up to the highest flights."

The accused were ultimately again remanded for a week on bail.

The adjourned petition to compulsorily wind up the Medical Battery Company was heard by Mr. Justice Vaughan Williams on Wednesday. Since the presentation of the petition the Company has passed a resolution to wind up voluntarily.—Mr. Bramwell Davis also asked for a compulsory order on behalf of Sir William Long.—Mr. Boxall, representing shareholders to the amount of £43,8 0, favoured the suggestion as to voluntary liquidation, so that "a valuable business might continue."

Mr. Justice WILLIAMS: I am not aware that there is any such valuable business.

Ultimately, his Lordship ordered the continuance of the order for voluntary winding up under supervision for a week.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *November* 4, 1893.

The Westinghouse Company.—This Company has been awarded a contract for three two-phase alternating-current dynamos of 5,000 H.P. each, of a design originating with engineers of the Niagara Falls Power Company. The E.M.F. will be from 2,000 to 2,400 volts, which will be increased by step-up transformers for long distance transmission and lowered by step-down transformers for distribution. A remarkable point in regard to the system thus definitely adopted is that the frequency will be only 25 periods per second.

Electricity for Canal Boats.—At the last session of the New York Legislature a sum of money was appropriated to experiment with electricity for towage purposes on the Erie Canal. This has furnished an attractive theme for the newspapers, which have devoted considerable space to this new application of electricity. A trial will soon be made over a short distance with a trolly system, but it is not thought that any of the experiments will have practical results.

Trolley Accidents.—The newspapers continue to teem with accounts of trolley accidents, which with scarcely a single exception were caused by persons being struck or run over by electric cars. The State Railroad Commissioners of New York are now considering the subject of regulations for electric street railways, and it is probable that they will place a limit on the speed, require cars to be equipped with suitable fenders and with a reliable system of brakes. Some of the more serious of the recent accidents have been caused by the brakes refusing to work at the critical moment.

Municipal Lighting Plants.—The subject of municipal electric lighting plants is becoming more prominent; several large cities have declared in favour of municipal plants, and quite a large proportion of the new town plants in New England and in the West were built by public funds authorised by large majorities at elections held for the purpose.

CORRESPONDENCE.

THE POLLAK ALTERNATE-CURRENT COMMUTATOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of November 3rd you make some remarks with respect to my device for commutating alternating currents described in the same number of your valuable paper. The process is, in your opinion, very wasteful and troublesome. Allow me to say that the efficiency of the transformers has proved, after exact measurements, made here as well as in Chicago, to be but very little lowered in applying them to my apparatus, the extra loss being from 1 to 5 per cent. The trouble, too, which is caused by the manipulation of the "rectifier" is very small, requiring no more attention or skill than a dynamo machine; the displacement of the brushes necessary to do away with sparks is, in charging storage batteries, necessary only during the initial and the final period, where the rise of the counter E.M.F. is rapid; for the purpose of driving direct-current motors automatic regulation is provided. The device is not only applicable to small installations; on the contrary, it is the more efficient and cheap, the greater the current, because it can wholly replace the motor-dynamo otherwise used. Nevertheless, I venture to say that where there is an alternating current supply, and a demand for 2 H.P. continuous current, my device would be far simpler and cheaper in first cost and maintenance than a gas motor and dynamo, and give an efficiency by itself of 95 to 98 per cent., which cannot be obtained by a 2-H.P. isolated plant. As to the difficulties of measurement alluded to, they are in practice by no means as great as it would appear, experience showing that nearly the same amount of power, the same time, and exactly the same instruments as in direct-current work are required for definite results. I am quite ready to prove this assertion by showing my device to anyone taking interest in the question.

Hoping you will give room to these lines in your next issue.—Yours, &c.,

C. POLLAK.

Frankfort, November 13, 1893.

[It was to the use of a transformer with a highly-saturated core, and not to the general working of the commutating device, that our remarks about wastefulness were directed. We observed indeed that the system appeared to give fairly efficient results. For electric lighting it is generally sufficient to measure the current, or the $\sqrt{\text{mean}^2}$ of the current. But in charging accumulators it is often necessary to know the quantity as well as the dynamical value of the current. As there are periods during which no current whatever flows, in this system, we do not see how it is possible to measure the ampere-hours put into a battery. In the laboratory to which we alluded, such measurements are essential.—ED. *E.*]

THE GLOBE TELEGRAPH AND TRUST COMPANY (LIMITED).

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A misleading circular signed "Scrutator" has been addressed to some of the shareholders of the Globe Telegraph and Trust Company (Limited), insinuating that the present value of its assets shows a deficiency in its capital account, and I am directed to ask you to be good enough to publish the following:—

The Directors yesterday caused a valuation to be made of the securities held, and this shows a present surplus market value over the paid-up capital of the Company of close on £300,000.

I beg to enclose you a copy of the balance-sheet of July 18, 1893, and you will find attached thereto full details of the Company's investments, which have not since been varied. The values of all but two or three comparatively small investments are quoted daily, and it will be easy for any shareholder to satisfy himself of the accuracy of the above-mentioned valuations.

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At the same time, I am instructed to say that the Directors do not consider the market prices of the securities they hold as being the only criterion of their values.—Yours, &c.,

SIDNEY COLLETT, Secretary.

Winchester House, Old Broad-street, London, E.C.,
November 16, 1893.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, which has a special interest at the present time, is now ready, and will be forwarded on receipt of the published price, 7s. 6d. (abroad 8s.), or it may be obtained from any bookseller. A prospectus can be obtained on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—This book, written by Mr. F. Marten Weymouth, is also ready, and will be sent direct on receipt of the published price, 7s. 6d. (abroad 8s.), or it may be obtained from any bookseller. A prospectus will be forwarded free on application.

TENDERS INVITED.—Tenders are invited for the extension to Laxey of the existing electric tramway from Douglas to Groudle Glen. Plans may be seen, and specifications, &c., obtained at the office of Mr. F. Saunderson, 7, Athol-street, Douglas, Isle of Man, to whom tenders must be sent by the 25th inst.

TENDER ACCEPTED.—The Staffordshire County Council have accepted the tender of Messrs. Rooper and Tozer for the providing and fixing of wiring for the electric light for the Council's new buildings for the sum of £460. The specifications for this work were prepared by Messrs. Kincaid, Waller and Manville.

APPOINTMENT VACANT.—The Crown Agents for the Colonies, Downing-street, London, S.W., will receive up to November 30th, applications for the post of telegraph mechanician for the Telegraph Department of the Gold Coast, West Coast of Africa, at a salary of £200 per annum, rising by annual increments of £25 to £250 per annum. Other particulars will be found in our advertisement columns.

——— The City and Guilds of London Central Institution (Physical Department) require two assistants. Applications must be sent in to Prof. Ayrton, at the Central Institution, Exhibition-road, London, S.W. Some further particulars are given in our advertisement columns.

LIQUIDATIONS.—At meetings held on October 14th and November 4th, the shareholders of the Halifax Mutual Electric Light and Power Company (Limited) resolved to voluntarily wind up the Company, and appointed Mr. W. D. Taylor, Town Hall-buildings, Halifax, as liquidator. Claims against the Company are to be sent in by December 16th.

——— The members of the Engineering Exchange (Limited) have resolved that the concern be voluntarily wound up, and Mr. A. T. Salisbury-Jones has been appointed liquidator.

——— A meeting of the Eclipse Electric Lighting Syndicate (Limited) is to be held at 8, Finsbury-circus, E.C., on December 18th, for the purpose of receiving the report of the winding up.

MESSRS. JULIUS SAX AND CO. (LIMITED).—Prince Louis of Battenburg on Tuesday last visited the works of Messrs. Julius Sax and Co., at Ridgmount-street, and inspected the new flash lamp, which is intended for signalling purposes in the Navy, and has been adopted by Sir William Armstrong, Mitchell and Co., of Newcastle.

THE ROBERTSON LAMP.—We have received from the General Electric Company a table showing the cost of electric lighting when using "Robertson" lamps of 16-c.p. at various efficiencies. The table is calculated on the basis of a one-and-sixpenny lamp, and that lamps are considered renewable when they have lost 25 per cent. of their original candle-power. In the table we find, for example, that at 6d. per unit, and at 4 watts per candle, the total cost per lamp hour is 0·397d., of which 0·013 is the cost of renewals. At 3·5 watts per candle it is 0·354d., the renewals being 0·018d.; at 2·5 watts per candle the renewals come to 0·05d. and the total cost 0·29d., while at 2 watts the renewals are more than twice the last figure, viz., 0·11d., and the total cost has risen slightly to 0·302d. It is guaranteed that the Robertson lamps will not take more current on an average, during their "efficient life," than the values given in this table.

CORLETT ELECTRICAL ENGINEERING COMPANY (LIMITED).—This company have opened a branch office at Newcastle-on-Tyne, under the management of Mr. C. W. Fairweather, late works manager to Messrs. Ernest Scott and Mountain.

PHOSPHOR BRONZE.—The Phosphor Bronze Company inform us that they have appointed Messrs. Dempster, Moore & Co., of 49, Robertson-street, Glasgow, sole agents in Scotland for the Phosphor Bronze Company's manufactures.

STORAGE BATTERIES AT BIRMINGHAM.—The Electrical Power Storage Company (Limited) inform us "that the Birmingham Central Tramways Company have (as will be seen from attached extract from their letter), after trying plates of other manufacturers for more than a twelvemonth, decided to renew the whole of the battery with E.P.S. plates. Two batteries of the original plates manufactured by the Electric Construction Corporation (the then owners of the E.P.S. patents), supplied more than two years ago, have been regularly working and giving excellent results. Owing to the manner in which the 'Results' on this particular line have been persistently advertised, we trust you will give this statement due prominence." The following is the extract referred to above:—

"To the Electrical Power Storage Company (Limited),
"4, Great Winchester-street, E.C.
"November 10, 1893.

"Birmingham Central Tramways.

"Dear Sirs: With reference to your favour of the 1st instant, we beg herewith to order from you, on behalf of the Birmingham Central Tramways Company, 960 positive sections, each of nine plates; and 960 negative sections, each of ten plates, in exchange for plates of other makers, as set forth in your letter of November 1st.

"Yours faithfully,
"(Signed) KINCAID, WALLER AND MANVILLE."

In reference to the above we are asked by the Epstein Electric Accumulator Company (Limited) to insert the following:—

"21A, Blyth-road, West Kensington, London, W.,
"November 15, 1893.

"From a letter of the Electrical Power Storage Company it would appear that out of the number of E.C.C. batteries supplied to the Birmingham Central Tramways Company about two years ago two have been regularly working till now, and giving excellent results. This is not according to facts. On the other hand, the results which have from time to time been published by the Epstein Electric Accumulator Company (Limited) are based on indisputable facts, and their correctness can be easily ascertained. The statement as to the lifetime, reliability, and absence of repairs and renewals were made publicly, and confirmed by those best able to judge, being in possession of official figures.

"The experience and responsibility of the gentlemen who are entrusted with the management of the affairs of the Birmingham Central Tramways Company should offer a sufficient guarantee that the order given to the Electrical Power Storage Company is coupled with a maintenance clause, and it would be doubting their business capacity if one presumed that the terms of the contract are not more to the interest of the shareholders than the offer made by the undersigned Company to work the line and defray all expenses, with the exception of permanent way and general charges, for 70 per cent. of the gross receipts.

"But electrical and tramway engineers would no doubt feel greatly obliged if the information regarding the lifetime, repairs and renewals of the accumulators, and the financial results to the supplying and maintaining company were officially vouchsafed from time to time."

HENLEY'S CABLES.—We have received a new price list of electric light cables and wires made by W. T. Henley's Telegraph Works Company. The insulation resistance given in each class is the minimum resistance guaranteed for the largest cable in that class, and as the cables decrease in size the insulation resistance increases. In the smaller cables the ratio of the thickness of the insulation to the diameter of the conductor must be increased for mechanical purposes. The tables are very clearly arranged, the particulars of the conductors being repeated on each opening. Mr. Preece's Paper on this subject has borne good fruit in the production of such price lists as this.

ELECTRICITY IN MINES.—The Moodie Gold Mining and Exploration Company of South Africa have concluded contracts with Messrs. W. T. Goolden and Co., for the supply and erection of plant for the electrical transmission of 250 H.P., generated by water-power from the Queen's River, to the various mines situated near Barberton, a distance of about ten miles. This is the most important power transmission scheme yet undertaken in South Africa, and if successfully carried out will have an important bearing on the future of many of the South African gold fields.

FALKIRK IRON COMPANY.—Mr. T. W. Alsop, manager of the Falkirk Iron Company, requests us to state that this company has no connection whatever with the London and Falkirk Foundries Company (Limited), the prospectus of which has been circulated this week. As the Falkirk Iron Company is well known to many, more especially in Scotland, by the name of the Falkirk Foundry, Mr. Alsop is anxious that it should be generally known that there is no connection whatever between the two concerns.

ELECTRO-HARMONIC SOCIETY.—A "Ladies' Night" will be held at the St. James's Hall Restaurant, Regent-street, W., on Friday, the 24th inst., at eight o'clock. An interesting programme will be provided.

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BARROW.—The Town Council last week decided to apply for a Provisional Order.

BATTERSEA.—The new Town Hall on Lavender-hill was opened by Lord Rosebery on Wednesday. The *Daily News* says that there are only two points of deficiency likely to strike the stranger who strolls through it—one being the want of the electric light instead of gas, and the other the absence of an organ, or a place for an organ, in the large public hall. Our contemporary says: "We understand that gas was adopted because there is, as yet, no installation or electric supply in the neighbourhood, and it would have added some £3,000 or so to the cost of the undertaking to have set up an independent supply. It seems almost a pity, though, not to have made at any rate necessary provision for electricity when by-and-by it has become available."

BUXTON.—The Local Board have decided to apply for a Provisional Order.

CAMBERWELL.—At the meeting of the Vestry held last week the Electricity Committee produced a list of streets through which they recommended the Vestry to lay electric mains. Some opposition was raised to the scheme, but after several divisions the Committee's recommendation was carried by a small majority.

CAMBRIDGE.—At the last meeting of the Town Council the Electric Lighting Committee reported that they have received a letter from the manager of the Cambridge Electric Supply Company (Limited) pointing out that at present the Company had to maintain a constant supply of energy, which resulted in considerable pecuniary loss to the Company, without any corresponding benefit to the public. They therefore desired to come to an agreement with the Corporation that there should be exceptions to the delivery of a constant supply. The Committee recommended that from the present time until the 31st day of December, 1894, the Company be permitted to make the following exceptions to a constant supply, viz.:—On weekdays, from October 1st to June 25th inclusive, from 2 a.m. to 6 a.m.; from June 26th to September 30th inclusive, from 2 a.m. to 5 p.m. On Sundays, from April 1st to September 30th inclusive, from 1 a.m. to 6 p.m.; from October 1st to March 31st inclusive, from 1 a.m to 4 p.m. But in no case on Sundays shall the supply be shut off after sunset. Some opposition was raised to the proposal on the ground that the application was an attempt on the part of the Company to evade the conditions under which they had undertaken to supply the electric light, and the consideration of the report was postponed until the next meeting of the Council.

CARLISLE.—On Wednesday last week the library of the Institute of Literature, Science, and Art, established by the Corporation at Tullie House, was formally opened by the Mayor. The building is lighted by electricity from plans provided by Mr. Howard-Smith, the city surveyor, under whose superintendence the installation was fitted up. The current is generated by two Latimer Clark dynamos, driven by Tangye gas engines. Over 400 incandescent lamps from 8 to 50 c.p., are distributed over the building. The contractors for the electrical work were Messrs. Latimer Clark, Muirhead and Co., and the work was carried out by their representative, Mr. W. E. Weise.

CHAGFORD.—At a Vestry meeting held last week it was decided to continue the lighting of the town by electricity.

CHERTSEY.—At the last meeting of the Rural Sanitary Authority the clerk was directed to again inquire of the Weybridge Electrical Supply Company when they intended to carry out their promise to place their conductors underground, and to ask them for their terms for the future lighting of the parish, the present contract having nearly expired.

CHICHESTER.—The last meeting of the Town Council had under consideration the electric lighting scheme suggested by Mr. Prior, an abstract of which has appeared in *The Electrician*, and after some discussion the Lighting Committee were instructed to take the matter into further consideration and report thereon.

CRIEFF.—Some time ago a proposal was brought before the Town Council for the introduction of the electric light into the town. Since then Sir Patrick Keith Murray, Bart., of Ochtertyre, has offered the use of the Falls of Barvick, two miles from the town, to be utilised for the motive power for generating the light; and at a meeting of the Council on Monday, Provost Adie urged upon the Board to take advantage of Sir Patrick's offer, and stated that he would shortly lay before the Board a scheme for this purpose.

GUILDFORD.—In June last the Holloway Electricity Supply Company (Limited) gave notice to the Corporation of their intention to apply to the Board of Trade for a Provisional Order, and last week Mr. Sidney Sharp attended a public meeting as representative of the company. He suggested that the company should be formed locally, and that a station should be erected sufficient for 4,000 8-c.p. lamps, the approximate cost of which would be £10,000. The proposal was well entertained by those present, but in order to get a more representative gathering the meeting was adjourned until Monday, when a Committee was appointed to consider the question.

KILLARNEY.—At the last meeting of the Town Commissioners, the contract for the lighting of the town by the gas company came up for signature. The Town Clerk read a telegram he had received notifying him that the matter was to be brought before the Queen's Bench, Dublin, and notice was given of a resolution to be moved at the next meeting of the Board, that the gas tender be rescinded, and the matter of the public lighting be reconsidered. After some discussion it was moved and seconded that the gas tender should be signed by the Chairman, and sealed, but on a division this was lost.

LANDORE.—It is stated that a proposal is on foot to establish in the neighbourhood of Landore large new works for the electrical deposition of copper and other metals.

LEYTON.—The Electric Light Committee reported at the last meeting of the Local Board that, in their opinion, it is not necessary to consider any scheme in detail for lighting the district, or any part of it, by electricity until further progress has been made with the Provisional Order about to be applied for, or such order has been obtained. The Board adopted this report.

NICE.—The electric light installation at Nice is expected to be completed by Christmas.

OYSTERMOUTH.—The Local Board of Health have requested their engineer to prepare and submit to them a report upon the installation of the district with the electric light.

POOLE.—Powers were recently obtained for the construction of an electric tramway between Poole and Bournemouth, and for the supply of the electric light to Poole and Parkstone. An influential meeting of the inhabitants of Poole, Parkstone, and Bournemouth was held last week at Poole to consider whether it would not be more economical to amalgamate these two schemes under one management. After a long discussion the meeting unanimously approved of the suggested fusion.

RAMSBOTHAM.—The Local Board last week decided to make application to the Local Government Board for a Provisional Order.

SMOKELESS COAL.—The City of London Electric Lighting Company (Limited) were summoned last week at Southwark for not using smokeless coal. The defence was that, owing to the coal dispute, the Company had been unable to obtain a supply of smokeless coal for which they had contracted, although they had offered 10s. per ton over the contract prices. It was impossible for them to stop their works without breaking their contract for the electric lighting of the City, and they were compelled to use whatever coal they could obtain. It was hoped, however, that the difficulty in this matter was at an end. The Magistrate adjourned the case for a month, in order to see if the nuisance were abated.

STEALING ELECTRIC WIRE.—At the Glasgow Sheriff Criminal Court on Friday, Walter Burns was sent to prison for three months for stealing 1,260 yards of copper telephone wire on the public road between Govan and Renfrew; and Walter Corbett was sentenced at the Old Bailey on Tuesday to six months' hard labour for stealing 56lb. of copper telegraph wire, which he had cut on one of the Post Office lines.

SUTTON.—Mr. E. C. De Segundo has forwarded a report to the Local Board suggesting that they should put in a small electric light installation for supplying the shops and public buildings in the High-street at a cost for plant of about £4,000. The actual expenses of such an installation he estimates at £500 and the receipts at £830, showing a profit, after paying the interest on the borrowed money, of £210.

SWANSEA.—The Swansea Electric Lighting Order is about to expire, and Messrs. Crompton and Co. (Limited) will apply for a Provisional Order to light the town by electricity.

VENICE.—The Municipality have given permission for electric launches to be used on the canals, and a trial trip was recently made with a launch constructed to carry twenty-eight persons.

WEST HARTLEPOOL.—The Town Council decided at their last meeting to apply to the Board of Trade for a Provisional Order.

WOLVERHAMPTON.—The Lighting Committee of the Corporation in their annual report, laid before the last meeting of the Council, dealt with the question of electric lighting for the borough. The Committee stated that plans and specifications were in course of preparation, and that Mr. F. H. Lewis, the electrical engineer, was in negotiations with the Electrical Construction Company with a view of obtaining a modified tender from them for the plant and machinery necessary to supply electricity for 5,000 incandescent lamps and 40 arc lamps for street lighting, also with Mr. John Thomson for the boilers, and the Callendar Company for the laying of cables, &c. The Council adopted the Committee's report.—It is reported that some extensive engineering and electrical works are about to be erected on the Wednesfield-road. The site consists of between three and four acres of level land, and is in close proximity to both the Midland and Great Western Railways. Details as to the scheme are not yet published; but it is understood that the works will be of an extensive character.

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COMPANIES' MEETINGS.

West India and Panama Telegraph Company (Limited).

The thirty-third ordinary general meeting of the members of this Company was held at Winchester House, on Wednesday, Mr. C. W. Earle presiding.

The ACCOUNTANT (Mr. J. L. Quick) read the notice calling the meeting, in the absence of the Secretary (Mr. R. T. Brown), and he afterwards read the minutes of the last ordinary and extraordinary general meetings. The report of the Directors was taken as read.

The CHAIRMAN then said: Gentlemen, by a strange recurrence of fatality, it happens that this is the third consecutive half-yearly report in which we have had to announce the death of one of the members of this Board which was elected by the committee of shareholders very nearly 20 years ago. I think that those gentlemen—I see some of them present—who took part in the discussions which resulted in the formation of that committee of investigation, will remember that its object was to place on this Board men of practical experience in telegraphic business. At that time I do not suppose there was any man in England, with the exception of my friend, Mr. Andrews, who had such a long experience of every detail of the management of a telegraph company as the late Mr. Weaver. He had filled various offices with the Electric and International Telegraph Company, which was the *principal* owner of the lines working in the United Kingdom before the telegraphs were acquired by the Post Office. I first knew Mr. Weaver when I was a member of that Board in the year 1865, and it was from him that I got what little smattering I possess of the details of telegraphic administration. When the State acquired the telegraphs, they appointed Mr. Weaver as the arbitrator for the Post Office in settling the price at which the railway companies' telegraph lines were to be taken over by the State; and I do not think there could have been a greater compliment paid to his knowledge of the subject and to his integrity than that appointment. Since then Mr. Weaver had had the management of the Anglo-American Telegraph Company, and he discharged the duties of that office up to the time of his death. This Company owes a great deal to Mr. Weaver. His experience and intimate knowledge of his business, coupled with that of Mr. Andrews, and supported by the rest of the Board, was chiefly instrumental, I think, in introducing order and system in place of the somewhat chaotic condition of things in which we found the telegraph service of the West Indies at the time we took over the affairs of the Company. I am sure that we owe Mr. Weaver in many ways a great deal of gratitude for what he did, and I am equally certain that my colleagues, who have known him and worked with him so long, feel very great sorrow that he is no longer with us. The times are somewhat changed since this Board was elected, and the necessity for the telegraph experience and power of organising a telegraph company's system is not so important now as it was then. In fact, the system inaugurated by the gentlemen I have mentioned continues to work well, and our staff are perfectly well acquainted with the ordinary rules of working a telegraph company. We have, therefore, thought it well to strengthen our body in another respect, and have requested Mr. Gerald Balfour, M.P., whose ability and position will be of advantage to us, to join our Board, and he has accepted our invitation. Looking now at the accounts and the report, I think we may congratulate ourselves on having had, for this Company, rather a satisfactory half-year. The normal proper traffic has increased somewhat from the great falling off that occurred through the reduced rates forced upon us in 1891; and owing to an accident to our competitors, the French Cable Company, by the breakdown of their cable between Hayti and Cuba, their traffic came over our line at Martinique, and gave us an increase of about £2,800 during the seven weeks they were interrupted. Another piece of good fortune for us was the diminished expenditure upon repairs of cables, under the head of Abstract C. That is, of course, a mere matter of good fortune. The very large difference between the expenditure in 1892—in which year, you may remember, we charged some £8,000 odd to the reserve fund—amounts to £12,358; and it is rather significant, as showing how risky, how variable the position of a company like this is, with so small a revenue, that the difference between the expenditure on cable repairs in 1892 and in 1893 is equal to about 25 per cent. of our gross receipts for six months. We have thought we could now do for a time, at any rate, with only one ship on the West Indies, and have therefore re-called the "Duchess of Marlborough." We have had this vessel repaired, and she has passed her survey, and is now lying in the West India Docks. I hope it will be long before we require her again; but if, through any interruption or misfortune of that sort, we should do so, she is ready to be commissioned and to resume the work she was formerly employed on. I now come to paragraph 6 of our report. It has long been a source of regret to me, with the very excellent staff we have, many members of which have been 20 years in our service, that we could do so little to improve their position, owing to the very unremunerative condition of our business. As you are all probably aware, the system of insurance has had a very great extension of late years. It is even proposed, I believe, by some statesmen that every one should be insured at the national expense. At any rate, with respect to telegraph companies, which more particularly come under our notice, it has been of late years a very general practice to assist the staff in obtaining the benefits of insurance. I think it will be good policy, as well as justice to the men who have served us so long and faithfully, to help them by some means in view of the time when they come to retire. I cannot say what the cost of the assistance we propose to give them will be—it will depend very much upon how far it is taken up by the staff; but I think I can promise you this, that there will be a good margin between the expense which this will entail and what we have saved by not filling up the two vacancies on the Board. We have, in fact, taken upon ourselves as Directors the additional labour caused by the death of two gentlemen, and we hope you will allow us to spend some part of the saving thus effected by benefiting the staff. If any shareholder wishes to ask me any question I shall be very glad to answer him, but meantime I will propose the following resolution:—

"*That the Directors' report and accounts to June 30, 1893, submitted to this meeting be, and are hereby, received and adopted; and that, as recommended by the Board, dividends of 6s. per share on the First Preference shares, 6s. per share on the Second Preference shares, and 1s. per share on the Ordinary shares—the latter free of income-tax—be, and the same are, hereby declared.*"

Mr. WILLIAM ANDREWS seconded the motion.

Mr. FRY said that he trusted he might be allowed, as a shareholder who had been interested in the Company for a number of years, and who had seen the good work which the Directors had done, thoroughly to endorse the remarks which the Chairman had made with regard to the loss sustained by the Company through the death of Mr. Weaver, who was believed in by all the shareholders in their Company, and in any other Company with which the deceased gentleman was connected. In their report the Board said that to fill the vacancy created by Mr. Weaver's death they had elected Mr. Balfour, "under the powers given to them by the Articles of Association." He desired to ask whether Mr. Balfour had been interested as a shareholder in the Company for any time, whether he represented any large interest in the Company, and whether he had any connection with any other telegraph company.

Mr. R. J. KING also expressed regret at the death of Mr. Weaver, whose value, he said, the Chairman had set forth most truly, and whose experience in the telegraph world must have been inferior to that of no one. He grieved to think that the Company had not suffered only a single loss, but that three deaths had taken place among them since the reconstituted Board was formed. The deceased gentlemen were distinguished members of the telegraph world, and had no doubt, as the Chairman had stated, been of essential service to the Company in extricating it from its difficulties and putting the shareholders into the comparatively comfortable position in which they now found themselves. With regard to the election of Mr. Balfour he also desired to know, like the shareholder who had preceded him, whether Mr. Balfour had any knowledge of telegraphy. Although the Chairman had said that the particular knowledge which was once necessary for the Company was now of less importance than it was when the reconstituted Board took office, he (the speaker) thought it desirable that the Directors should be gentlemen knowing something about the conduct of telegraph companies. He had not the pleasure of knowing anything about Mr. Balfour, but he trusted, for the sake of that gentleman himself, that he was no connection of the man whose name had become so thoroughly obnoxious to all respectable citizens. He congratulated the Company on the progress it was making, notwithstanding the difficulties against which the Directors had to contend. The French competition and other disappointments, and the loss of subsidies, were serious, but he thought they had reason to congratulate themselves on the fact that the skill of the Board had enabled them to devise means in some degree to counterbalance the losses thus sustained. He only hoped that they would continue to progress.

Mr. W. GRIFFITH thanked the Chairman for the lucid statement which he had made to them, as the figures alone would not have given the shareholders so clear an understanding of the position of the Company as the addresses they had listened to had done. The Chairman had taken the shareholders into the confidence of the Board, and he thought they might say that their Company was in a sound state, although, at the same time, they had a somewhat gloomy prospect before them. The fact that they had not yet recovered the losses which occurred from the diminution of the subsidies showed, he held, that they had been almost too liberal in regard to their tariffs. The West India islands were greatly indebted to the Company for what it had done, and yet, although its traffic fell off, and the dividends of the shareholders were likely to become less, they found their subsidies decrease. With reference to the proposal that they should consider the services of their old servants, he thought that the Directors would have the shareholders at large with them in what they suggested. Other telegraph companies had adopted a similar course, and he thought it was wise, in these days of competition, that they should retain in their service able and faithful men, and that the latter should have the prospect of a competence in their old age, and not be distracted in the performance of their duties by having to consider their wants hereafter. The details of the scheme required consideration, and if the Chairman could furnish them with some of the details beyond the general statement he had made, that the expense would be somewhat less than the income of two of the deceased Directors, the shareholders would be able to form some opinion of the matter. Beyond that they need not go on that occasion. He hoped the servants would be liberally treated, and that the Company would retain their services. He would like to know whether it was proposed that the insurance of the staff should be effected with one office only, or with various offices. He believed the latter system would be best, as in that way the Company might increase its *clientèle*.

The CHAIRMAN: I am rather sorry that the question of the appointment of Mr. Balfour has been raised, because it is a matter we discussed a great deal at this Board, and we saw very good reasons for asking him to become a Director. As I said, we do not now want the organising talent which we required in 1873 and 1874. The system has got into perfect order, it works uniformly, our servants are all experienced, and we have still on the Board Mr. Andrews, who is quite as capable in these matters as was

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the late Mr. Weaver. There are, however, other points in a man of Mr. Balfour's position which are of importance to us, and I trust that you will not exact from me more upon this matter than I am now stating. You may depend upon it that the request which was made to Mr. Balfour to join our Board was done in the best interests solely of the Company whose affairs we have to administer. There are questions with the Government, in regard to which the mere technical knowledge of telegraphy would not be so valuable as the services which a man in Mr. Balfour's position may render to us. Of course, he is no connection with Jabez Balfour. He is a brother of the leader of the Opposition in the House of Commons. With reference to the question of insurance, we have not yet thrashed out the details. We shall go to a good many offices, and the one that we get the best terms from, being a reliable office, we shall probably adopt.

Mr. ANDREWS: You always get better terms in that way.

The CHAIRMAN: Yes, the terms are always better if the business is given to one office.

Mr. FRY said he assumed that Mr. Balfour represented no other interest on the Board, and that he was quite a fresh shareholder.

The CHAIRMAN: He has been an old shareholder, but he was not a shareholder at the time he was asked to join the Board. I may remind you that the gentlemen who were appointed by the committee of investigation were non-shareholders at the time.

Mr. FRY said that among the shareholders there were several who were largely interested in the Company who were thoroughly capable men of business, and who might be appointed Directors when the necessity arose.

The CHAIRMAN: I think you must allow us to deal with matters of this sort as we think most advisable in the interests of the Company. He then put the resolution, which was carried unanimously.

On the motion of Mr. KING, seconded by Mr. CHURCH, a cordial vote of thanks was passed to the Chairman and Directors for their able management of the Company's affairs.

The CHAIRMAN: We are very much obliged to you for your vote of thanks and your testimony that you approve what we have done. I am quite sure that we shall continue to do all we can to promote the interests of the Company as long as you give us your confidence.

The proceedings then terminated.

Western and Brazilian Telegraph Company (Limited).

The twenty-sixth ordinary general meeting of this Company, was held yesterday at Winchester House, Old Broad-street, E.C., under the presidency of Mr. W. S. Andrews.

The SECRETARY (Mr. R. M. Cunningham) read the notice calling the meeting and the minutes of the last general meeting, and the report of the Directors was taken as read.

The CHAIRMAN: I must ask you to excuse me to-day if I am not over clear, because I have rather a sore throat, which renders it a little difficult to explain matters as one would like to do. In referring to the accounts for the half-year we will first of all, as usual, deal with the receipts. They amounted to £79,370, and they compare with £84,022, showing a decrease of £4,648. I will remark upon the question of the traffic a little later, and will pass on to the expenses, which amounted to £43,424, compared with £39,140, showing an increase, apparently, in one sense, of £4,285. Well, it appears, on the face of it, somewhat unsatisfactory that there should be a decrease in revenue and an increase in expenses, but I think I shall be able to show you before I have gone very far that that points in one respect to a very satisfactory position in your affairs, and considerable improvement in the stability of your Company. I do not know whether you would like me, as usual, to go through all the items making up those figures. I shall have pleasure in doing so if you like, but as respects more particularly the staff expenses I cannot throw any light upon the position, because you are all aware of the reason why there is an increase in those expenses; and they account for £1,881 out of the increase, leaving only a difference of £654. That again is pretty well accounted for by the fact that we sent out stationery to the amount of £576 more. This is always a variable item, and, as I have explained before, we send it out in large quantities in order to avoid the recurring expense of carriage, &c. The indents were particularly large last half-year, and as a matter of fact, a lot of that stationery remains. You have to work it off, and that consequently means that we shall be spending somewhat less in this direction in connection with demands coming forward in the next few months. Apparatus accounts for an increase of £42, which is ascribable to the new lines; and travelling expenses account for about £54 more. There you really have the whole of the increase in these items. In other respects there has been a little economy, but I do not know that I need labour these figures any more. Then comes the question of the ships. On the question of the staff, of course, the new scheme, so to say, is in operation—the cables are now laid and being worked. With respect, however, to the ships, that is not the case. The changes were all going on in the last half-year, and for a time we were compelled, in carrying out the policy of the company to have three ships on the station in order, ultimately, to be able to do with one ship. On the "Norseman" there is a decrease of £1,038, because she was taken out of commission on the 13th of March. There is a slight increase in her coal. On the "Viking" there is an increase of expenses, because during the corresponding period she was out of commission for a considerable period, and that makes £1,735 on that account. On coals in the case of the "Viking," there is an increase of £341. Then come the items of the new ship, including her fitting up, &c., £4,205, and coal £769. The total result of the reductions and the increases is an advance of £1,845. With respect to Abstract "C" there was a considerable diminution of expenses. Abstract "C" deals with the expenses in London, and there is a saving there of some £230. That is satisfactory to you, I know, because you always look very narrowly at the London expenses, and therefore abstract "C" comes out all right. Of course, both with respect to the staff and with respect to these ships these figures, although, as I began by saying, somewhat unsatisfactory in themselves, embody the result of a policy which has been that of the shareholders as well as that of the Board, and I think that in view of that fact we ought just to look at the position which has been brought about. Now, what was the object with which these loop cables were laid? It was to avoid interruptions, to keep the traffic together by preventing interruptions—I will refer to this later on—and to enable us ultimately to do with one ship. You will observe from the report that these objects have been secured. There has been since these cables were completed between Pernambuco and the River Plate not one single interruption. You may remember that we said to you when we recommended this policy that the interruptions would be very much less by its adoption—that you would probably not suffer from so many; but on this particular occasion I am very pleased to say that you have not suffered from any. Then there is at present, and has been now for some little time, only one ship in commission on the South American coast. Therefore the policy as respects the ships, as far as we can see, is also a success. Having, however, achieved these two points—having successfully carried out your policy with respect to the ships and the interruptions—we ought to look a little further. In providing the loops and the duplex of the new cable, we had, of course, certain objects too, and those objects were to enable us successfully to meet the numerous competitors that were in the field, to do our work well, and to hold the traffic together. Well, it would be manifestly useless to have an additional cable, with a duplex arrangement—which practically makes three circuits instead of the one originally—without providing the staff to meet them, and consequently the staff had to be provided, and therefore the expenses on that account were increased. Now, have we held the traffic together; have we succeeded, without more damage than might have been expected, in facing these various competing lines, which at one time appeared to be springing up from every quarter of the globe almost? Well, the work has been done in such a satisfactory manner—I do not mean to say it is from that fact alone—but the work has been done in such a manner that there is not only no diminution in it, but, with all this competition, we have actually 12½ per cent. more words. It is quite true that the 12½ per cent. more words has produced less money owing to competitive rates, because the rates have had to be lowered owing to the shifting of the traffic and the bad exchange. All of you know that a milreis is now worth about 10½d., instead of, at par, 27d. That is a considerable difference, and it is a thing we cannot avoid. But let us look a little further. I daresay that you are thinking, "We have spent a great deal of money but we are not getting any dividend." Well, I quite admit the reasonableness of the idea, but let us follow it out a little further. Let us suppose that these measures had not been taken, and that you were richer by the reserve fund, what would have been the position? Why, all these causes for the diminution not merely of your receipts but of your traffic would have remained. You would not have averted one of them. You would still have had all this competition; only if you had been weak you might have had more of it. In addition to that you would have had the same exchange. But you would have had a good deal worse, which we used to suffer from when we got no dividend at all, and when the position of things was so precarious—that is, the total interruption from mechanical causes of your line. Your line being only a single cord, if it were broken in one point, beyond that point you could get nothing and send nothing, and therefore the loss would have been very great indeed. You would have had a smaller share of the traffic, and your position would have been worse than it now is in every respect. I have seen an analysis in a newspaper of the accounts—evidently inserted by a friendly critic—of one of these opposing companies. Well, that opposing company has not been able to earn sufficient money to pay its expenses, and it went back, either last half-year or the half-year before it, by something like 76,000 francs, and it is not making provision to meet accruing liabilities—providing amortisation funds, and so on. This is pretty much what we ventured to forecast. We said that some of these concerns might damage existing interests, but that they would not benefit themselves. That is an instance in this case of our accuracy. Of course, the shareholders there whose money was secured for such a speculative venture are not alone getting no return for it, but they see their capital dwindling away and the liabilities on their debentures, &c., coming forward. Our position is this: that we have retained our traffic, increased it, in fact; and we only need a restoration of order—I will not say peace—in Brazil, for the encouragement of enterprise and the probable establishment of exchange upon a reasonable footing, to become again a remunerative enterprise. You see what you have lost. Independently of all these political matters—the exchange, and so on—the only thing you could lose would be traffic, but you have not lost it. On the contrary, you have had an increase, as I have said, of 12½ per cent. Therefore, as far as the working of the concern goes, it has been quite as successful this last half-year, only that the work it has done has not produced the same money. The shareholders are aware, as everyone is, of the troubles in Brazil—I am speaking now more particularly of the current half-year; and what has occurred throws rather a strong light upon the recommendation of the Board that there should be no dividend. During the current half-year message work was entirely suspended on our lines by the Government of Brazil from the 6th to the 18th of September. That suspension was then withdrawn with respect to messages in plain language. I need not, however, tell you that when merchants and others who have arranged the whole of their business for about 25 years upon the system of coding—which has been the universal telegraphic language of the world—when they are told suddenly (because no notice

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whatever was given of this), "You cannot send any more code messages," such an intimation must very much impede the transaction of their business, and must very much discourage telegraphic communication. Following upon that again, the Government prohibited communication with the Santa Catarina office in Brazil. Later on the Mello Party got possession of Santa Catarina, and they were so obliging as to seal up our office and the instruments. Then, only yesterday, I am sorry to say we got another notice—namely, that the Government of Brazil had suspended communication between Pernambuco and Rio for internal Brazilian messages. That last bit of news had not come at the time of our decision as to dividend; but, in face of our knowledge of what had occurred previously, I think you will all agree that under such circumstances, if the Directors, who call themselves men of business, had "stretched a point" —although Directors are always anxious to please shareholders—they would on this occasion have been very severely to blame. The present state of things throws an extremely lurid light on possibilities. These suspensions of communication that have taken place might go further, and we might be, without the power to hinder it, in this position—that we should have practically no revenue, and that our expenses would be going on. Well, you know we had our reserve fund, but you are aware that that has gone into cables, shipping, and various things, and, therefore, that is not available, and the only thing that is available, in the event of anything of this sort occuring—though I fervently hope that nothing of the kind will take place, although it is not in our power to prevent it—but in case of anything of that sort occurring, the only safety you have is in the money we have got in reserve. We have £19,000 to guard us against the contingency of a total absence of revenue. I do not think I need say one more word on that point, because I am satisfied—at least I hope it is so—that you will agree with me. Our Company is not in a position to be able to save itself from all these causes and consequences. We have laid cables in Brazil and we are there. If Brazil is at war, if she has a revolution, if any of these unpleasant things occur, we cannot button up our coats and walk off and say it is no concern of ours. We must do our best to make the position as little hurtful as we possibly can. You heard what I have said about interferences with our cables in the current half-year, and you will see from that that there is a great probability of our doing worse. I like to be always plain and open with you, and that you should know as much as I do about your position. You will have gathered from what I have said that the receipts are not so satisfactory, and neither are they. If they go on at the present rate they show that we shall be £9,000 worse off than we were during the half-year I am now talking about, so you see that for the moment, until there is a great change in the political position in Brazil, your position is not a satisfactory one. The key note of our position is the political position in Brazil and the state of the exchange. If those evils are cured, *ipso facto*, with your existing traffic, you would be doing exceedingly well. It is nothing else but that. There is one little gleam of sunshine—it rather regards the future than the present. You know that the cables which have been laid have not exhausted the competitive schemes by which we were surrounded. There was still one of them left, and a formidable one—the project to lay a cable from Rio direct to the River Plate, so as to tap all our Brazilian trade. I am pleased to say that that is averted, and we have got the boot put on the other leg. If there is to be such a cable laid at all we are to have the first chance of constructing it; but no cable is to be laid unless it can be proved that the Government lines, which are working in the interior of Brazil, and the lines of this Company are absolutely inadequate to carry the traffic, a position which will not arise, I think, for a good many years. No such line as that is to be laid, however, except in that eventuality. We have done that for you, and that excludes the only line, as far as I can see, by which we were threatened. I therefore hope that we have bottomed these competitions, although we cannot make an absolute statement on the point. I think I ought now to say a word about our staff. You know, of course, that they are eminently men of peace, engaged, as they suppose, in a peaceful avocation, and doing peaceful work. Well, it is a little alarming to such men to find shells exploding in front of their office doors; it is a little alarming for one of them to be hit, and to feel that the bombardment which produces these effects is going on from day to day without his knowing what its results may be. I am sorry to say that we received a telegram a few hours ago to say that one of them, a porter, had been killed by a stray shot. I think that, under the circumstances we ought to feel that these men have done very well in sticking to their posts, and that, without concerning ourselves with any formal resolution, they deserve an expression of the feeling of the meeting. (I am very pleased to hear that intimation of your approval.) There is not very much more for me to say. I made a note to say that our affairs are wrapped up with the prosperity of Brazil, but that is a truism. With respect to the new ship, she works exceedingly well, and has already rendered us eminent services, which go far to repay a considerable portion of her cost. We have every reason to anticipate, from our experience up to the present time, that this ship will be capable of keeping our system in good order without the assistance of a second ship. There will therefore be an economy in the working of that department. The "Norseman" will settle down presently; we shall ascertain her lowest working cost, and shall bring that to bear. Then, after the 31st of December, when the transition period ceases—because there were certain engagements which could not be got rid of at twenty-four hours' notice—there will be a considerable saving in certain expenses connected with the other two vessels, the lying up of which in dock will cost us little. As respects Brazil, our service there, as you may judge from what I have said, is rather exceptional. We do our utmost to keep expenses down there, but what with the exceptional climatic character of the coast, and the expensive regions we have to do our work in, the expenses are higher than we like to see them. We keep them as low as we can, however, and we shall continue to do so. I think I may now conclude by moving—

"*That the Report and Accounts to June 30, 1893, now submitted, be and are hereby approved and adopted.*"

Mr. C. W. EARLE seconded the resolution.

Mr. PETO stated that he had attended many of the meetings of the Company, and it had nearly always been his pleasure to express his satisfaction with the accounts. On the present occasion, however, the non-payment of a dividend had come upon them with very great disappointment. So far as he was personally concerned, he spoke quite disinterestedly, as he held only Deferred shares, but he represented a large number of holders of Ordinary and Preferred shares. The payment of no dividend in such times as these was very hard on those people. He agreed that the position of the Company was very much better than it ever was before, and he recognised that the Directors had had a very anxious time. It was in no hostile spirit that he proposed an amendment to the effect that a dividend of 3s. a share, free of income-tax, should be paid for the half-year ended June 30th.

Mr. ENNIS seconded the motion, and ventured to think that the views expressed by the Chairman might be too pessimistic.

The CHAIRMAN pointed out that the amendment was inadmissible in the form in which it had been put.

The SOLICITOR stated that according to the Articles of Association no larger dividend could be declared by the meeting than that recommended by the Directors.

The CHAIRMAN said that the Directors had very carefully deliberated on the subject, but, although they were most desirous of declaring a dividend, they felt that, as prudent men, they could not do so. It had been said that his remarks had been unduly pessimistic, but he thought that that could not truly be said in view of the fact which he had pointed out, that the Government had actually stopped their whole lines. He might state that they had received considerably more proxies on the present occasion than they did last time when they paid a dividend. Reference had been made to the value of the continuity of dividend, but there was something a good deal more important than that, namely continuity of communication and continuity of credit. If they paid the dividend suggested, and found out that they had exceeded their margin, they might have to borrow money, supposing they could do so. But what was to be the condition of things in Brazil a day, a week, or a month hence? and how were they likely to be able to borrow money if the state of things was such that people coming to the Company's offices found that they could not send a message? Having very carefully considered the whole question in conjunction with the other Directors, and including their latest member (Mr. J. Coppen)—having all of them given the utmost consideration to the question—they deliberately, although reluctantly, came to the conclusion they had arrived at. The shareholders, as business men, must know that the Directors—who were in no way responsible for the existing state of things—were doing the very best they could.

Mr. FRY suggested that the sum of £5,000 should be put to the reserve fund, and that a larger balance should be carried forward.

The CHAIRMAN stated that there was no power for the shareholders to act upon such a proposal. The money had been put to the reserve fund by the Directors and could not be taken out.

Mr. FRY afterwards contended that the Directors ought to reduce their fees, and that the Managing Director's remuneration was too heavy. He objected altogether to managing directors in telegraph companies. The Directors' qualifications ought also, he argued, to be increased.

The CHAIRMAN stated that no board of directors that he was acquainted with had a larger holding than the former Directors of this Company when it was on the high road to the Bankruptcy Court. He had never yet found—and there were reasons which told the other way—that very large shareholders were the most fitting men to put on boards as directors. He regretted that the discussion seemed to imply that the directors were not doing their best, although the policy which had been proposed and approved by the shareholders had all been carried out, with results successful in every direction. In answer to Mr. Dyett he added that no Director of the Company held less than his qualification, according to the Articles of Association. The clause in the Articles dealing with this matter was not the present Directors' clause, it having been proposed by their predecessors, who had the enormous holdings he had mentioned, and under whose management the Company was going rapidly to a very unpleasant place.

Mr. FRY: Would it not be a good thing to have this clause altered?

The CHAIRMAN: There is not the least objection to that.

Mr. BAKER also complained of the non-payment of a dividend in the present dreadful state of things, financially. If the Directors did not think that a dividend could be paid they ought, he held, to set about reducing expenses. He did not think that a managing director was wanted at such a heavy salary.

Mr. JOHN COPPEN addressed the meeting at some length and warmly defended the action of the Directors in not declaring a dividend. They very much regretted this course, but they were not philanthropists, and must look at the question from the hard standpoint of business. The remarks regarding the Directors' remuneration could not have been made at a more unfavourable time than the present. It was absolutely necessary for them in their business to have a managing director, who had most responsible duties to fulfil, and who, like the Secretary, and all the Directors, had done their utmost for the Company.

The CHAIRMAN stated that Major Wood was a most efficient, zealous and able officer.

Major WOOD (the Managing Director) reminded the shareholders of the former position of the Company, when Mr. Cunningham and himself had to "back" its bills to keep the Company from going into bankruptcy. He had rendered them valuable services in the past, although he was aware that he had made himself unpopular with certain gentlemen, whose business it was to buy and sell shares, owing to his openly

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expressed regret at the high prices which some persons in the past had paid for the Company's shares.

The resolution on being put to the meeting was carried with a few dissentients.

On the motion of Mr. ENNIS, seconded by Mr. BAKER, a vote of thanks was passed to the Chairman, and the meeting then terminated.

Electric Construction Company (Limited).

The Statutory meeting of this Company was held yesterday (Thursday), at the Cannon-street Hotel, Sir Daniel Cooper, Bart., presiding.

The SECRETARY (Mr. James Gray) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, this meeting has been called in compliance with the provisions of the Limited Liability Companies Act, which directs that a meeting of the shareholders be held within four months of the registration of the Company, and we have no formal business to submit to you; but we are glad to have this opportunity of informing you as to the position of the Company. I will do so generally, and our Managing Director (Mr. Garcke) will give you some further information as to the business we are doing, and how the work is going on at Bushbury. I am happy to inform you that the reconstruction of the old Company into the new has been carried out with complete success. Practically all the debenture-holders of the Corporation have accepted corresponding debentures of the Company, and the Directors feel obliged to them for their confidence, which I believe they will find has not been misplaced. As regards the shareholders, only two holders of 55 shares decline to accept the new shares instead of the old, and the reconstruction may, therefore, be said to be complete. We have applied to the Stock Exchange for a quotation for the new shares, and, as we have supplied them with full and, as we believe, satisfactory information on all points, we hope that the quotation may soon be granted. Then we have succeeded in re-establishing the credit of the Company, and are in consequence able to do business on more advantageous terms than was possible in recent years. We have therefore, so far, every reason to expect that we shall be able (next autumn) to submit a satisfactory report to you of the year's transactions. Since our last meeting the Board has been strengthened by the addition of Mr. Philip Edward Beachcroft, who on our invitation accepted a seat at the Board. He represents the Trustees of our First Mortgage Debentures and also large holdings of shares. Mr. Garcke will now give you some information respecting the business of the Company and the work it has turned out and is now engaged upon.

Mr. EMILE GARCKE said: I am aware that it is not necessary that I should take up much of your time on this occasion, as it is only four months ago that I made a full statement to you on the affairs of the Company. When I had the pleasure of addressing you as shareholders of the old Company on July 5th, I explained in some detail the financial position of the Company, and I gave you a description of your various assets. I told you that there was still much to be done before we should be in what we considered a thoroughly sound financial and commercial position, but I told you also that many of our investments were of such a character that, if properly developed and taken care of, they promised, not only to become more valuable, but also to have the effect of largely increasing the business of the Company. I also told you that prior to the reconstruction the Company was suffering both in name and credit, that we had difficulties in competing fairly with others, and that we did not get the full benefit of the good work we had done or were doing; and I explained that if the reconstruction were carried the prospects of the Company in these respects might be expected to improve. I now wish to indicate generally how far these anticipations have been realised in the four months which have since elapsed. The financial position has greatly improved. We have taken steps to realise some of the securities in which so much of your money is locked up, and the credit of the Company now stands on a much firmer basis. Of course these changes can only be accomplished slowly, and four months is not a long period in which to do very much in such matters, but so long as our progress is sure and on right lines, we must not complain. The business, as you are aware, was taken over from the old Company as from July 1st, and that is the date from which the profit and loss account of the new Company will start. Since then, notwithstanding the general depression in trade, we have not done badly in the matter of orders. Our orders are I believe fully up to the average of previous years, and we ought to have a satisfactory profit upon these orders, but until our books are closed I cannot speak with certainty as to the result of work still in course of execution. In discussing this question of profit it must not be forgotten that we have very extensive works equipped for carrying out more extensive orders than we have yet obtained; and we all know that when factories are only partially employed the work is not so economically done as when the plant and staff are working up to their fullest capacity, for the standing charges and expenses of management are the same, whether we do much work or little. With regard to the various subsidiary companies in which so much of our capital is invested, our policy has been to assist them into a sound position, and to do this without prejudicing the parent Company, and without adding to our responsibilities, our policy being to liquidate outstanding liabilities and to reduce our responsibilities. I mentioned to you that we looked forward to the development of electric traction with much hope, and that our investments in this direction would help us to get further business. I am glad to say there are good reasons for believing that these anticipations were well founded. The work which we have done in the field of electric traction, not only in South Staffordshire, but in Liverpool and other places, is the best recommendation we can have. Numerous engineers and representatives of local authorities have been to inspect our work, with the result that we have secured some contracts, and are at present negotiating for several others. With regard to electric traction we have acted as pioneers in this country, and having done good work, are in the best position to undertake successfully large contracts of this kind. It will interest you to know that a company has been formed in America, under good auspices, to manufacture electrical apparatus of our design. We have not put cash into this business, but agreed to assist the Company with particulars of our inventions, designs of our machinery, and to give them the benefit of our experience. In consideration of these services, they will assign to us an interest in their company. With regard to electro-chemistry, I mentioned at the last meeting what our views were of this department of the electrical industry, and I am glad to say we are negotiating with several parties for the working of some of the electro-chemical patents in which we are interested. Other people are giving their attention to this subject, but I cannot find that any of them are ahead of us. Our technical staff have been working at these matters for many years past. They have achieved success before in this branch of electrical science, and believe that in the electro-chemical inventions now developing we have some good things. In other branches of electricity I believe I am right in saying we get our fair share of orders. Of course one firm cannot be pre-eminent in everything, and I am glad to recognise the good work done by other firms. We for our part are entitled to take credit for having done a great deal to demonstrate the capabilities of electrical apparatus and the reliability of electrical processes, and my great encouragement with regard to this Company is that its technical work is sound and beyond reproach. The working of the Overhead Railway at Liverpool is a revelation to electrical engineers in this country, and the economy with which we are running the electrical cars in South Staffordshire will, I believe, suggest a new future to many tramways which at present are working with horses or steam, but without dividends. You will, no doubt, ask what bearing all this has upon your dividends, and I want to assure you therefore that while we shall do whatever we can for the commercial development of electrical science, we shall not as a Company do any work or take any contract which does not promise to yield a fair profit to you. You will recognise that in such a business we cannot give you the actual results of the four months' working, but when the time comes for closing the books and making up the balance-sheet we have no doubt that we shall be able to show you that we have made satisfactory headway, and that our operations have been carried on at a profit, but whatever the position may be you may rely on our taking you fully into our confidence, and that we will let the balance-sheet of the new Company fairly represent its position. For myself I have confidence that we shall be able to show you that we have a sound business containing the elements of success, and that with careful management and strict economy we may reasonably look for a prosperous future. (Applause)

This concluded the business of the ordinary meeting.

An extraordinary general meeting was subsequently held for the purpose of considering resolutions proposing certain alterations in the Articles of Association.

The CHAIRMAN said the alterations embodied in the resolutions were made in compliance with the wishes of the Stock Exchange Committee. The changes were simple and intended to give to shareholders more control of the Company, and the Directors were very pleased to co-operate with the Committee of the Stock Exchange in this direction. The Chairman then moved the first resolution, viz.:—

"1.—*That Article 60 of the Articles of Association of the Company be amended by substituting the words 'one-tenth' for the words 'one-fifth' in the fourth line thereof.*"

The Article will then read:—"The Directors shall call an extraordinary meeting whenever a requisition in writing signed by not less than one-twentieth in number of the members of this Company, holders in the aggregate of not less than one-tenth in amount of the capital then issued and paid up, and stating fully the general nature of the business for which the meeting is proposed to be called, shall be delivered to the Secretary or left at, or sent by post to, the office."

Mr. BARCLAY seconded the resolution, which was carried unanimously.

The CHAIRMAN next moved:—

"2.—*That Article* 135 *of the Articles of Association of the Company be amended by adding at the end of the Article the words 'and a copy of such balance-sheet and report shall be sent out, seven days previous to the general meeting, to those shareholdrs entitled to receive the same.'*"

The Article will then read—"Once at least in every year the Directors shall lay before the Company in general meeting a proper balance-sheet and profit and loss account for the past year, made up to a date not more than four months before such meeting, and a copy of such balance-sheet and report shall be sent out, seven days previous to the general meeting, to those shareholders entitled to receive the same."

Mr. BARCLAY seconded the resolution.

Mr. HANCOCK thought it a disgrace to the Directors and the Solicitors of the Company, knowing so well what the requirements of the Stock Exchange were, to allow Articles of Association to be drawn without making provision for a statement of accounts to be sent to the shareholders seven days before the date of the general meeting. In the Articles of all companies such a provision was usual, and it was not right that such an omission should have been made in this instance. He was exceedingly pleased that the Stock Exchange Committee had refused to give a quotation to the shares of the Company without such a reasonable and proper condition being provided for.

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The CHAIRMAN, in reply, said almost every set of Articles were amended by the Stock Exchange Committee when an application was made for a quotation. The Company's solicitor (Mr. Harold Brown) was one of the very best solicitors in London for work of this kind.

The resolution was then put and carried unanimously.

A vote of thanks to the Chairman and his colleagues concluded the proceedings.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, pages 320-348, *&c., &c.*]

ANDERS' TELEPHONE COMPANY (LIMITED).—This Company was registered, on November 13th, with a nominal capital of £10,000, in £1 shares, to acquire all the following English patents:—No. 1,637 (1892), for "Improvements in and connected with telephones"; No. 5,712 (1892), for "Improvements in and connected with diaphragms of telephones"; No. 12,528 (1892), for "Improvements in telephonic apparatus and switches"; and No. 20,610 (1892), for "Improvements in telephonic circuits": to acquire, develop and turn to account other patents and inventions connected with improvements in telephones or telephonic apparatus, telegraphic apparatus, electric lighting, &c.; and to carry on the business of electrical engineers, and manufacturers of, and dealers in, telephones, telephonic apparatus, electric lamps, &c. The signatories (with one share each) are:—M. F. Barthelness, 158, Fenchurch-street, E.C.; J. Limberger, 83, Underhill-road, S.E.; G. Francke, 106, King's-road, Camden-road, N.W.; W. Seward, 22, Haldon-road, Wandsworth, S.W.; W. Heynemann, 50, Beresford-road, N.; R. W. Hutchison, 6, Mansfield-terrace, Milwall, E.; R. H. Wedekina, Ferndale, Shortlands.

EDINBURGH TRAMWAYS COMPANY.—This Company has been registered in Edinburgh, with a capital of £125,000, in £5 shares, to enter into and carry into effect an agreement with Dick, Kerr and Co. (Limited) to undertake and fulfil the obligations of the lease in that agreement, and also to acquire and work the tramway mentioned in it, or any other tramway within the burghs of Edinburgh, Leith, Portobello, or within a radius of 10 miles of the Register House, Princes-street, Edinburgh.

MADRAS ELECTRIC TRAMWAYS COMPANY (LIMITED).—The first annual return of this Company, made up to October 13th, has been filed. The nominal capital is £100,000, divided into shares of £1, or Rs.15, each. 78,792 shares (of which 34,077 are £1, and 44,715 are Rs.15) have been taken up, of which 19,650 £1 shares have been issued as fully paid. Upon the remaining 14,427 £1 shares a call of 10s. per share has been made, while upon the 44,715 Indian shares a call of 9s. 4d., or Rs.7, has been made, resulting in the payment of £,19,544. 19s. 8d. (England £7,192. 5s., India £12,352. 14s. 8d., or Rs.185,291).

MERVEILLEUSE ELECTRIC ARC LAMP SYNDICATE (LIMITED).—The statutory return of this Company, made up to October 11th, has been filed, and shows that out of a nominal capital of £15,000, in £1 shares, only the seven subscribers' shares have been allotted, these being issued as fully paid. By an agreement dated April 20th the Company through its agent, Alfred Conder, acquired from Emilio Zaccani the invention, provisional protection (granted February 28, 1893), and all patent and other rights in respect of the electric arc lamp "Merveilleuse," in consideration of the sum of £13,000, payable £4,500 in cash, and the remainder by the allotment of fully-paid shares. By an agreement made November 1, 1893, the Company adopted the preliminary contract, and allotted shares in part payment of purchase consideration.

MIDLAND ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return of this Company, made up to October 11th, has been filed. 3,139 shares have been taken up out of a capital of £50,000, in £10 shares; 3,132 have been issued as fully paid, while the full amount has been called and paid on the remaining seven shares.

MINERS' LAMP ELECTRIC LIGHTING COMPANY (LIMITED).—The usual return for 1893 of this Company, made up to October 9th, shows that with a capital of £3,000, in £5 shares, 301 have been subscribed for, of which 190 have been issued as fully paid. Upon the remaining 111 shares the full amount has been called, resulting in the payment of £550.

NATIONAL TELEPHONE COMPANY (LIMITED).—The annual return of this Company, made up to August 1st, has been filed. The nominal capital is £4,000,000 divided into 15,000 First Preference £10, 15,000 Second Preference £10, 250,000 Third Preference £5, and 490,000 Ordinary £5 shares. All the First and Second Preference, 119,234 of the Third Preference, and 484,597 of the Ordinary shares have been taken up, and 35,028 Ordinary, and 28,284 Third Preference shares have been issued as fully paid. Upon the remainder the full calls have been made, resulting in a payment of £3,002,595.

OTIS ELEVATOR COMPANY (LIMITED).—The statutory return of this Company made up to July 31st has been filed; 2,000 shares of £10 each have been taken up, of which 650 were issued as fully paid. The remaining 1,350 shares have had a call of £4 per share, resulting in a total payment of £8,100.

PACIFIC TELEGRAPH COMPANY (LIMITED).—The return of this Company for 1892, filed on October 23rd, shows that only 18 shares have been taken up out of a nominal capital of two millions sterling, in shares of £10 each. The full amount has been called on these shares, resulting in the payment of £130 and leaving £50 unpaid.

SALT LAKE AND OGDEN GAS AND ELECTRIC LIGHT COMPANY (LIMITED).—An agreement made October 6, 1893, between John E. Condict, of Salt Lake City, Utah, U.S.A., and this Company states that the Company agrees to purchase from the vendor 5,000 Preferred and 7,997 Common shares of stock of $100 each in the Salt Lake and Ogden Gas and Electric Light Company, a concern formed under the laws of the State of New Jersey, U.S.A., and in consideration therefor has allotted to the vendor 259,940 Ordinary shares.

CITY NOTES, &c.

ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT.—The eleventh annual report of the Directors, to be presented to the general meeting to be held in Berlin on the 28th inst., commences with a review of the financial progress of the Company during the ten years it has been in existence. It was founded in May, 1883, as the Deutsche Edison-Gesellschaft für Angervandte Elektricität, with a capital of M.5,000,000, which has been several times increased until now it is M.20,000,000; and the average dividend paid, including that proposed for the last year's working, is 7·62 per cent. The report reviews in succession the progress of business at the Company's various branches and agencies, and gives particulars of the 14 electric tramways it is working or which are in progress. Referring to the Electrical Company, in London, which has been reorganised, the report says that 80 per cent. of its capital of £15,000 has been called up, and the Company is now beginning to reach the English market, which is extremely difficult to cater for. The Directors congratulate the shareholders on the prosperous condition of the Company, and propose to pay a dividend for the year 1892-1893 of 8½ per cent.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended November 12th were £909, as against £945 for the corresponding period of last year, being a decrease of £36. The total receipts for the half-year amount to £15,546, against £15,345 in the corresponding period of 1892, being an increase of £201.

COMMERCIAL CABLE COMPANY.—The Committee of Awards at the World's Columbian Exposition, Chicago, has granted to this Company the only two awards issued for improved apparatus and system of working submarine cables.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY (LIMITED).—Notice is given of the drawing of 345 £100 Five per Cent. Mortgage Debentures of this Company, for payment at par, on January 1st next, by Messrs. Barclay, Bevan and Co., 54, Lombard-street, E.C., and interest on which will cease on January 1st. The list of bonds is set out in our advertisement columns.

PANULCILLO COPPER COMPANY (LIMITED).—A meeting of this Company is to be held at Winchester House on Friday next, the 24th inst., to consider a proposal for the sale of the Company's property and under taking, and, if this is agreed to, to pass a resolution voluntarily winding up the Company.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LTD.).—The Directors of this Company give notice that they intend to renew the existing £5 per cent. Debentures which mature on January 1st next, and those which mature on January 1, 1899. Holders of the existing Debentures are requested to leave them at the office of the Company, 38, Old Broad-street, E.C., between December 15th and December 31st, and they will be exchanged after January 8th for an equal amount of new Debentures. Existing Debentures not so lodged with the Company will be paid off in cash by the Company's bankers.

THE PROJECTED CABLE BETWEEN AUSTRALIA AND CANADA.—Speaking at the meeting on the 10th inst. of the Scottish Australian Investment Company (Limited), the Chairman, Mr. F. P. Ward, stated that Mr. Sanford Fleming had left Canada for Australia to arrange for the construction of a cable between the two colonies. He had four different plans in view, which had been regarded as very much dependent on Imperial support, but he believed it was now likely that they would be able to do without such assistance. A cable was an essential condition of trade between the two colonies.

THE ZANZIBAR-SEYCHELLES TELEGRAPH CABLE.—The Eastern Telegraph Company (Limited) announce the laying and opening for traffic of the cable between Zanzibar and the Islands of the Seychelles, being the first section of the cable Zanzibar-Seychelles-Mauritius. The extension of the cable to the Island of Mauritius is expected to be completed by the end of this month. The tariff from the United Kingdom to Seychelles will be 7s. 3d. per word.

WENHAM COMPANY (LIMITED).—After bringing into account the sum of £595. 4s. 7d. from last year, the profit and loss account shows a debit balance of £1,887. 10s. 9d. The report states that the operations of the Company have not only been materially affected by the extreme depression of trade, but have also suffered from the exceptional competition of other

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systems of lighting. The outstanding debentures of the Company, amounting to £17,500, become due on December 1st next. To provide for the same the Directors have decided on an issue of Seven per Cent. Debentures.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ended November 10, 1893, after deducting 17 per cent. of the gross receipts, payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,316.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price, Nov. 8		Price Wednesday, Nov. 15		Rate per Cent. Yielded (£ s. d.)	Dividend Due	Business Done During Week Ending Nov. 15, Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	12/6	Anglo-American	46	47	46	47	5 17 0	Jan., Apr., July, Oct.	45½	..
£2,932,680	Stock	25/0	Do. Preferred	84	85	85	86	6 7 11	" "	85½	84¾
£2,932,680	Stock	5/0	Do. Deferred	7¾	8¼	7¾	8¼	..	..	8	—
£195,100	100	4%	African Direct Telegraph 4% Deb. (Reg. & Bearer)	100	103	100	103	3 17 8	January and July ..	..	..
130,000	£10	4/0	Brazilian Submarine xd & bonus	11¾	12¼	11¾	12¼	5 6 1	Mar., June, Oct., Dec.	12 3/16	12⅛
£36,400	£100	5%	Do. 5 per Cent. Bonds	100	103	100	103	4 17 1	January and July ..	..	—
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	..	—
$7,716,000	$100	7%	Commercial Cable Capital Stock	140	150	140	150	4 13 4	April and October ..	..	..
16,000	10	8/0	Cuba Submarine	11½	12½	11½	12½	6 8 0	February and August	12 1/16	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October ..	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	8½	..
60,710	20	3/6	Direct United States	11¼	11⅝	11¼	11⅝	6 3 4	Jan., Apr., July, Oct.	11⅝	11 3/16
400,000	10	2/6	Eastern	14¾	15	14¾	15	5 4 0	" "	14 15/16	14¾
70,000	10	6%	Do. 6 per Cent. Preference	15½	16½	15½	16½	3 12 9	" "	15 15/16	15¾
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	113	115	113	116	3 9 0	May and November	114¾	..
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	108	111	108	111	4 10 1	February & August	..	..
250,000	10	2/6	Eastern Extension	15	15¼	15⅛	15⅜	4 11 1	Jan., Apr., July, Oct.	15¼	15⅛
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113	116	113	116	3 9 0	February & August	113¾	..
£70,600	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	102	105	102	105	4 15 3	January and July ..	103¼	102¾
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	101	104	101	104	4 16 2	" "	102½	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101	104	101	104	3 16 11	February & August	..	..
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	103%	106%	104%	107%	3 14 9	May and November	106	..
180,227	10	1/6	Globe Telegraph and Trust	8½	8¾	8¼	8½	5 5 11	Jan., Apr., July, Oct.	8¾	8½
180,042	10	6%	Do. 6 per Cent. Preference	14½	15	14⅞	15⅛	3 19 4	" "	15⅛	14¾
150,000	10	5/0	Great Northern	20	20½	20	20½	4 3 0	Jan., April, and July	20½	20 1/16
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	103	106	103	106	4 14 4	March & September	..	..
17,000	25	12/6	Indo-European	40	43	40	43	5 16 3	May and November	40½	40
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	3 6 8	" "	..	—
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	105	108	5 11 1	March & September	..	—
£100,000	£100	4%	Pacific European Telegh. 4% Guar. Debs. "Red' 1942	102	105	102	105	3 16 11	..	..	..
11,802	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October ..	..	..
3,381	£100 Cert.	35/0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	" "	..	..
15,609	10	5/0	West African Telegraph	5½	6½	5½	6½	7 13 10	January and July ..	..	..
£260,900	100	5%	Do. 5 per Cent. Debentures	98	101	98	101	4 19 0	March & September	99	..
30,000	10	2/0	West Coast of America	2	3	2	3	..	January and July ..	..	—
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	103	99	103	7 15 4	June and December	101½	101½
88,321	10	6d.	West India and Panama	1⅛	1⅝	1⅛	1⅝	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10	10½	5 14 3	May and November	10	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9	10	9	10	6 0 0	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	107	110	107	110	4 10 11	June and December	..	..
64,242	15	4/6	Western and Brazilian	5½	6½	5½	6½	5 15 7	May and November	5¾	..
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	5¼	5¾	5¼	5¾	..	..	5 5/16	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1	1½	1	1½	..	..	..	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	103	106	103	106	5 13 2	February & August	..	—
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	103	106	103	106	5 13 2	" "	..	..
$1,214,000	$1,000	7%	Western Union 7 per Cent. 1st Mtge Building	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do. 6 per Cent. Sterling Bonds	102	105	102	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	..	..	—
224,500	10/0	3⅕d.	Consolidated Telephone Const. & Maintenance	⅛	⅜	⅛	⅜	..	May and November	..	—
220,000	£1	4·76d.	Oriental (11s. paid)	⅜	⅝	3/16	5/16	7 18 2	Yearly	..	—
458,867	5	2/6	National	4¾	5	4¾	5	5 0 0	June and December	4⅞	4 13/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	13½	14½	14	15	4 0 0	" "	14⅝	14½
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	13½	14½	13½	14½	4 2 9	" "	..	..
90,950	5	2/0	Do. 5% Non-Cumulative 3rd Pref.	5½	5¾	5½	5½	4 10 11	..	5½	5⅜
726,477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully paid)	113	115	113	115	3 18 3	January and July ..	114½	113½
58,000	5	1/0	United River Plate	2	2½	2	2½	..	January and July ..	..	—
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11½	11¾	11½	11¾	..	—	11¾	..
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	12¾	13¼	12¾	13¼	..	—	13⅛	12¾
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	—	..	—
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	—
8,322	£5	..	House to House Electric	..		..		..	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		..	..	—	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	—		..		..	January and July ..	..	—
30,000	£5	3/4 '92	Liverpool Electric Supply (£3 10s. paid)	4½	4½	4½	4½	..	—	—	—
15,000	£5	5/0 '92	Do. (fully paid)	6¾	6	6¾	6½	..	—	..	—
111,000	5	..	London Electric Supply	¾	1	¾	1	—	..	..	—
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	7½	8	7¼	7¾	2 11 8	..	8	7½
£100,000	Stock	5%	Do. 5 per Cent. Debs. (Bonds of £10, £20, & £40)	104	107	106	109	4 11 9	June and December	108	106¼
6,452	£10	..	Notting Hill Electric	5	6	5	6	—	—	..	..
19,980	£5	9½%	St. James' and Pall Mall	6	6½	6	6½	..	—	6½	6 7/16
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	—	8 7/16	8 7/16
59,900	5	1/6	Westminster Electric Supply (fully paid)	5½	6	5½	6	2 18 4	—	5 9/16	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
77,978	3	2/1	Brush Electrical Engineering	2¾	3	2¾	3	6 0 0	—	2 15/16	2¾
75,000	2	6%	Do. 6 per Cent. Preference	2¼	2⅝	2¼	2⅜	5 1 1	—	2⅜	2¼
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	106	108	106	108	4 3 4	March & September	..	—
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	4	4½	4½	4¾	..	January and July ..	4 7/16	—
12,139	5	..	Edison and Swan United	—		—		—	—	..	—
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	—	..	—
49,900	10	12/0	Electric Construction	1¾	2¼	1¾	2¼	..	—	—	—
91,195	2	10/0	Elmore's Patent Copper Depositing	⅜	⅝	⅜	⅝	—	—	—	—
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	—	..	—
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21½	22½	21	22	5 18 7	February & August	21¾	—
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	..	—
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	..	—	—
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	—	—
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/0	4/0	3/0	4/0	..	..	—	..
78,949	5	1/9	Swan United (£3. 10s. paid)	2	2½	2	2½	13 19 8	May and November	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	33	35	34	36	5 0 0	March and July....	35½	34
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101	104	101	104	4 16 2	January and July ..	..	—
39,639	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		—	—	—	—
41,098	£5	..	Do. Preference (fully paid)	..		..		—	—	—	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	¾%	City and South London Railway	28	33	28	33	2 5 5	May and November	..	—
37,500	£10	—	Liverpool Overhead Railway	5⅛	5⅝	5⅛	5⅝	—	—	—	—

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THE ELECTRICIAN:

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NOTES.

The draft regulations for electric tramways which have been submitted for the consideration of the Board of Trade, and which we print in full in another column, are the most important of the kind since the much-discussed overhead wire regulations, and they are potentially of far greater importance. The tests to be made, and the records to be kept, appear at first to be rather alarming; but on closer examination they seem to compare favourably with the self-imposed work of any conscientious manager of an electric supply station. Tramway engineers, it is true, have not hitherto troubled themselves about such matters. They seem to be able to run their cars to their own satisfaction in some cases without any measuring instruments whatever. We do not find among the definitions any attempt to draw the line between a tramway and a railway, but that, perhaps, is settled by the Tramways Act. These regulations will, we suppose, receive the careful attention of tramway engineers, but it is quite possible that they will ignore them until it is too late, and then get up an agitation for alterations.

The accident at Manchester on the morning of the 16th inst. has afforded an opportunity for the exhibition of the extraordinary ignorance of electrical matters which is tolerated by editors of London and provincial daily papers. A journalist making mistakes of a quasi-scientific kind in descriptions of flower shows or street accidents, volunteering such statements, for example, that chrysanthemums are endogenous tubers, or that a cab collided with a lamp-post with great centrifugal force, would soon meet with his deserts; nor would literary, historical, artistic ignorance be allowed in dramatic or art criticisms. Any nonsense, however, is allowed in electrical matters. Only last week we alluded to an article in the *Daily Chronicle*, and again we find this journal distinguishing itself on the subject of the Manchester accident. "The explanation," it says, "will probably be that the copper mains were somehow carrying too heavy a current, became fused, and temporarily converted the cable chamber into something like a blast furnace."

It seems probable that the explosion, which, by-the-bye, only just raised the box cover out of its seat, was due to leakage of gas into the conduit, as at Glasgow on the 9th inst. and in several other cases. Such accidents merely arise from the presence of a conduit in a street in which leaky gas mains are laid; it is to be surmised that they are often ready to explode, and merely wait for a spark. Electric light mains are by no means essential for producing the necessary spark; an explosion has occurred in a telegraph junction box at Newcastle, and the Glasgow accident is attributed to a match thrown down by a smoker. The fault, of course, lies with the company that impregnates the soil with explosive gas, for we have as yet seen no evidence as to electrolytic evolution of gases. Soon after the explosion at Manchester the mains were short-circuited, with, we presume, the usual result of a blown fuse at the station. The flame had set fire to the insulation of the rubber-covered cables, which were united at this box to bare conductors. These were quite uninjured. The insulation having been burned away, the cables, Mr. Wooler informs us, came into contact with the iron pipe and to dead earth.

In our account of the Manchester station (*The Electrician*, Vol. XXXI., p. 614), an allusion to the plant for ventilating the conduits was made. Air is continuously circulated through them by means of a fan driven by a motor at the station. In New York a similar provision has been made, but the different mode of application is worthy of notice. In *The Electrician*, Vol. XXX., p. 471, we recorded that twelve Roots blowers are run at different parts of the subways and force air into the conduits at a greater pressure than the gas pressure in the surrounding soil. The blast is sufficient to renew the whole of the air about once an hour. The joints are made as tight as possible, and the air is compelled to make its way, not back to the station, but through such leaks as are inevitable. We hasten to give every credit to our American friends for this very ingenious device.

The letter from Mr. Steinmetz in our Correspondence column this week tends to some extent to explain his position with regard to the candle-power of search lights, and brings out, as Mr. Nerz has done, the interesting theoretical fact that when the source of light has a finite size the beam diminishes in intensity as the square of the distance. As is generally the case in long discussions, the disputants have been writing about different things, and we admit that our reference to a beam of parallel rays does not bear upon the point which Mr. Steinmetz now emphasises. But the discussion originally related to the actual photometry of search lights, and not to theoretical reflectors. In practice, the angular divergence of the projected beam of light depends not only on the size of

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the arc, as compared with its distance from the reflectors or projecting lenses, but also upon any irregularities in the latter which tend to prevent them from sending off all the rays in a truly parallel beam. In the former case, as our correspondent points out, the divergence commences at the projecting surface, but is not the same for all parts of the surface. In the latter case the spreading of the light follows a different law altogether.

It cannot be assumed that if the path of the rays be produced backwards, through the projector, that they will meet at a point. The diagram (Fig. 4) in M. Nerz's article, *The Electrician*, Vol. XXX., p. 714, shows that a cone of rays starts from each point on the surface of the reflector. Not only are these cones necessarily of different angles, decreasing towards the periphery, but if the rays are produced backwards, they will begin at once to diverge again, and will not intersect at any particular point on the axis. So long as the axes of these cones are strictly parallel, the surface of the reflector may, as Mr. Steinmetz contends, and as M. Nerz proves in the second part of his article, be considered as a luminous surface of nearly the same brilliance as the crater. So long as this condition is rigidly maintained, it is permissible to speak of the photometric candle-power of the search light along the axis. But a very small convergence or divergence of the axes of the cones, whether by incorrect focussing, or by imperfect figure of the reflector, at once renders meaningless the photometric measurement as well as the photometric designation of the candle-power of the search light. The candle-power of the beam will depend on the divergence of the rays, and this can be altered in several ways without affecting the total quantity of light which is given out, and which after all is the really important thing. With an ordinary light the candle-power is proportional to the quantity of light given out. We are dealing, practically, in the case of projectors, with a mixture of light sources; and we think it highly improbable that any three photometric measurements of candle-power of a search light at different distances along the axis would be found to agree.

We print this week an interesting article by M. Abdank-Abakanowicz on the subject of compensating electrical instruments for hysteresis effects. A device, due to Mr. Evershed, for the same purpose was recently described in our columns by Mr. E. B. Vignoles, and it will be observed that there is a great similarity between the two methods. In each case the greater retentiveness of a steel core is used to neutralise that of the iron. There are, however, differences between the two systems of compensation. Mr. Evershed uses the magnetism of the steel to destroy the remanent magnetism of the iron; while in the other method the magnetism of each is retained, and so utilised that their effects on the moving parts of the instrument neutralise each other. The former method seems much simpler, and the compensation may be quite sufficiently good, but the latter is likely to secure far more perfect compensation.

One of the numerous drawbacks to the practical realisation of the thermo-dynamic beauties of the internal combustion engine is the frailty of the materials of which this engine has, in its present mode of action, to be built. The useful working of a piston in a cylinder is inconsistent with a temperature approaching red heat, and it becomes necessary to rob the working substance of the greater part of its heat, almost as soon as it is generated, in order that the engine may be preserved in a state in which it is capable of doing any work at all. But there are differences of opinion as to the most satisfactory way in which this large amount of heat may be abstracted. The most obvious, and absolutely inefficient way, is to follow Lenoir, and place a water jacket round the cylinder containing the working gases. A common improvement on this consists in the prior compression of these gases inside the cylinder, thus reducing the surface of cylinder wall per pound of fuel consumed per explosion. Even this, however, was found, in the Society of Arts trials, to result in the abstraction of 52 per cent. of the heat in useless jacket warming. Another mode occurs in the well-known "Atkinson" cycle, in which the gases are exploded and expanded to several volumes very rapidly, being passed through the cylinder too quickly to give up much heat to the walls, but retaining a large proportion of unused heat in the exhaust.

The latest attempt to prevent excessive cylinder heating is the result of a suggestion by Dr. Pröll, in which it is proposed to abolish the cooling by water and to put in its place a cooling agent by expanding compressed air. The suddenly generated heat of the fuel gas is largely absorbed by the expanding compressed air, the useful activity of the latter being thereby increased by the heat which would ordinarily pass into the water jacket. The ordinary compressed air is used only, of course, where there is such a system available. In other cases an auxiliary compressor would be necessary, and would absorb power. The net advantage of the compressed air would be the difference between the power thus absorbed and the power developed in the heated expander. It is impossible to comment further upon this system, which from a theoretical point of view is commendable, until further details as to the mode in which the expanding air is heated are forthcoming. We presume the compressed air is retained in a separate chamber from the fuel gas, otherwise the combustion would be imperfect; and, if so, the whole practicability of the scheme must depend on the arrangement of these two chambers.

The attack made the other day upon Major Wood at the Meeting of the Western and Brazilian Company is no doubt accounted for by the non-payment of a dividend, owing to the state of affairs which has existed for some time in South America. The suggestion to get rid of the Managing Director, so as to save his remuneration, was ill-considered, and showed that the gentlemen who made it evidently possessed very little knowledge of the subject, or they would not have advocated such a change in the management. Major Wood replied with considerable spirit and effect, and showed that he thoroughly understood the details of the Company and its management, as well as how necessary it was that himself or some equally-competent man should

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occupy the position. Submarine telegraphs require very careful and constant attention; they have become an important factor in the political, commercial and social world, and it is clearly necessary that men of the highest character and ability should be responsible for their management. These undertakings cannot work themselves, and if the views of the gentlemen who attacked Major Wood were carried out it would, we think, very soon be found that chaos would exist where at present order prevails.

Cable Interruptions and Repairs:

	Dates of Interruption.	Date of Repair.
Perim-Obock	November 10th.	November 17th.
Cayenne-Paramaribo	October 25th.	—

The Telephone at Cardiff.—The National Telephone Company have made arrangements at Cardiff and Penarth to keep the Exchange open continuously day and night, including Sundays and holidays.

Technical Education.—Mr. Acland, Vice-President of the Committee of Council of Education, on Saturday last laid the foundation stone of the new Technical School, which is being erected by the Corporation of Birmingham at a cost of nearly £50,000.

Fire at Electrical Works.—A large five-story factory, formerly in the occupation of Blakey, Emmott and Co. (Limited), and now supplying some Halifax shops with electric light, was burned out yesterday morning. A gable fell out on to the residence of Mr. Emmott and demolished a great part of it.

Bristol.—Last Monday evening the arc lamps on Bristol Bridge and down Victoria-street were lighted, this being the beginning of the permanent street arc lighting in Bristol. The gas lamps have not yet been dispensed with, as for a few evenings the electric light will cease at midnight.

Cable Extensions.—The Eastern Telegraph Company announce the laying and opening for traffic yesterday of the Mauritius cable, thus connecting the Islands of the Seychelles and Mauritius with Zanzibar and the Company's general system of submarine telegraphs. The through tariff to Mauritius from the United Kingdom will be 8s. 9d. per word.

The Phonopore.—We are informed by the Phonopore Company that it has happened lately on four different lines that whilst the ordinary telegraph could not work, on account of a breakage of the wire, messages were sent by the phonopore just as if nothing unusual had taken place; the currents by which the phonopore is worked jumping the gap at the breakage.

Appointments Vacant.—The governors of the Battersea Polytechnic Institute invite applications for the appointment of teachers of the various evening classes from January to May, 1894. Particulars appear in our advertisement columns. ——An experienced master is required to take charge of the Physics section of an important modern school in the South of England; further particulars appear elsewhere.

A Self-Recording Target.—A self-recording target which is being exhibited at the Drill Hall, Plymouth, is exciting much local interest. The face of the target is composed of steel, and the various rings are all separate. When the bullet reaches the target the ring on which it strikes gives way, and is forced forward again by a spring. The backward motion of the ring closes an electric circuit actuating an indicator at the shooting point.

The Montefiore Electro-Technical Institute.—On Thursday last week the King of the Belgians went to Liége to inspect the Electro-Technical Institute, founded by Senator Montefiore-Levi. The rector explained the origin of the Institute and the difficulties which had to be surmounted in founding it. Four hundred electricians had, he said, been trained in it. This year there were 75 students, two-thirds of whom were foreigners.

Lamp-Holders.—We have received from Mr. W. J. Jenks, of New York, a copy of the "Complainant's Proofs" in a lampholder patent infringement action which is being brought by the Edison Company of America against the Electric Engineering and Supply Company. Amongst the patents said to be infringed are the American equivalents of the Edison (1880) and Johnson (1882) patents held in this country by the Edison-Swan Company.

Brussels.—The Brussels central lighting station was at last formally opened at the beginning of the present month. The work was, it may be remembered, entrusted to the India-Rubber, Gutta-Percha and Telegraph Company. The station is of 40,000-light capacity, and is on the low-pressure sub-station system. The plant will be run from sunset till midnight, after which current will be furnished to the consumers by the accumulators, which are of the Julien type. The system of street-wiring employed is that of insulated cables in cast-iron tubes.

Obituary.—The death is announced of Dr. Wm. F. Hutchinson, who died suddenly in Providence, U.S.A., on September 30th, of organic disease of the heart. Dr. Hutchinson, who was 55 years old, was well known as a leading physician in Rhode Island, and as a specialist in electricity. He was an able writer, and besides contributing many articles on electromedical subjects to the medical journals, was also the author of "Practical Therapeutics." To Dr. Hutchinson is also due the discovery of the local anæsthetic effect of the "Faradic" current when the number of interruptions of the "Faradic" coil correspond to a certain pitch.

Cheltenham.—Col. J. Ord Hasted, R.E., of the Local Government Board, held an inquiry last week relative to an application by the Cheltenham Corporation for sanction to borrow £16,000 for the purpose of electric lighting. The scheme is to be carried out on the alternating system. There was strong opposition to the scheme on the grounds that the expense ought not to be incurred; that the estimate of the cost was not sufficient for all that the scheme would lead to; and that the ratepayers had not had sufficient opportunity of discussing the question. The inspector promised to submit these representations to the Local Government Board.

The Edison Lamp Patent in America.—The expiration of the English patent on the Edison lamp will not, says our New York correspondent, affect the American patent, as the date of the latter is January 27, 1880. According to the Federal Courts the life of an English patent is to be computed from the date when it is sealed, and not from the actual date on the patent; in the present case the former is May 10, 1880, and the latter November 10, 1879. The law on the subject is that the life of a domestic patent is limited by that of foreign patents granted previous to the issue of the American patent, and as a consequence the Edison lamp monopoly will expire with the Canadian Edison patent on November 19, 1894, instead of January 27, 1897, the natural limit.

Science Examinations.—In answer to a question in the House of Commons last week, Mr. Acland stated that second-class passes in the elementary stage of all science subjects were abolished by the Science and Art Department after due notice given in the time of the late Government, the object of the change being, as explained at the time, the encouragement of more advanced instruction, for which increased payments were offered. He saw no reason to believe that this action would in any way impede the progress of sound technical education, while, on the other hand, it would afford a salutary check on a good deal of instruction of a kind which it was not, on the whole, desirable to assist. Under the circumstances he could hold out no hope of the revival of second-class passes or of an alternative scheme.

Strike of Italian Telegraph Clerks.—The telegraph clerks at Milan, following the example of their colleagues in Rome, have gone out on strike. Their places have, however, been filled, and the service is therefore not interrupted. There is also a partial strike among the telegraphists at Venice. The telegraph clerks at Naples also left their posts for a few hours, but then reconsidered their decision and resumed work. At Turin, where nearly all the *employés* have joined the strike, the service

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is being carried on by men from other Government departments. It has been decided to immediately recall a certain section of military telegraph operators who are now away on furlough, and to dismiss all *employés* who have in any way instigated the strike. The Ministers at the same time intimate that they are prepared to deal with all strikers who fail to resume their duties within twenty-four hours.

Royal Society.—The following Papers were down for reading yesterday:—Prof. Lockyer, on "The Photographic Art Spectrum of Electrolytic Iron;" Prof. Thorpe and P. L. Gray, "Magnetic Observations in Senegambia;" Dr. Hopkinson, E. Wilson, and F. Lydall, "Alternate-Current Electrolysis;" S. Dunkerley, on "The Whirling and Vibration of Shafts." The Royal Society's medals have this year been adjudicated by the President and Council as follows:—The Copley Medal to Sir George Gabriel Stokes, for his researches and discoveries in physical science; a Royal Medal to Prof. Arthur Schuster, for his spectroscopic researches and his researches on disruptive discharge through gases and on terrestrial magnetism; a Royal Medal to Prof. Harry Marshall Ward, for his researches into the life history of fungi and schizomycetes; and the Davy Medal to Messrs. J. H. van't Hoff and J. A. le Bel, in recognition of their introduction of the theory of a symmetric carbon, and its use in explaining the constitution of optically active carbon compounds.

Liquid Air.—In connection with the forthcoming lectures at the Royal Institution on "Air, Gaseous and Liquid," it may be mentioned that Prof. Dewar has successfully conveyed a considerable quantity of liquid air from London to Cambridge. The liquid air was carried in one of the double-glass, vacuum-jacketed flasks, the space between the inner and outer flask containing nothing but extremely attenuated mercurial vapour, together with a little liquid mercury. On pouring liquid air into the inner flask its outer surface is rapidly covered with a mercurial film of extreme thinness, forming a reflecting surface highly impervious to radiant heat. As soon as this is formed the whole apparatus is packed in solid carbonic acid, which at once freezes the liquid mercury, arrests the deposit upon the mirror, reduces the mercurial vapour to an infinitesimal quantity, forms an almost perfect vacuum, and supplies an envelope 80deg. below zero. Thus protected the liquid air reached Cambridge. The protective power of the high vacuum and the mercurial mirror will be better appreciated if it be borne in mind that the difference of temperature between liquid air and solid carbonic acid is the same as between ice and boiling water.

Telegraphy Extraordinary.—The following is a characteristic instance of the amount of energy which is devoted on the other side of the Atlantic to the rapid propagation of news. On the day of the race deciding the struggle for the International Yacht Cup, a violent storm broke down all the telegraph lines between New York and Chicago. When the evening came, the New York manager of the United Press was in possession of lengthy descriptive accounts of the race, but he had not the slightest idea of how he was going to get through to Pittsburg or Chicago. At 10.30 he went to the Long-Distance Telephone Office, and induced the officials there to do their best to get through. They got through to Pittsburg soon after 11 o'clock. A telephone message was sent to Pittsburg to hunt up a Morse instrument, and a man to work it. Meanwhile a Morse instrument was attached to the New York end of the line. At midnight all was ready. The manager of the United Press then telegraphed to Pittsburg, asking them to telephone to Chicago asking that office also to secure a Morse instrument and an operator. At Chicago, however, there was some difficulty in doing this. Finally the news was transmitted to Chicago in the following way:—At Pittsburg a telephone transmitter was placed over the Morse sounder, and at Chicago a telegraph operator held a telephone receiver to his ear with one hand, writing out what he heard in the receiver with the other hand. Transmission began at 12.30, and by 2.30 3,000 words had been sent through about the yacht race and other matters.

A 1,000-H.P. Electric Locomotive.—The following are some additional particulars with regard to the 1,000-H.P. electric locomotive, described briefly on page 32 of our issue of November 10th, which is now being constructed in America to the designs of Messrs. Sprague, Duncan and Hutchinson. The engine, says the *Electrical Engineer* of New York, is intended for switching purposes and slow-speed freight traffic. It is carried on a steel frame supported by eight coupled wheels, each 56in. in diameter. Each axle carries the armature of a 250-H.P. motor, whilst the field-magnets are supported by the axle-boxes. The armatures in question are 31in. in diameter, and have 237 coils. The motors are compound wound, and are designed to take a current of 250 amperes at 800 volts, their normal speed being 225 revolutions per minute. The four motors, when working at their maximum power, are expected to exert an effective pull of 30,000lb. on the drawbar. The connections to the motors are made through a contact cylinder, which permits them to be arranged, either all in parallel, all in series, or partly in series and partly in parallel. In changing over from one arrangement of contacts to another, resistances are first thrown in, the change is then made, and the resistance finally switched out again. This contact cylinder being of large dimensions is operated by air pressure, though hand gear is also fitted. The air is taken from the brake tanks, which are kept charged by an automatic electric pump. The reversing switch is separate from, but interlocked with, the contact cylinder in such a way that it can only be operated when the current is cut off from the motors. Provision is made for two trolleys above the car, to collect the current from the line. The total weight of the motor will be 120,000lb., so that if a drawbar pull of 30,000lb. is expected, an adhesion of one-fourth will be required. To insure as high an adhesion as possible the coupling-rods between the wheels are double-jointed, and equalising beams are used between the springs supporting the frame of the car. The total wheel base is 15ft. only, leaving only 4in. clearance between the wheels. The outer wheels only are flanged.

Blackening of Incandescent Lamp Bulbs.—I have repeatedly noticed (writes Mr. W. Stuart-Smith in the *Electrical World*) discussions as to the cause of blackening of incandescent lamp bulbs. The latest theory seems to come from France, and is to the effect that residual oxygen in the bulb, together with that which was occluded in the filament, attacks the carbon and forms carbonic oxide, which undergoes dissociation by coming in contact with the comparatively cold glass, depositing the carbon and leaving the oxygen free for a repetition of the process. It has been some years since I have paid attention to chemical matters, but, unless I am mistaken, cooling as above would *not* cause dissociation, and the above explanation cannot be the correct one. It seems to me that a portion of the action at least *must* be due to the following cause:—It is well known that all substances in the solid or liquid form give off vapour, in fact, are surrounded by an atmosphere of their own vapour. If the substance is confined in an air-tight space the vapour density is definite for every substance and for every temperature, but varies greatly with the temperature, being much greater for high temperatures. For a given substance and a given temperature the vapour density will be the same, no matter what other gases may be present; but if other gases are present in considerable quantities considerably more time will be required for the density to reach its maximum value. In a vacuum, on the contrary, the action is comparatively rapid. Carbon, when cold, is a very stable substance, and its vapour density very low; but at the high temperature of the white-hot filament, vaporisation must be comparatively rapid and the vapour density relatively great. As the hot vapour comes in contact with the cooler glass it will deposit, and thus vaporisation, instead of stopping, as would be the case if the glass was the same temperature as the filament, continues while the lamp is burning. When the lamp is extinguished the vapour in the globe must deposit on the glass until the definite density of the vapour of the cold carbon is attained. The more rapid blackening when the lamp is new may be due in part to the better condensing action of the clean glass, and it may be due in a greater part to the fact that some portions of the filament are more easily volatilised than others, and the action consequently more rapid while these are being thrown off.

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ELECTRIC MOTIVE POWER.*

BY ALBION T. SNELL.

(Continued from page 69.)

There is considerable difference of opinion as to whether an alternate-current armature should have iron cores or not. In the thin disc type there is no doubt that iron is inadmissible, as the armature would inevitably be drawn out of flat and jammed against the pole-pieces; but in drum and Gramme-wound machines there is no mechanical reason why the magnetic resistance should not be decreased by a liberal use of thin iron plates. But the magnetic density must be kept low or the losses from hysteresis will be serious: B_a'' must not exceed from 40,000 to 65,000. Iron cores are said to have the effect of reducing the loss from eddy currents in the copper. Regarded from a purely mechanical standing, the author is of opinion that the iron-cored drum-wound type of alternators, such as those built by the Westinghouse and the Gülcher companies, are the better adapted for power purposes. The Brush and Ferranti armatures compared with these are fragile in make, and appear to be much more likely to give trouble. The experience of Continental and American engineers seems to confirm this, and the gradual development of multiphase alternators with iron cores undoubtedly points in the same direction.

From a purely electrical point of view the Mordey alternator is almost perfect, and certainly possesses the important feature of a high efficiency of conversion at light loads—a most important consideration with some kinds of work. On the other hand, it is an undoubted fact that the light-load efficiency of many of the iron core alternators is extremely low. In designing alternators with iron in the armatures it is always important to estimate the power which will be wasted in simply magnetising and demagnetising the cores, as this will be sufficiently large to be comparable with the copper loss. Table L which is calculated for 50, 83, 100, and 130 periods per second gives the data necessary for most practical cases.

Table L.—*Power Wasted by Hysteresis.*

B C.G.S.	B'' per square inch.	Watts wasted per cubic inch. ∿ = 50.	Watts wasted per cubic inch. ∿ = 83.	Watts wasted per cubic inch. ∿ = 100.	Watts wasted per cubic inch. ∿ = 130.
4,000	25,800	0·116	0·192	0·232	0·310
5,000	32,250	0·1665	0·277	0·333	0·434
6,000	38,700	0·2165	0·360	0·433	0·564
7,000	45,150	0·2675	0·444	0·535	0·695
8,000	51,600	0·3205	0·532	0·641	0·832
10,000	64,500	0·450	0·748	0·900	1·170
12,000	77,400	0·597	0·995	1·194	1·550
14,000	90,300	0·760	1·260	1·520	1·970
16,000	103,200	0·910	1·510	1·820	2·360
17,000	109,650	1·1375	1·890	2·275	2·950
18,000	116,100	1·4075	2·340	2·815	3·660

It will be noticed that for a fixed induction the waste of power increases in direct proportion to the frequency; and that for a given frequency the loss varies as the induction raised to the 1·6 power.†

The effect of the frequency on the size of an alternator for a given output demands careful attention. The frequency of an alternator is proportional to $p\frac{n}{60}$, that is, it varies directly as the number of pairs of poles in the field magnets and the number of revolutions. If the speed be fixed, the frequency determines the number of poles, and, consequently, to a large extent, the size and cost of the machine. The bearing of this point in the design of alternators will be readily appreciated on inspecting Table N, which shows the necessary revolutions per minute at the frequencies customary in this country, with various numbers of pairs of field poles.

It is seen that for a given number of pairs of poles the revolutions vary directly as the frequency, which on this account should be low. But the output of a given alternator, other things being equal, is proportional to the frequency, and therefore a low frequency means a heavy machine for the output. This is counterbalanced to a large extent because a higher induction becomes permissible as the frequency is diminished.

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† See Mr. Steinmetz's experiments.

Table N.

Number of pairs of field poles.*	∿ = 50 revs. per min. =	∿ = 80 revs. per min. =	∿ = 100 revs. per min. =	∿ = 130 revs. per min. =
2	1,500	2,400	3,000	3,900
4	750	1,200	1,500	1,950
6	500	800	1,000	1,300
8	375	600	750	975
10	300	480	600	780
12	250	400	500	650
14	215	343	432	557
16	187	300	375	487
18	166	266	332	433
20	150	240	300	390

* The number of pole pieces in a machine is equal to $2p$.

The ordinary values of B_a'' are given in Table O, and are practically the same as those found advisable in the design of transformers.

Table O.

Frequencies ∿ =	Induction B_a'' = from
50	32,000 to 40,000
60	30,000 to 32,000
70	28,000 to 30,000
80	26,000 to 28,000
90	24,000 to 26,000
100	22,500 to 24,000
110	21,000 to 22,500
120	19,500 to 21,000
130	18,000 to 19,500

If the magnetic field vary in strength the induction must be the $\sqrt{\text{mean square}}$ value.

The preceding investigation of alternate-current working will be sufficient to show the modifications necessary to apply the method of designing dynamos and motors previously described. But special attention must be given to the magnetic induction, and the current density must be chosen according to the ventilation provided. For example, in an iron cored armature having a large heat waste from hysteresis, the loss in the copper must be kept relatively small, whereas in a coreless armature of the Brush or Ferranti type, the current density may be as high as 4,000 amperes per square inch, or even more. The effective pressure and current will in all cases be of chief importance, since the output, heat waste, and average torque are proportional to these values. But the maximum pressure will determine the limiting stress on the insulation, and must be considered accordingly. From this point of view the Kapp and Gülcher alternators appear to be excellent, for they give a flat top to the theoretical curve of pressure (*see* Figs. 76 and 79). Also the maximum torque will be proportional to the maximum value of the current, and the stresses must be calculated with reference to this value. In cases likely to be met with in practice both pressure and currents closely approximate to a sine law in the outer circuit, and it is also probably safe to assume that the armature pressure curve does as well; at any rate, judging from the illustrations given in Figs. 75, 76, 77, 78 and 79, the probable error is not sufficiently large to seriously affect the results. But it is pretty well demonstrated that the current in the armature coils departs widely from the simple sine function. The peripheral velocity of alternators is generally greater than that of Gramme or drum armatures, and is a question of mechanical construction. Generally, with non-magnetic core armatures of the Ferranti type, the moving parts are so light that the centrifugal strains are easily dealt with at even from 5,000 to 8,000ft. per minute. And in revolving field machines of the Brush and Brown type it is clear that the speed is only restricted by the tensile strength of soft cast iron. In revolving fields of the Construction Corporation type, since the magnets are mainly built up of wrought iron, the chief factor will be the ultimate strength of the bolts and screws holding the parts together, &c.

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The estimate of the excitation presents some difficulty, but since the current is almost invariably provided by a separate direct-current dynamo, often coupled to the shaft of the alternator, a limited adjustment can be made by a variable resistance placed in series with the coils. However, it is important to notice that for every driving power there is one value of exciting current which will make the output, and, consequently, the efficiency a maximum. In fact, the output does not vary with the field strength as is the case with continuous-current machines; and it follows that a proper regulation cannot be made by the exciting current alone, but requires as well an adjustment of the driving power for each load. This is of special importance when alternators are coupled in parallel. If the exciting current be either above or below this critical value, the efficiency will be lowered and the output reduced (for the given driving power). In the first case, the armature current will be increased, and the terminal pressure also; but the efficiency will be diminished, owing to the increased loss over the armature resistance. In the second, the current will also be increased, but the terminal pressure will be lowered. But this effect is not very marked with many alternators, and in most cases the best excitation is nearly the same through the working range of output. Perhaps it is of more importance in the case of alternate current motors, for then the increase of main current may

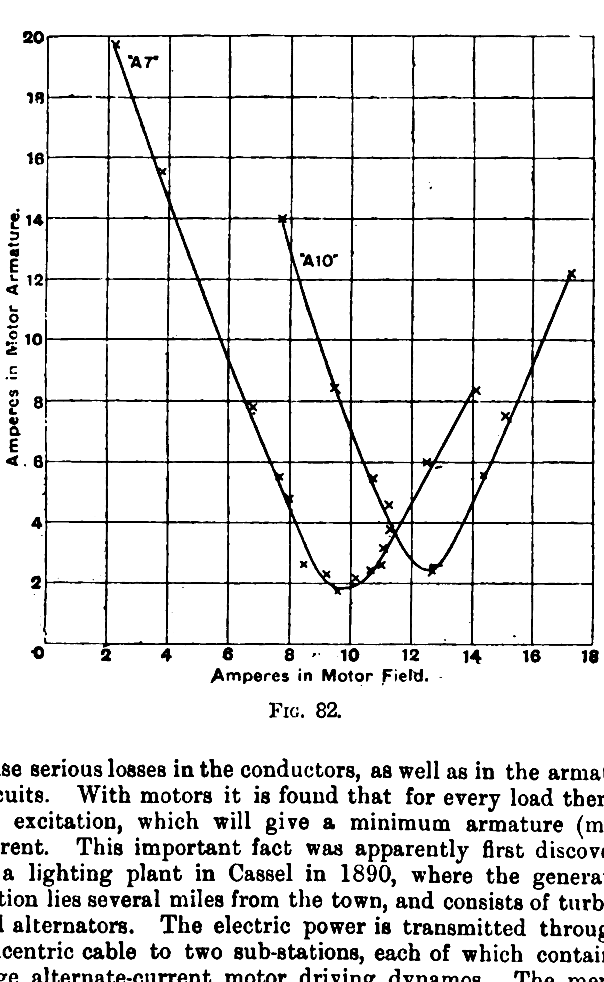

Fig. 82.

cause serious losses in the conductors, as well as in the armature circuits. With motors it is found that for every load there is *one* excitation, which will give a minimum armature (main) current. This important fact was apparently first discovered at a lighting plant in Cassel in 1890, where the generating station lies several miles from the town, and consists of turbines and alternators. The electric power is transmitted through a concentric cable to two sub-stations, each of which contains a large alternate-current motor driving dynamos. The men in charge of these machines found that the main current could be varied for different values of motor excitation. A similar effect is illustrated in Fig. 82, which refers to experiments made by Mr. Mordey with two Brush alternate motors running light. The terminal pressure was maintained constant at 2,000 volts and 100 ∿, the speed also being constant throughout the range of observation. The tests were continued with various loads, and it was found that for every output there was one value of exciting current corresponding to minimum armature current; and that the armature current rose as the excitation was increased or diminished; and that the critical excitation was approximately the same for all loads (this is partially due to the small self-induction of the machines). The terminal pressure was maintained constant throughout.

Mr. G. Kapp, Mr. Swinburne, Mr. Mordey, and others have investigated the theory of exciting alternate-current machines. And it appears that the *output* of an alternator depends on the steam admission, or simply the driving power; while the *lag*, and, consequently, the wattless current, is controlled by the excitation. And for a given brake horse-power of an alternate-current motor, the excitation determines the lag and wattless current.

The problem is complicated by armature reactions, self-induction, and capacity effects in the circuit. Armature self-induction tends to weaken the field, and therefore to necessitate more than the calculated excitation, while capacity in the armature tends to strengthen the field, and hence to reduce the value of the necessary excitation. The actual number of ampere-turns for any load will, therefore, depend on the balancing of these two effects, and no general rule can be stated. When alternators are running in parallel, with separate engines, the steam admission should be controlled by a common single governor, and not by separate governors to each engine. And the real output of each dynamo, after the throttle valve is properly set for the full output of the machine, should be measured by a wattmeter, and controlled (in accordance with its readings) through the field excitation. An ammeter is of no use for this purpose, as it gives no indication of the lag between current and pressure; and the omnibus pressure being the same for all of the machines is no criterion of the actual total electromotive force of any of the alternators. It may therefore happen that two alternators in parallel may be giving pressure differing as widely as 2,500 and 1,500 volts, and yet the omnibus pressure will show 2,000 volts, the proper station pressure, say.

(*To be continued.*)

Errata.—On p. 69 of last issue *for* $V_e = 0{\cdot}7854\ V_{max}$, *read* $V_e = 0{\cdot}835\ V_{max}$. The arrangement of poles in Fig. 76 should be such that the pairs of poles should be alternately N and S, with *similar* poles opposite one another.

THE INDIRECT CONTROL OF TELEGRAPHS BY THE UNITED STATES GOVERNMENT.

BY THOMAS COMMERFORD MARTIN.

In view of the fact that all the American telegraph, telephone, and submarine cable systems are in private hands, assumably independent of Government control, it has, I am given to understand, struck many observers in England and Europe as strange and contradictory that the Postmaster-General of the United States should dictate to any of the companies interested the terms and rates upon which they handle the Government's messages. A few explanatory words on this subject may not come amiss, especially if I shall be able to show that here, as almost everywhere else in the world, it has appeared desirable to those invested with the supreme authority, to place themselves in the position of having at their command, for moments of urgency and necessity, and with absolute right of priority and precedence, the best means of transmitting intelligence. The truth is, that in recent years, despite the principle in our constitution that the Government shall not sequester private property, at least one Postmaster-General has practised the worst form of socialistic confiscation by forcing on the companies an unfairly low rate. Compared with such a process, the conditions under which the private lines of England were annexed and converted into a public department were highly liberal and generous.

The Postmaster-General of this country is empowered by statute to fix every year the rate at which the telegraph companies shall carry Government messages. The Act vesting such power in him was approved July 24, 1866, and now is known as Title LXV. of the Revised Statutes of the United States. Discussions in Congress as to Government telegraphs are nothing new, and this Act was practically a compromise that quieted those who were supposed to voice the popular wish. Many of our legislators to-day speak and write as though they were utterly ignorant of the existence of the

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provision under which the Government, on the appraisement of five competent persons, can buy any telegraph system it may hanker after, if Congress will but vote the money, and if its owners are operating within the Act. That virtually means every telegraph company here, as no fewer than 101 have accepted the conditions in the 27 years since 1866. On their side, the companies attempted, while the Bill was under discussion, to obtain advantageous concessions, and at first glance it might seem that they secured some very valuable privileges; but as time has gone by the gains have faded from tangibility. The right to acquire public lands now means nothing. The right to run wires along post roads is a mockery. Every city in the Union, well-nigh, has a department organised expressly to keep poles and wires off the post roads, and drive them into subways; and more than one mettled Mayor, with a whetted axe, has himself been ready to lead on the forces of destruction. Moreover, the Government has priority, and some of its officials, ambitious of organising and directing a national telegraph service, have, I am sorry to say, made the most of such a provision, and of the power to fine for refusal to transmit, thus rendering the lives of the telegraph presidents anything but happy ones. Section 5,266 I venture to quote as bearing on this point:—

"Telegrams between the several departments of the Government and their officers and agents, in their transmission over the lines of any telegraph company to which has been given the right of way, timber or station lands from the public domain, shall have priority over all other business at such rates as the Postmaster-General shall annually fix; and no part of any appropriation for the several departments of the Government shall be paid to any company which neglects or refuses to transmit such telegrams in accordance with the provision of this section."

At one time this paragraph caught the fancy of such officials as I have alluded to as an admirable implement for baiting and goading the telegraph companies; but the sport lost its edge after a while, and was not revived until a few years ago, when resort was had to a scale of starvation rates, fixed by a Postmaster-General whose enemies allege that he was animated by motives of personal or political resentment.

These rates have, of course, varied a great deal. In 1845, after our Government had spent $30,000 on Morse's experimental line, the Postmaster-General fixed a common rate of one cent. for four characters. Congress then refused to buy the Morse patents for $100,000, and they fell back into private hands, the Postmaster-General reporting that "the operation of the telegraph between Washington and Baltimore had not satisfied him that under any rate of postage that could be adopted, its revenues could be made equal to its expenditures." This was hardly the public view of the situation when the great consolidations of 1866 took place, with their rapid doubling up of stock values, and hence, as I have hinted, came the Compromise Act, whose object, among others, was to secure cheap telegraphy for the Government should rates advance, as they have occasionally done under those conditions. That Act has certainly accomplished such a purpose very thoroughly. One considerable element of variation militating against the companies has been the increase in the length of their circuits. It might be said, without impropriety, that every time a company has extended its lines for commercial business it has rendered itself more vulnerable to possible Governmental imposition. In 1866 the length of the ordinary circuit upon which the rates were based was, perhaps, 100 or 200 miles. Now it is quietly assumed by the Government that the basic unit for tolls must be a circuit of not less than 1,000 miles. Since the pacification of the Southern States, our country has grown with wonderful leaps and bounds. Every year has witnessed the penetration by the telegraph lines of distant territory from which profit can only be expected in the future; yet the Government reaps immediate benefit. I will cite here the actual phraseology of the recent order from Postmaster-General Bissell, establishing rates for the current year 1893-94:—

"For day messages containing not more than twenty (20) words, exclusive of place from and date, twenty (20) cents, not exceeding one thousand (1,000) miles, and one cent for each additional word. One quarter of this rate to be added for each five hundred (500) miles, or fraction thereof, but no rate on a message of twenty (20) words to be more than forty (40) cents, nor on an additional word more than two (2) cents. The rate between all points in any State, territory, or the district of Columbia shall be twenty (20) cents for twenty (20) words, and one cent for each additional word.

"In cases where the price of a message, determined as herein provided, shall include a fraction of a cent, such fraction, if less than one-half, is to be disregarded; if one-half or more it is to be counted as one cent.

"For night messages not exceeding twenty (20) words, exclusive of place from and date, fifteen (15) cents for any distance within two thousand (2,000) miles, and for greater distances twenty-five (25) cents; in each case one cent for each additional word.

"Instead of computing the actual distances of transmission, the distance for payment shall in all cases be taken absolutely to be the number of miles between the capital of the State or Territory, or from the City of Washington, if from within the district of Columbia, from within which (whatever the place) the message is sent, and the capital of the State or Territory, or the City of Washington, if within the District of Columbia, within which (whatever the place) the message is received, as shown in the accompanying table, *wherein such distances are given as computed upon the shortest practicable route between such capitals*, and which is to be taken as part of this order.

"But it is provided that if on July 1, 1893, or at any time during the ensuing year, any such Company shall charge the public for a message of 10 words or less, exclusive of the date, address, and signature, a less rate than is herein fixed for 20 words, exclusive of place from and date, the rates here prescribed shall, as to such Company, thenceforth during the year be reduced to the rates so charged to the public."

In comparison with these rates I may state that under the present Western Union schedule the public pays for an ordinary 10-word day message, sent a distance of about 1,000 miles, 40 to 50 cents. A message to Chicago from New York—nearly 1,000 miles—costs 40 cents, but one to any other part of Illinois costs a private individual or a company 50 cents. It is provided in the Government schedule that no rate on a 20-word message shall exceed 40 cents, nor on an additional word more than 2 cents; but the ordinary rate to California—say 3,000 miles—for a 10-word message from New York is $1, and the rate per extra word is 7 cents. As an offset, making to the advantage of the Company, address and signature are counted in, but even then the reduction is a most substantial one. The cases I have cited above will serve to show how the system works.

The companies affected have, I may say, made no complaint against these rates, but those fixed by Mr. Bissell's predecessor were the subject of a bitter fight, still echoing in the Courts. Mr. Wanamaker, in 1889, made the Government rate 10 cents for 10 words, and ½ cent for each additional word, after trying to enforce a rate far lower than that. The Western Union Company objected strenuously, and refused to accept such terms, as being obviously far below actual cost. The average cost to the Company of a message is over 20 cents. It insisted that the Government had no right, and could create none, under the Constitution, by which it could make anybody sell it an article for less than the cost of production. At last the Company took its 10 cent allowance under protest, and its case, dating back to 1889, is now, I believe, awaiting adjudication in the Court of Claims at Washington.

One might imagine that with so much fuss and pother, the telegraph business from the Government would be enormous. But it is not, after every item has been counted in. My impression is that the Western Union Telegraph Company has several customers whose business exceeds that of the Government. It should be understood that the Government and the departments have some wires of their own, but these are of limited length and usefulness, and the bulk of the business must pass over private lines, just as the bulk of the mails passes over private railways. Army officers are under orders to make no use of the telegraph unless it is a case of dire necessity; but many of the civil branches are very free in their use of the wires, and would be more so but for the fact that appropriations are pretty closely watched.

The talk that was so abundant two or three years ago as to the Government acquisition of the telegraphs, or the establishment of a national competing system, is but faintly heard. The huge credit balance in the United States Treasury has dwindled away under the drain of the Pension List and the decline of trade, and now that we are discussing the issuance of bonds to meet ordinary expenditures, Government telegraphs have ceased to be a burning question. But the Act of 1866 is in vigorous operation; to its conditions every company in the field bows, and it has within its clauses all the potentiality necessary to convert our private lines into a system in every wise analogous to that which responds to the guiding hand of Mr. Arnold Morley.

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CENTRAL STATIONS AND NEW TRANSFORMERS.*

BY G. CLAUDE.

The important improvements that have been made in the construction of transformers within the last three years is well recognised, and they have been brought out in a striking manner by Dr. Fleming, in his now classical Paper. From being a mediocre, and under certain conditions of working a detestable piece of apparatus, the transformer has passed at a bound to the front rank, and is now one of the most perfect instruments that the electrical industry has at its disposal. Formerly an important, and for a short time a preponderating, feature was the quantity of electrical energy transformed into heat. In modern transformers the heating is not so great as that of the best dynamos, and this has been attained without the sacrifice of any other valuable qualities, such as compactness, ability to run without supervision, and almost perfect self-regulation, which, in spite of all its other defects, soon marked out the transformer as a remarkable apparatus. No doubt, the alternate-current transformer, on which at an early date so many hopes were legitimately founded, although at that time nothing foreshadowed such rapid improvement, will benefit much from the progress that has been made. But now that the period of transition may be considered as ended, and transformer construction has arrived at such a pitch that it is not probable it will ever be appreciably improved, it is time to inquire whether all the results one might reasonably anticipate have followed. One would have supposed indeed that as soon as the results obtained had been corroborated the first care of those concerned would have been to replace their ancient old-fashioned apparatus by something up to date ; one would have thought that the almost complete suppression of the large amount

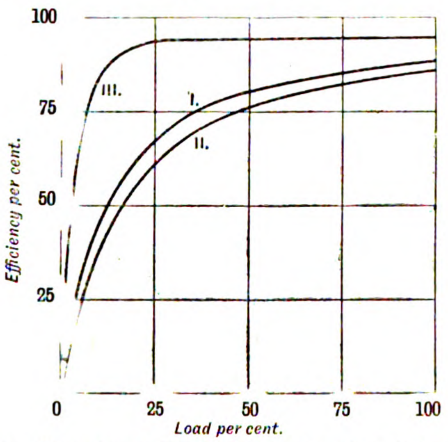

Fig. 1.—Transformer Efficiency as a Function of the Load.

of coal consumed by old transformers, in order to enable them to play the at once useless and expensive part of a stove, would in default of any other reason have been by itself enough to overcome all hesitation. It has not, however, been the case, and with the exception of quite recent installations the evolution of the transformer has not as yet received the *imprimatur* of practice. In France, amongst the numerous stations laid down previous to 1890 or 1889, the plant of which could not consequently profit by modern improvements, we can at the most only cite the Havre station, and perhaps one or two others, as having made the necessary alterations to their plant. This indifference of alternate-current stations to a question which is of such direct interest to them is astonishing enough to make one look for the cause of it in a lack of appreciation of the advantages which result to a station in getting rid of its old plant. It may not therefore be superfluous, I am inclined to think, to call attention to this point, and now I propose to do so.

To avoid generalities, I will devote my attention to the case of the old French stations, in most of which the consumers are supplied by old Ferranti transformers, which ought to be replaced by those of a more recent type. But first let it be remarked that all the transformers at present on the market being about as good one as the other, the conclusions arrived at can be applied indifferently to any pattern, although I have been obliged, in order to make my calculations, to base them on the experimental results of a certain particular type. Further, without attaching any particular importance to the choice, let me take as the typical transformer one of the Labour type, of which a description has been given already (*L'Industrie Électrique*, April 25, 1893). Let us assume, moreover, that the transformers in use are reduced to one common type of 7·5 kilowatts. By doing so we make an hypothesis favourable to the old plant, inasmuch as the transformers are nearly all of a smaller output, and that the efficiency of the old patterns decreases very rapidly with their nominal output, as can be seen by an inspection of curves I. and II. (Fig. 1), which relate to some old Ferranti transformers of 5·75 and 7·5 kilowatts. I now propose to determine the annual saving of energy consequent on the substitution of a Labour transformer of 7,500 watts (Curve III., Fig. 1), for a Ferranti transformer of the same power. The economy at different loads may be found by a comparison of the efficiency curves, if one has a knowledge of the power lost on open circuit. The open-circuit loss in the 7·5 kilowatt Ferranti transformer attains the enormous figure of 700 watts—that is to say, 9 per cent. of the full load, whilst the power lost in the Labour is only 140 watts, or barely 2 per cent. The following table gives as a function of the load the excess of power lost in the Ferranti transformer, compared with that lost in a Labour transformer of the same power :—

Load per cent.	Excess of power wasted, in watts.
0·0	560
2·5	640
5·0	630
10·0	610
20·0	600
50·0	570
100·0	570

Taking into account the long period of open-circuit working, and remembering that transformers practically hardly ever work at more than from 2 to 10 per cent. of full load, but work for the greater part of the time either on open circuit or only at a fraction of the maximum load, we arrive at this interesting conclusion : that whatever be the time of year or day, the economy realised by merely replacing a transformer is near yconstant, and amounts, at least, to 570 watts. In consequence, ccording as the current is cut off during the day—that is to say, during about 12 hours, or the transformers are in circuit during the whole 24 hours, the daily economy in energy will amount to 7·0 or 13·5 kilowatt hours, aggregating in one year to 2,500 or 5,000 kilowatt hours for each transformer.

In spite of the importance of this result the preceding considerations are nevertheless insufficient for the proper appreciation of the economy realised. In almost all the stations, indeed, the nominal output of each transformer is much greater than the effective demand of the circuit which it has to supply ; this was done either in anticipation of a further increase of the demand, or because at the time these installations were laid down a sufficiently exact estimate was not made of the importance of getting as near as possible to working on full load. It is certain that with the conditions of heating inherent in the apparatus then in use it would have been impossible to follow with impunity the excellent method which has since been put into practice, notably in the Champs Élysées district. This system is based on the fact of the short duration of the full load and currents, including the transformers' work at the moment of maximum demand above their nominal output. It is certain that in numbers of stations the transformers work at the time of full load at 50 per cent. of their nominal output. Without speaking of the first cost of the installation, which is very considerable when it is so arranged, I will only point out this result, namely, that the loss on open circuit is no longer the 9 per cent. to which allusion was made just now, but in reality 18 per cent. of the full load. We see, then, that it would be a great mistake to admit the specious reasoning that a bad efficiency matters little at low load, since at that moment the output of the transformer is very small. In fact, I have shown that this loss is, with old plant on low load, far from being as small as we were led to suppose. Moreover, the time factor comes in to give the conditions of working on low load a preponderating influence. The consequences of holding such erroneous views can be better appreciated after an inspection of the curves (Figs. 2 and 3), which relate to normal working conditions, Fig. 2 corresponding to an average summer load, and Fig. 3 to an average winter load, the transformers being in circuit during the whole of the 24 hours. The curves in Figs. 4 and 5 show the alteration which would result from the installation of modern transformers, in which the open-circuit loss can be reduced to 4 or 5 per cent., and even less, if we follow the Champs Élysées plan. From this we see the energy saved will amount to from 20 to 50 per cent. of the output, according as it is winter or summer.

The economy which has just been discussed may be looked at from two points of view, namely, as diminishing the cost of production, and as increasing the useful output. As to the first, it is obvious that the daily economy of from 20 to 50 per cent. of the output of a station does not show itself in a proportionate diminution of the cost of production, the only consequence is, in fact, to lighten the load on the engines, a relatively large diminution when the transformers are on open circuit. If it be impossible to take

* From *L'Industrie Électrique*.

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advantage o' his . sened load by running a smaller engine* we can, nevertheless, diminish the steam, and, therefore, the coal consumption. On the other hand, at the time of maximum load, the available effective output of the station is, by the mere fact of having

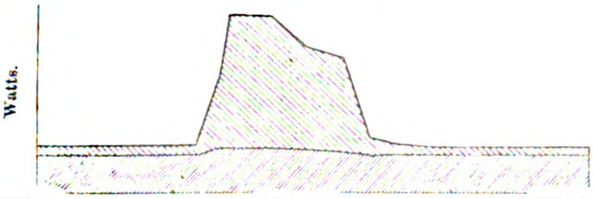

FIG. 2.—Summer.

substituted new transformers, increased by 12 to 14 per cent., which allows of a corresponding increase in the number of consumers without any increase of plant. These two advantages are sufficiently important to enable us, where the conditions are worst, to make

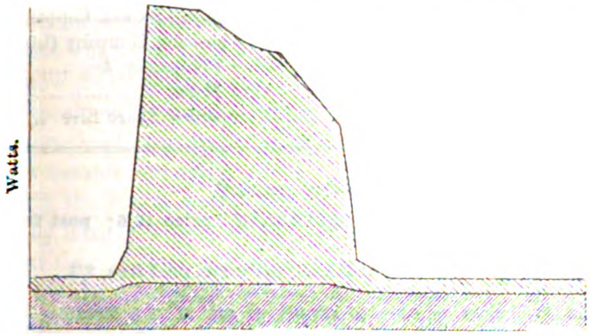

FIG. 3.—Winter.

good in a very short time the outlay on new transformers, from which indeed must be deducted the value of the old material. If it be possible, as it is in some stations, to absorb all the power thus rendered available, either in producing a continuous current

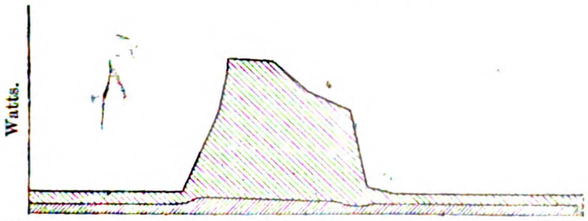

FIG. 4.—Summer.

and charging accumulators with it, or in any other way, the reform will prove still more beneficial. In that case the energy saved will no longer be, as we have assumed, merely deducted from the output, but will become useful, and in that case it will be necessary

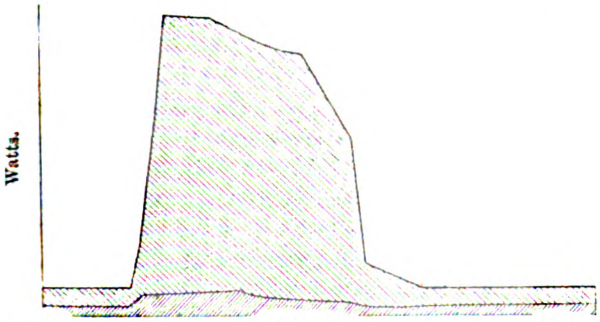

FIG. 5.—Winter.

to credit each kilowatt-hour saved with its cost of production. In such circumstances the first cost could be covered in a few months.

* It is well known, the advocates of accumulators in central stations having called attention to the fact pretty often, that the labour, oil, and maintenance bills remain constant under these conditions, whilst the efficiency is lowered.

THE RESISTANCE AND THERMO-ELECTRIC POWER OF HYDROGENATED PALLADIUM.*

BY G. BRUCCHIETTI.

Palladium in the form of thin plates deposited by electrolysis occludes the greatest quantity of hydrogen, the quantity reaching 985 volumes when the lamellæ are heated in the gas to 100deg. and then cooled. For determining the resistance and the thermo-electric force of a pile consisting of a palladium wire 10cm. long and 1mm. in diameter and pure nickel wire, the palladium wire was placed at the cathode of a voltameter, arranged in series with another water voltameter to determine the amount of hydrogen absorbed. Special precautions were adopted to ensure a uniform absorption of hydrogen, and the absorption was carried as far as 936 volumes at the ordinary temperature and pressure.

The palladium, when hydrogenated, assumes a peculiar brown tint and loses its flexibility. The hydrogen may be withdrawn by heating the wire to a bright red in a gas flame for a few minutes. Repeated charges and discharges make the metal brittle, most of the specimens breaking down at the fifth discharge.

The palladium and nickel for the thermocouple were very pure, and were obtained from the Trommsdorff establishment. They were soldered together by means of silver, and the currents were compared with those from a copper-iron couple.

The results show that in a couple composed of pure and hydrogenated palladium respectively the thermo-electric current will pass from the latter to the former across the hot junction.

The resistance increases with the charge of hydrogen, and a saturated wire has a specific resistance 1·553 times as great as the pure wire. The thermo-electric power of a palladium-nickel couple also increases with the number of volumes of hydrogen absorbed, and the saturated couple shows a thermo-electric force 1·66 times that of the pure palladium-nickel couple. The resistance and the thermo-electric power both increase in a linear ratio.

After repeated charges and discharges of hydrogen, the difference between the behaviour of the palladium in the two states is less marked, and it is probable that after a large number of such operations a state would be reached in which *the presence or absence of hydrogen would make no difference.*

* *L'Elettricista*, November, 1893.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, November 24th.

PHYSICAL SOCIETY.

5 p.m. (1) "The Magnetic Shielding of Concentric Spherical Shells," by Prof. A. W. Rücker, M.A., F.R.S., President. (2) "The Action of Electromagnetic Radiation on Films containing Metallic Powders," by Prof. G. M. Minchin, M.A.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Concert at St. James's Hall Restaurant (Ladies' Night).

TUESDAY, November 28th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Discussion on:—"Impounding Reservoirs in India, and the Design of Masonry Dams," by Messrs. Clerke, Sadasewjee, Col. Jacob, and Prof. Kreuter.

WEDNESDAY, November 29th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "The Regulation of Street Advertising," by Richardson Evans.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

Magnetic Induction at Varying Pressure and Temperature. M. Curie has recently studied the relation between the magnetic properties of a gas and the conditions of temperature. He finds that the permeability of oxygen is constant between inductions of from 200 to 1,350 C.G.S. units, and pressures of from 5 to 20 atmospheres, when the temperature of the gas remains unchanged; also that the permeability varies inversely as the temperature (presumably in absolute degrees) between the limits of 20°C. and 450°C. on the ordinary scale. A further development of these relations would throw some light on the relationship of magnetic induction to the elasticity and density of gases.

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TELEGRAPHS IN THE UNITED STATES.

According to intelligence just received from New York, another attempt is being made in the United States Senate to induce the Government to undertake telegraph business, this time not by acquiring existing systems, but by competing with them. The idea is not, to our thinking, a very promising one, having all the drawbacks of the British Government telephone scheme without any of its excuses. As a measure of self-preservation the erection of trunk telephone lines by the Government instead of by private enterprise is not without justification; but for a Government to erect wires, either telephonic or telegraphic, and work them in opposition to a fully-established system belonging to a commercial company, is neither politic nor fair. If the competition is confined to a limited number of lines, as proposed by Senator BUTLER—that is to say, in the areas that are most remunerative—the greatest injury would be inflicted on the telegraph companies, but without any commensurate benefit to the public at large. If, on the other hand, the conflict were conducted seriously, and with the intention of gradually but effectually superseding all the working companies, the process would involve a huge waste of public money, larger by far than might be needed to purchase outright the whole concerns.

It has long been a matter of wonderment in this country that the United States has not followed the example of European Governments in this respect. We have seen it urged on behalf of American private enterprise that to hand it over to the State would increase to that extent the number of place-hunters. But in a country where "spoils to the victors" is a recognised political axiom this objection would seem to have little weight. A more cogent reason, perhaps, is one let fall incidentally by Mr. T. C. MARTIN in his article on the United States telegraphs, which appears in our columns this week. An impression has prevailed everywhere outside the States that it possesses a reserve of wealth somewhere, gathered

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up from surplus taxation, arbitration awards, and similar windfalls, of embarrassing dimensions, and greater than it knows what to do with. Why not spend it on purchase of the telegraphs? But Mr. MARTIN, who is on the spot, informs us that the much-talked-of credit balance in the United States Treasury has long been a vanishing quantity and is now non-existent. Bad trade is accountable for this partly, but pensioners mostly. In America, State pensioners who do not live for ever continue to receive their warrants in the next world; and even the German Emperor's war hoard could not hold out against a drain such as that.

The excuse therefore for inaction, or for action of the feeble sort recommended by Mr. BUTLER, is, that the United States is too poor to buy up the telegraphs and take over their management. We scarcely credit it, though we admit that the undertaking, compared with our own of twenty-three years back, is of unwieldy proportions. Still the United States may be credited with knowing its own affairs best; and we agree with Mr. MARTIN that the talk about State purchase of the telegraphs is now but faintly heard so far as America is concerned. Unconsciously, perhaps, Mr. MARTIN's interesting article supplies us with the most potent reason of all for the present system remaining undisturbed. The initiative must always rest with the Government, and so long as the Government profits by letting matters alone, we shall not expect it to move. And that it does profit, Mr. MARTIN demonstrates in a way that will be a surprise to most of our readers. The hitherto mysterious fact that, while claiming no ownership or control of the telegraph lines, the American Government determines the rates to be charged for its own telegrams, receives a full explanation at Mr. MARTIN's hands. We are reminded of the relations subsisting here between the railway companies and the Post Office—concessions gradually diminishing on one side, but growing rapidly and to enormous dimensions on the other. For conceding rights-of-way, timber and station lands to the American telegraph companies—rights which have proved inoperative against the attacks of municipalities—the Government exacted the power to fix its own rates; a power exercised to this day, and on the same basis as when the lines did not extend a tenth of the distances they cover now. These governmental rates are subject to revision every year, on much the same principle as Mr. BENJAMIN PICKARD, M.P. for British miners, particularly favours, namely, that every advantage is taken of prosperous times, but nothing yielded to the unprosperous.

Nobody can read the conditions under which, in these respects, the American telegraph companies carry on business without feeling that they are badly handicapped by the States Government. But our sympathy is not for them alone or chiefly. That they submit to it is only to be explained by the facility they enjoy of making the public pay. We in this country can understand the Government stipulating for workmen's trains in consideration of concessions to railway undertakers. That is Democratic Socialism. But things are different in the great Republic, where the State, so to speak, takes the workmen's ticket and lets him pay the difference. Of course, the whole business is a costly extravagance looked at from a broad and national point of view; but until the American people wake up to that fact it need not surprise us much that the Government remain satisfied with an arrangement under which its telegrams are accepted at greatly reduced rates. That arrangement would be certainly broken up if Senator BUTLER's project were set on foot, for even the long-suffering telegraph corporations would rise in revolt against a competitor who underpaid them in one direction and undersold them in another.

COMPENSATION FOR HYSTERESIS.

BY H. ABDANK-ABAKANOWICZ.

My attention was directed to an article on the same subject by Mr. E. B. Vignoles, in which this gentleman indicates a method applied by Mr. Evershed and himself for diminishing the effects of hysteresis in measuring instruments containing iron.

Mr. Vignoles, after describing Mr. Evershed's method, alludes to my method, and in view of the closing paragraph of his article, in which occurs the following sentence:—"It seems desirable, however, that, in view of the publication of M. Abdank-Abakanowicz, the results of our earlier work should be put on record in these pages," I feel called upon to draw a short comparison between our methods, in order to avoid possible confusion in the minds of the readers of *The Electrician* as to the similarity or difference in the two methods.

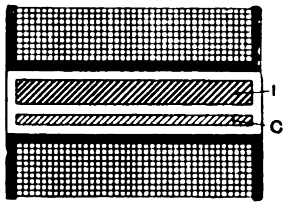

FIG. 1.

Before going any further, I wish to make the statement that neither I nor my distinguished collaborator (Mr. Meylan), who did all the experimental work on this subject, have made any publications concerning it, everything that has been published emanating probably from the records of the different Patent Offices, which are not precisely the sources for purely scientific information. It is, therefore, probably too early to try, from what has been published on the subject so far, to establish a satisfactory comparison between the two methods. However, to show that there is considerable difference between the two, it may be interesting to the readers of *The Electrician* to see the following two examples, one representing Mr. Evershed's method, and the other my own.

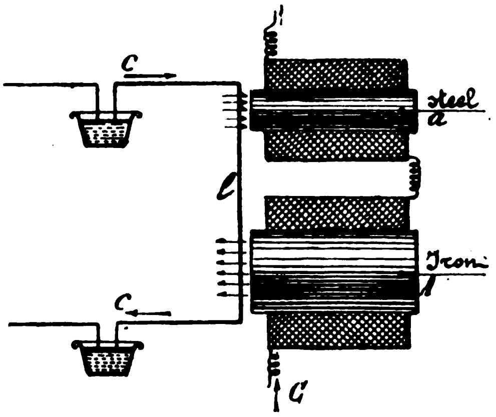

FIG. 2.

Method of Mr. Evershed.—The device of Mr. Evershed is described by Mr. Vignoles as follows:—

"The simplest form of the Evershed method is illustrated by the adjoined sketch, which represents a section of a coil magnetising the iron cores I and C. Suppose the current tends to make the left side north, and suppose that C is made of hard steel, and has, therefore, a much greater coercive force than the soft iron I. When the current is cut off the core C remains more intensely magnetised than I, which is thus demagnetised, and may be reversed. By suitably proportioning the parts the effect outside the core may be entirely obliterated."

This method of diminishing the effect of residual magnetism in special cases is so simple that it needs no further explanation.

Method of Abdank-Abakanowicz.—Let us consider the simplest form of a device consisting of a single wire, *l* (Fig. 2), on which

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are acting the lines of forces of two electro-magnets A and *a*, the former with an iron and the latter with a steel core. The electro-magnet A, of larger section, acts in one direction and the electro-magnet *a* in another, as indicated by arrows. We will suppose that the same current C is flowing through A and *a*. The force exercised by A on *l* will (the current flowing through *l* being invariable) be represented in function of the current in the electro-magnets by a curve which is simply the curve of magnetisation of the core A, and which affects the well-known

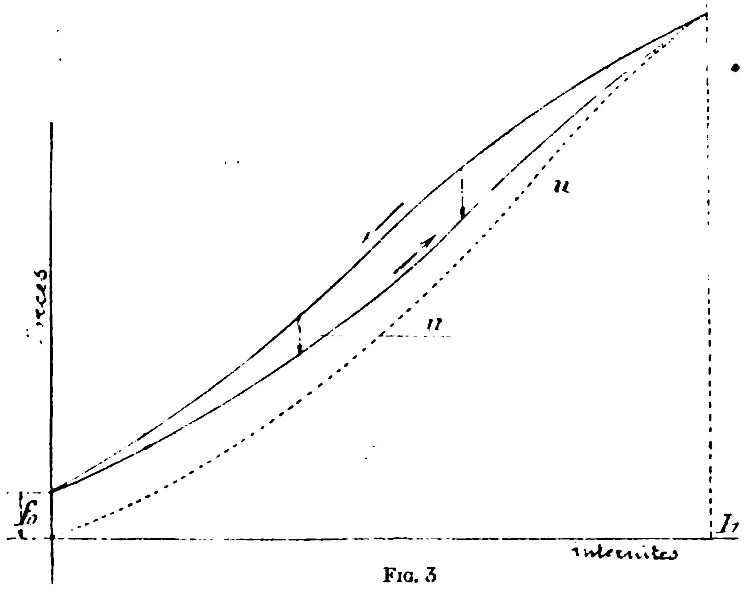

Fig. 3

form of Ewing's cycles (Fig. 3). We admit here that we are starting from zero, and that we follow the cycle in the positive part of the field. The force exercised by the smaller electro-magnet, *a*, is represented by a nearly similar function (the curve is not indicated on Fig. 3), but in which the ordinates of the loop *u u* have a greater relative value. It is easy to understand that by an appropriate choice of the magnetic conditions of the two systems A and *a*, we can arrive at the following results.

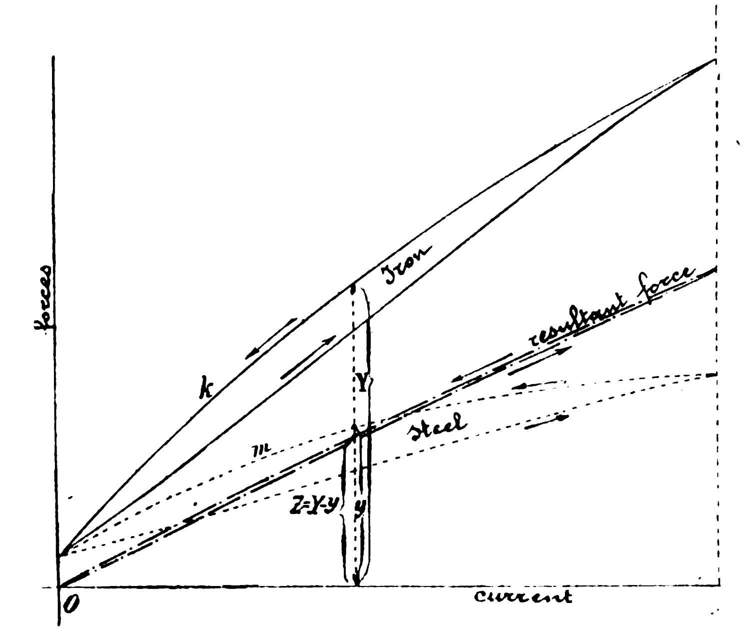

Fig. 4.

1. The remanent magnetism f_0 of the iron is equal to the remanent magnetism of the steel, for the different values of maximum current C obtained in each experiment, and, as the resultant force is the algebraical sum of the actions of A and *a*, and as they are equal, and of opposite sense, the remanent magnetism is zero.

2. The ordinates *u u* of the two loops can be made nearly equal for the correspondent values of the current and for different values of the maximum current. In such conditions the resultant force on the wire, *l*, which is equal to the *difference* of the two elementary forces, will be a definite function of the current C, and will not therefore present the effects of hysteresis, *i.e.*, there will be approximately no loop.

3. Furthermore, the curve of resultant forces having ordinates (Fig. 4) equal to the difference of the ordinates of the two curves *k* and *m*, and these having convexities and concavities of similar character, this resultant curve will approach to a straight line.

Fig. 4 shows how the correction is effected for cyclic variations of current from zero to the maximum value C. Several instruments that we have constructed have given proof that by appropriate choice of conditions it is possible to obtain deviations proportional to the current within very large limits. The principal difficulty consists in maintaining equilibrium when the current reaches a value very much in excess of the given limit. In a very short time we will publish the results of our experimental work on this subject.

TESTS OF GAS BURNERS.

While no exact comparison between the cost of electric ligh by glow lamps and by gas burners is possible, because of th variety of the one and the gradual deterioration of the other, som better estimates may be made than the wild and thoughtles statements of enthusiastic electricians, or the deliberately mis leading figures of many gas engineers. The electricians to often consider little else than volts and amperes, and concoc imaginary coal bills and wages accounts. Gas engineers, o the other hand, almost invariably take a standard Argan burner as a base for their comparisons. Tests of ordinar burners are rarely seen. Gas engineers are probably aware the performance of ordinary burners, but the figures are nev alluded to. One of the only occasions on which tests of comm burners have been published was a report by Dr. J. Hopkins on a system of enriching gas by hydro-carbon vapour som four or five years ago. The peculiarity of this system was th the worse the burner the better was the effect; it may ha failed because no burner was bad enough to do justice to it.

We cannot, of course, afford to devote much of our space the discussion of gas lighting; but in view of the importan of making a fair comparison between lighting by gas and l electricity, we offer our readers an abstract of a very caref and complete report on "The Photometry of Gas Burner made by three students at the Central Institution of the Ci and Guilds of London, under Prof. Ayrton. The observe were Mr. H. C. Haycraft, Mr. A. T. Weightman, and Mr. C. Gawthorp.

The apparatus used was the following:—A Bunsen pho meter, with grease-spot and mirrors; a photometric be about 200cm. long, of which a length of 150cm. was usual employed; a Sugg meter, placed between a regulating tap a the burner under test, giving cubic feet per hour by observ tion during one minute, *i.e.*, reading sixtieths of a cubic foo a pressure gauge, placed between meter and burner; a Met ven two candle standard, used without pentane; and a reflect used in obtaining spherical candle-powers, 5in. in diamet mounted on an axis at 45deg. to its plane.

The report contains an account of the calibration of t meter by displacement of water. The first result showed th it read 0·3 per cent. too high. In other tests in which the ta meter, and collector were differently placed, the results we 1 per cent. too low and 1 per cent. too high, showing th within the limits of experimental error the meter was corre Experiments were made to find the error due to variation the water level from the mark on the meter. Other necessa corrections seem to have been made, with two rather importa exceptions. The barometric pressure was not recorded, and is remarked, in the report, that the mass of gas correspondi to a given reading of the meter may vary within about 10 p cent., the result is in favour of the consumer in fine weathe The other omission is a correction for temperature. It is we known that the candle-power of gas is considerably affected b changes of temperature of the surrounding air,

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For determining the spherical candle-powers, a 5in. circular [mi]rror, A, was mounted on a wooden frame attached to a brass [tu]be at an angle of 45deg., Fig. 1. This tube rotates in a [sp]lit tube mounted horizontally, and carries at its end a disk, B, [div]ided into 5deg. divisions. The distance from the centre of [th]e mirror to the vertical axis was eight centimetres. The [co]efficient of absorption of the mirror was determined by the

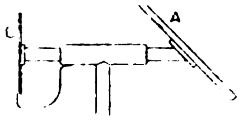
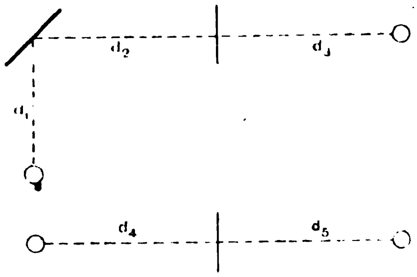


Fig. 1.

[fol]lowing method. A No. 6 Bray's "special" burner was first [co]mpared with the standard in the usual manner, and then [m]oved out at right angles to the bench, its place being taken [b]y the mirror, the ratio of the candle-power in the first to that [in] the second position is termed the absorption coefficient.



[Fi]g. 2.—Measurement of Absorption of Mirror :—d_1, distance from [bu]rner to mirror ; d_2, distance from mirror to photometer ; d_3, distance [fro]m photometer to standard ; d_4, distance from burner to photometer, [witho]ut mirror ; d_5, distance from photometer to standard.

The following are a few of the observations :—

d_1	d_2	d_3	d_4	d_5	Apparent C.P.	Real C.P.	Absorption coefficient.
[illegible]5	94·4	47·6	111·8	38·2	14·62	17·2	1·18
[illegible]5	79·7	62·3	99·6	50·4	6·26	7·8	1·25
[illegible]	97·7	44·5	113·5	36·5	16·45	19·3	1·173
[illegible]	66·3	75·7	87·8	62·2	3·23	3·99	1·24

[Th]e mean of a number of determinations was 1·22.

The Methven Standard was compared with a Harcourt [Pen]tane Standard, and was found to agree very closely with it. [The] height of the flame of the Pentane burner was adjusted [by] the occasional application of a spirit flame, since the perma[nen]t height of the flame lags considerably behind an adjustment [of] the wick.

Tests of Gas Burners.

The gas burners tested consisted of Sugg's, Bray's, Albo [Car]bon, and Wenham. From one-third to one-half of the [obse]rvations have been omitted in the following abstract :—

I.—*Governed Burners.*

[Dist]ance of [bur]ner from [phot]ometer.	C.P.	Cub. ft. per hr.	Pressure in inches of water.	Efficiency C.P./C.F.	Face or edge of flame.
[...] Governed Burner, No. 1—					
[illegible]65	1·27	1·33	1·7	0·957	Face.
[illegible]61	1 245	1·33	1·7	0·936	Edge.
[illegible]93	0·855	0·9	0·55	0 95	Face.
[...] Governed Burner, No. 2 Table Top—					
[illegible]37	3·2	1·945	1·7	1·65	Edge.
[illegible]49	3·4	1·945	1·7	1·75	Face.
[illegible]30	3·1	1·75	0·5	1·77	„
[illegible]65	1·25	0·95	0·16	1·32	„
[...] Governed No. 5 Dome Top—					
[illegible]50	3·42	1·65	0·14	2·07	Face.
[illegible]01	8·05	3·35	0·4	2·4	„
[illegible]21	5·15	2·37	0·24	2·18	Edge.
[illegible]00	12·4	4·75	1·1	2·61	Face.
[illegible]47	10·65	4·75	1·1	2·25	Edge.
[...] Governed No. 5 Table Top—					
[illegible]16	17·0	6·7	1·43	2·54	Edge.
[illegible]29	18 6	6·7	1·43	2·78	Face.
[illegible]08	10·0	3·75	0·5	2·67	„
[illegible]12	2·8	1·49	0·1	1·88	„
[...] Burner for Street Lamps, with Governor—					
[illegible]92	7·65	3·93	1·5	1·95	Face.
[illegible]90	7·53	3·80	0·7	1·98	„
[illegible]13	2·8	1·50	0·2	1·77	„

II.—*Ungoverned Burners.*

Distance from photometer.	C.P.	Cub. ft. per hr.	Pressure in inches of water.	Efficiency C.P./C.F.	Face or edge of flame.
Suggs' No. 1, Table Top Ungoverned—					
72·8	1·78	3·27	1·55	0·545	Face.
73·4	1·83	3·26	1·5	0·562	Edge.
67·4	1·33	1·40	0·6	0·953	Face.
Suggs' No. 5, Table Top Ungoverned—					
115·9	23·1	10·88	1·0	2·12	Face.
113·8	19·85	10·8	1·0	1·84	Edge.
110·2	15·4	5·75	0·35	2·68	Face.
85 7	3·55	1·8	0·05	1·97	„
Bray's No. 6 "Special" Batswing Flame—					
115·4	22·2	8·12	1·1	2·74	Face.
107·2	12·6	5·00	0·48	2·52	„
89·2	4·3	2·02	0·12	2·13	„
Bray's No. 6 "Special" Union Jet—					
111·2	16·5	7·7	1·27	2·14	Face.
109·7	14·8	7·7	1·27	1·92	Edge.
108·75	13·8	5·94	0·85	2·33	Face.
91·4	4·85	2·28	0·2	2·13	„
Bray's No. 6 Patent Enamal Regulators (Batswing)—					
114·9	21·4	8·91	1·1	2·4	Face.
110·95	16·2	5·97	0·6	2·74	„
96·2	6·4	2·52	0·2	2·54	„
Bray's No. 6 Patent Enamel (Reg.) Slit Union—					
117·3	25·8	9·72	1·0	2·66	Face.
110·2	15·4	5·40	0·45	2·85	„
88·3	4·09	1·85	0·1	2·21	„
Bray's No. 6 Patent Enamel Regulator Union Jet—					
109·0	14·2	7·63	1·1	1·86	Face.
94·8	5·9	2·92	0·23	2·02	„
82·7	3·01	1·67	0·1	1·8	„
Bray's No. 5 "Special" Batswing—					
112·0	17·4	7·70	1·22	2·26	Face.
103·0	9·6	3·92	0·4	2·44	„
75·5	2·05	1·19	0·05	1·72	„
Bray's No. 5 "Special" Slit Union—					
111·0	16·2	7·00	1·25	2·32	Face.
101·2	8·6	3·41	0·37	2·52	„
75·5	6·03	2·67	0·25	2·26	„
Bray's No. 5 "Special" Union Jet—					
107·4	12·7	6·69	1·3	1·9	Face.
100·6	8·3	3·76	0·5	2·2	„
76·1	2·12	1·32	0·08	1·61	„
Bray's No. 5 Enamel Regulator. Batswing—					
109·35	14·4	7·5	1·25	1·92	Face.
107·1	12·5	5·75	0·8	2·17	„
97·8	7·0	2·98	0·25	2·37	„
Bray's No. 5 Enamel Regulator. Slit Union—					
110·7	15·9	7·7	1·25	2·07	Face.
107·7	12·9	5·45	0·67	2·37	„
99·7	7·9	3·35	0·35	2·36	„
Bray's No. 5 Enamel Regulator. Union Jet—					
106·8	12·2	7·25	1·25	1·68	Face.
103·8	10·1	5·4	0·8	1·87	„
97	6·7	3·26	0·35	2·06	„
Bray's No. 4 "Special," Batswing Flame—					
109·1	14·3	6·2	1·25	2·31	Face.
106·1	11·7	4·92	0·8	2·38	„
89·1	4·29	1·97	0·2	2·18	„
Bray's No. 4 "Special," Slit Union—					
106·5	12·0	5·84	1·22	2·06	Face.
102·6	9·4	4·28	0·8	2·2	„
94·7	5·85	2·62	0·37	2·23	„
Bray's No. 4 "Special," Union Jet—					
105·6	11·2	6·13	1·3	1·83	Face.
103·4	9·9	4·9	0·95	2·02	„
98·3	5·03	3·45	0·5	1·46	„
Bray's No. 4 Enamel Regulator, Slit Union—					
110·4	15·6	7·7	1·1	2·03	Face.
108·7	13·8	6·4	0·85	2·16	„
102·5	9·3	4·68	0·4	1·99	„
Bray's No. 4 Enamel Regulator Union Jet—					
102·6	9·3	6·95	1·3	1·44	Face.
101·0	8·5	5·3	0·7	1·61	„
96·2	6·4	3·6	0·42	1·78	„
Bray's No. 3 Enamel Regulator Union Jet—					
98·3	7·21	6·3	1·5	1·14	Face.
96·3	6·4	5·17	1·0	1·24	„
87·5	3·92	2·62	0·33	1·5	„
Bray's No. 3 Enamel Regulator Union Jet with Spong's Patent attachment—					
107·5	12·8	6·2	1·4	2·07	Face.
98·7	7·4	3·38	0·5	2·19	„
65·5	1·21	1·19	0·07	1·02	„
Bray's No. 2 Enamel Regulator—					
85·8	3·57	5·06	1·4	0·76	Face.
84·6	3·35	3·99	1·0	0·84	„
70·2	1·56	1·41	0·2	1·11	„

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From the above results, and the curves plotted from them, it is deduced in the Report that—

(1) Governed burners, though their maximum efficiency is no greater than that of ungoverned ones, have the advantage of a more uniform efficiency, especially seen where high pressures are used. The candle-power also remains fairly uniform for considerable changes in the pressure.

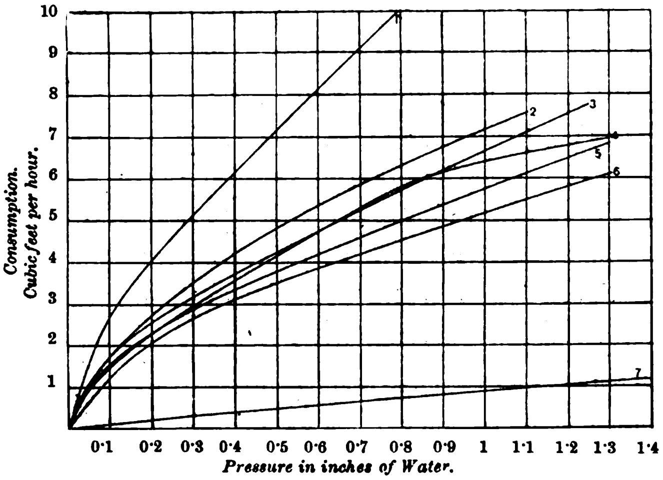

Fig. 3.—Consumption and Pressure.

1. Sugg's Table Top No. 5, Ungoverned.
2. Bray's Enamel Regulator No. 6, Union Jet.
3. Bray's No. 6 Union Jet, Special.
4. Bray's No. 4 Enamel Regulator Union Jet.
5. Sugg's No. 5, Governed.
6. Bray's No. 4 Special Union Jet.
7. Sugg's No. 1 Table Top, Ungoverned.

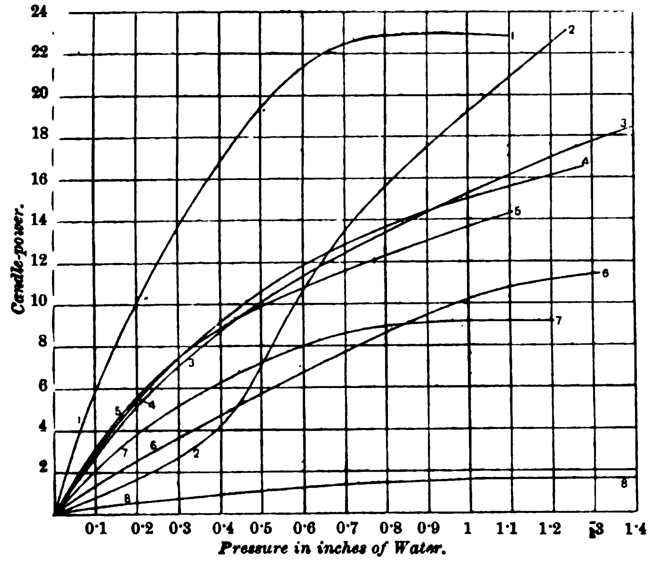

Fig. 4.—Candle-power and Pressure.

1. Sugg's No. 5, Table Top, Ungoverned.
2. London Argand, Sugg's No. 1.
3. Sugg's No. 5, Governed Table Top.
4. Bray's No. 6, Union Jet, Special.
5. Bray's No. 6, Enamel Regulator, Union Jet.
6. Bray's No. 4, Special Union Jet.
7. Bray's No. 4, Enamel Regulator Union Jet.
8. Sugg's No. 1, Table Top, Ungoverned.

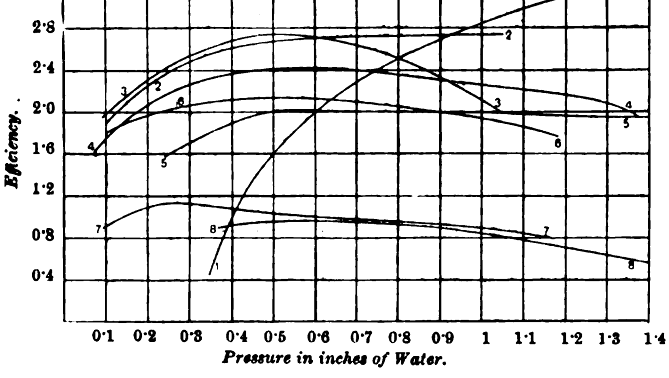

Fig. 5.—Efficiencies (candle-power / cubic feet per hour) and Pressure.

1. London Argand.
2. Sugg's No. 5, Table Top, Governed.
3. Ditto ditto Ungoverned.
4. Fray's No. 6, Union Jet, Special.
5. Bray's Burner for Street Lamps, with Governor.
6. Bray's Enamel Regulator, No. 6, Union Jet.
7. Bray's No. 2, Regulator, Union Jet.
8. Sugg's No. 1, Table Top, Ungoverned.

(2) Of the ungoverned burners Sugg's appear to be more efficient than Bray's. Sugg's No. 5 table-top ungoverned reaches an efficiency of 2·72, while Bray's No. 5's average 2·3 as maximum efficiency, and only one reaches 2·52.

(3) Throughout the above results we see that the efficiency (max.) of all burners increases with the size of the burner, *cœteris paribus*, and that even for low candle-powers it usually pays to use a large burner.

(4) As regards Bray's burners, his "Special" type has a somewhat higher efficiency than the ordinary enamel regulators, and the efficiency does not fall off so much at high pressures. Of the three types of flame—slit-union, batswing, and union-jet—the slit-union and batswing burners are considerably more efficient than the ordinary union-jet burner, the batswing being usually rather less efficient than the slit-union.

Burners for large candle-powers (Bray's and Wenham's).

1. Bray's "standard" burners for large candle-powers.—Two "standard" burners of 30 and 80-c.p. nominal were tested. The two candle power standard being unsuitable for this work an Argand burner was used whose candle-power was found before and after the experiments. It was not found to var appreciably whether the large burners were in use or not. Candle-power of Argand = 14·9. Dist nce from argand t burner to be tested 190cms.

30-c.p. "Standard—

Distance of photometer from Argand.	C.P.	Cub. ft. per hr.	Pressure.	Efficiency C.P./C.F.	Face or edge of flame.
70·5	43·0	17·85	1·5	2·41	Edge.
67·2	49·8	17·85	1·5	2·79	Face.
74·3	36·2	11·8	0·75	3·07	Face.
82·0	25·9	8·45	0·5	3·07	Face.

80-c.p. "Standard"—

Distance of photometer from Argand.	C.P.	Cub. ft. per hr.	Pressure.	Efficiency C.P./C.F.	Face or edge of flame.
57·3	80·0	23·2	1·3	3·45	Face.
64·2	57·3	23·2	1·3	2·47	Edge.
68·6	46·8	14·3	0·6	3·28	Face.
79·0	29·5	9·8	0·3	3·01	Face.

The above efficiencies are fairly high and fairly unifor It may be noticed that whereas the candle-power of ordina burners only varies about 5 to 10 per cent. between edge a full face, the variation with these large burners is great being nearly 30 per cent. in the case of the 80-c.p. burn These burners take too much gas to be run from an ordina tap; they were run from a half-inch pipe, and this only su plied just enough gas for the 80-c.p. burner.

(To be concluded.)

BOARD OF TRADE ELECTRIC TRAMWAY REGULATIONS (DRAFT).

The Electric Powers (Protective Clauses) Joint Committee this session reported that statutory powers for the use of e tricity by tramway and railway companies should be quali by regulations to be made by the Board of Trade for protection of the electric circuits of other parties, and pipes of gas and water companies, &c. The accompany draft regulations have consequently been prepared and mitted for the consideration of the Board of Trade :—

Draft.

Regulations made by the Board of Trade under the provisions of the Tramways Act, for regulating the employment of insulated returns, uninsulated metallic returns of low resistance; for preventing fusio injurious electrolytic action of or on gas or water pipes or other me pipes, structures, or substances; and for minimising as far as is reaso practicable injurious interference with the electric wires, lines, apparatus of parties other than the company, and the currents the whether such lines do or do not use the earth as a return.

Definitions.

In the following regulations—

The expression "energy" means electrical energy.

The expression "generator" means the dynamo or dynamos or o electrical apparatus used for the generation of energy.

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The expression "motor" means any electric motor carried on a car and used for the conversion of energy.

The expression "pipe" means any gas or water pipe or other metallic pipe structure or substance.

The expression "wire" means any wire or apparatus used for telegraphic, telephonic, electrical signalling, or other similar purposes.

The expression "current" means an electric current exceeding one thousandth part of one ampere.

The expression "the company" has the same meaning as in the Tramways Act.

Regulations.

1. Any dynamo used as a generator shall be of such pattern and construction as to be capable of producing a steady continuous current.*

2. One of the two conductors used for transmitting energy from the generator to the motors shall be in every case insulated throughout its length, and is hereinafter referred to as the "line"; the other may be insulated throughout, or may be uninsulated in such parts and to such extent as is provided in the following regulations, and is hereinafter referred to as the "return."

3. Where any rails on which cars run or any conductors laid between such rails form any part of a return, such part may be uninsulated. All other returns or parts of a return shall be insulated.

4. When any uninsulated conductor laid between the rails forms any part of a return it shall be electrically connected to the rails at distances apart not exceeding 100ft. by means of copper strips having a sectional area of at least one-sixteenth of a square inch, or by other means of equal conductivity.

5. When any part of a return is uninsulated it shall be connected with the negative terminal of the generator, and in such case the negative terminal of the generator shall also be directly connected, through the current indicator hereinafter mentioned, to two separate earth connections which shall be placed not less than 20 yards apart.

Provided that in place of such two earth connections the company may make one connection to a main for water supply of not less than 4in. internal diameter, with the consent of the owner thereof.

Such earth connections shall be constructed, laid, and maintained, so as to secure contact with the general mass of earth, and so that an electromotive force, not exceeding four volts, shall suffice to produce a current of at least two amperes from one earth connection to the other through the earth, and a test shall be made at least once in every month to ascertain whether this requirement is complied with.

Where any portion of either earth connection is placed within 6ft. of any pipe, and the company are unable to obtain permission to metallically connect it with the earth connection, they shall provide, by means of a non-conducting screen, that no current can pass between the pipe and the earth connection, without traversing at least 6ft. of earth.

6. When the return is partly or entirely uninsulated the company shall in the construction and maintenance of the tramway (*a*) separate the uninsulated return from the general mass of earth, and from any pipe in the vicinity; (*b*) connect together the several lengths of the rails; (*c*) adopt means for reducing the difference produced by the current between the potential of the uninsulated return at any one point and the potential of the uninsulated return at any other point; and (*d*) maintain the efficiency of the earth connections specified in the preceding regulations, so as to fulfil the following conditions, viz.:—

(i.) That the current passing from the earth connections to the generator shall not at any time exceed 10 amperes.

(ii.) That if at any time and at any place a test be made by connecting a galvanometer or other current indicator to the uninsulated return and to any pipe in the vicinity, the direction of the current, if any, shall be from the return to the pipe and not *vice versâ*.

(iii.) That under the conditions specified in (ii.) it shall always be possible to reverse the direction of the current by interposing a battery of three Leclanché cells connected in series.

In order to provide a continuous indication that the condition (i) is complied with, the company shall place in a conspicuous position a suitable, properly connected, and correctly marked, current-indicator, and shall keep it connected during the whole time that the line is charged.

The owner of any pipe may require the company to permit him to ascertain by test that the conditions (ii.) and (iii.) are complied with as regards his pipe.

7. When the return is partly or entirely uninsulated its electrical resistance shall be tested by the company at least once in every three months. If at any such testing it appears that the resistance has increased by more than 15 per cent. above the value recorded at the time the tramway was opened, the company shall take immediate steps to reduce the resistance to the said recorded value.

8. Every electrical connection with any pipe shall be so arranged as to admit of easy inspection, and shall be tested by the company at least once in every three months.

9. Every line and every insulated return or part of a return shall be constructed in sections not exceeding one half of a mile in length, and means shall be provided for isolating each such section for purposes of testing.

10. The insulation of the line and of the return when insulated, and of all feeders and other conductors, shall be so maintained that the leakage current shall not exceed one-hundredth of an ampere per mile of tramway. The leakage current shall be ascertained daily before or after the hours of running when the line is fully charged. If at any time it should be found that the leakage current exceeds one-tenth of an ampere per mile of tramway, the running of the cars shall be stopped until the leak has been localised and removed.

11. The insulation resistance of all lines, insulated returns, feeders, or other conductors, laid below the surface of the ground, shall not be permitted to fall below the equivalent of 10 megohms for a length of one mile. A test of the insulation resistance of each part of the circuit shall be made at least once in each month.

12. Where in any case in any part of the tramway the line is erected overhead and the return is laid on or under the ground, and where any wires have been erected or laid before the construction of the tramway in the same or nearly the same direction as such part of the tramway, the company shall, if required so to do by the owners of such wires or any of them, permit such owners to insert and maintain in the company's line one or more induction coils or other apparatus for the purpose of preventing disturbance by electric induction.

13. Any insulated return shall be placed parallel to and at a distance not exceeding 3ft. from the line when the line and return are both erected overhead, or 13in. when they are both laid underground.

14. In the disposition connections and working of feeders the company shall avoid injurious interference with any existing wires.

15. The company shall so construct and maintain their system as to secure good contact between the motors and the line and return respectively, and they shall not allow sparking to occur at the rubbing or rolling contacts in any part.

16. In working the cars the current shall be varied as required by means of a rheostat containing at least 20 sections, or by some other equally efficient method of gradually varying resistance.

17. In the construction and use of their generator and motors the company shall take all reasonable precautions to prevent the occurence of undue sparking.

18. Where the line or return or both are laid in a conduit the following conditions shall be complied with in the construction and maintenance of such conduit:—

(*a*) The conduit shall be so constructed as to admit of easy inspection of, and access to, the conductors contained therein and of all insulators and supports.

(*b*) It shall be so constructed as to be readily cleared of accumulation of dust or other *débris*, and no such accumulation shall be permitted to remain.

(*c*) It shall be laid to such falls and so connected to sumps or other means of drainage as to automatically clear itself of water without danger of the water at any time reaching the level of the conductors.

(*d*) If the conduit is formed of metal, all separate lengths shall be so jointed as to secure metallic continuity for the passage of electric currents, and where the rails are used to form any part of the return they shall be electrically connected to the conduit by means of copper strips having a sectional area of at least one-sixteenth of a square inch, or other means of equal conductivity, at distances apart not exceeding 100ft. Where the return is wholly insulated and contained within the conduit, the latter shall be connected to earth at the generating station through a high resistance galvanometer suitable for the indication of any contact or partial contact of either the line or the return with the conduit.

(*e*) If the conduit is formed of any non-metallic material not being of high insulating quality and impervious to moisture throughout, and is placed within 6ft. of any pipe, a non-conducting screen shall be interposed between the conduit and the pipe, of such material and dimensions as shall provide that no current can pass between them without traversing at least 6ft. of earth.

19. The company shall, so far as may be applicable to their system of working, keep records as specified below. These records shall, if and when required, be forwarded for the information of the Board of Trade.

Daily Records.

No. of cars running.
Maximum working current.
Maximum working pressure.
Maximum current from the earth connections (*vide* Regulation 6, i.).
Leakage current (*vide* Regulation 10).

Monthly Records.

Condition of earth connections (*vide* Regulation 5).
Insulation resistance of different conductors (*vide* Regulation 11).

Quarterly Records.

Resistance of return (*vide* Regulation 7).
Conductance of joints to pipes (*vide* Regulation 8).

Occasional Records.

Any tests made under provisions of Regulation 6 (ii. and iii.).
Localisation and removal of leakage, stating time occupied.
Particulars of any abnormal occurrence affecting the electric working of the tramway.

* The Board of Trade will be prepared to consider the issue of regulations for the use of alternating currents for electrical traction on application.

Science Scholarships.—The Coutts Trotter Studentship, of the annual value of £250, for the promotion of original research in Natural Science, more especially in Physiology and Experimental Physics, open to graduates of Trinity College, not being Fellows, of not more than seven years' standing from the time of commencing residence, has been awarded to Mr. Daniel Henry Moore, B.A., scholar of Trinity College. Mr. Moore obtained a first-class in the Natural Sciences Tripos, Part I., June, 1891, and a first-class for Physics in the Natural Sciences Tripos, Part II., June, 1893.

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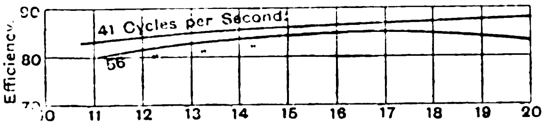
THE ELECTRICAL TRANSMISSION OF POWER FROM NIAGARA FALLS.*

BY PROF. GEORGE FORBES.

(Continued from page 72.)

But the most obvious advantage of low frequency is the improved efficiency of motors. I have arrived at this conclusion from my own observations, but I find it confirmed collaterally. With synchronising motors, of course, the fact has long been thoroughly established that the performance is very much improved by using low frequencies. Again, those who have used the motors with rotating field of the two-phase or three-phase type have all been obliged to reduce the frequency of the current to get the best results. In this connection I am pleased to be able to show a diagram giving some tests which were made for me of a three-phase motor at 41 complete periods per second, and at 56 periods per second.



It will be noticed that at 56 periods the maximum efficiency is given when the output is 17 H.P. It is then 85 per cent., and the efficiency at 41 periods per second at the same output is 87 per cent. But it will be noticed that the efficiency at the latter frequency goes on increasing until the output of the machine is 19½ H.P., when the efficiency rises to nearly 88 per cent. Thus, by lowering the frequency from 56 to 41 periods per second, not only had the output of the motor been increased 15 per cent., but the efficiency had also been increased 3 per cent. It is also found —which is a matter of the utmost importance—that in every self-starting alternating motor, whether multiphase or otherwise, the effort at starting is increased by lowering the frequency.

Again, I find that the ordinary direct-current motor with a laminated field works extremely well with low frequency; even without lamination of the field it works, though not well. I have consulted nearly every electrician of experience in this direction whom I have met during the last year or two, either in Europe or America, on this point, and they generally agree with me that the facilities of working motors of whatever kind are very much greater with a low frequency. Last year, being aware that Prof. Anthony had experimented considerably in the direction of series-wound motors with laminated field, I asked him his opinion, and he expressed himself as follows :—

"In reply to yours of August 30th, I have built two or three continuous-current machines with laminated fields to run with alternating currents, and have succeeded in running motors of about one-eighth H.P. directly from the Westinghouse converter, where the frequency is some 130 per second. Such small machines run very nicely where the alternations do not exceed 25 per second. In fact, so far as I have tested, they seem to give an output fully equal to what they will with continuous currents. Of course, with high frequencies the self-induction of the field is against their working, but at 8 per second I should say that large motors could be run with perfect success."

I wish to repeat that, from what I have seen in the workshops of all advanced electricians in the last year or two, I am confident that in the near future single-phase alternating-current motors, self-starting on full load will be largely used; and there is not the slightest doubt that all of these work far better with low frequencies. In fact, as Mr. Brush once said to me when I was discussing this matter with him, "Really, your best plan would be to lower the frequency so much that you get a direct current."

Whilst speaking of low frequency in relation to motors, I must say that I have much greater hopes of obtaining a good commutating device with a low frequency than with a high one; and I will also state that I have great hopes of important advantages coming to us from the invention of such a commutating appliance which will enable us to furnish street railway companies, electro-metallurgical works, and other consumers with the direct current without the use of any heavy revolving machinery at the transforming station.

I am not sure that it ought not to be said that the greatest advantage of low frequency is in connection with the conductors used for transmission, and in the parts of the apparatus that require high insulation. When a high frequency is used there are certain difficulties which are well known. The first of these has been strongly urged by Lord Kelvin, namely, that when using large conductors an alternating current of high frequency tends to confine itself to the outside of the conductor, thus increasing the total resistance. Attention was first generally directed to this subject by the Presidential Address of Prof. Hughes to this Institution. A second difficulty is that with high frequency the impedance of the line due to the magnetic field formed between the go and return wires may amount to a very sensible quantity. Attention has been drawn to these matters by Mr. A. E. Kennelly, and his Paper* on the subject should be carefully studied. Then, again, with high frequency there is a greater tendency to discharge from an electrified conductor into the air. This means that the insulating of a bare conductor is more difficult with a high than with a low frequency. Lodge and others have made this very manifest with exceptionally high frequencies, but the truth of the statement is well known by those who have experimented even with lower frequencies. Another trouble is that, whenever it is necessary to use solid insulation, a current of high frequency has a greater tendency to injure the insulation. Mr. Tesla has shown and explained so clearly the rapid deterioration of solid insulation by currents of enormously high frequency, that we cannot fail to see that advantage is gained by using currents of low frequency. Another very important fact is that with low frequency we are less troubled by the capacity of cables, and we have less loss of static charge accompanied by heating of the insulation. Again, the serious troubles which have been encountered at Deptford and elsewhere, owing to abnormal rises of electric pressure in the mains above the pressure generated by the dynamos, due to the resonant effect produced by the capacity of the cable and the self-induction of the circuit, may be reduced as much as we please by sufficiently lowering the frequency. All these facts are the explanation of what has been thoroughly established in actual practice, namely, that there are difficulties on the line when using high frequencies which tend to loss of power and to destruction of the insulation, and that these difficulties are largely mitigated, if not entirely obviated, by reduction of the frequency. It must also be remembered that, if we reach a frequency as low as 16 periods per second, any induction in neighbouring telephone circuits is utterly inappreciable by the ear. Finally, all eddy-currents diminish as the square of the frequency. Having now stated, as clearly as I can, what seemed to me the principal advantages of low frequency, I will place on the other side the disadvantages.

Besides the increased cost of transformers there is one fact which is apt at first sight to impress one as almost fatal to the employment of very low frequency, but which further consideration shows to be of little moment in the case of Niagara Falls: this is, that a low frequency is not suitable for electric lighting directly. But it must be remembered that it is decidedly preferable to use a direct current for arc lamps, and, in fact, in the present position of the art in America it would be almost a necessity. Hence the natural method of arc lighting would be to use the alternating current by means of a motor to drive the well-known arc lighting machines. In the course of the work at Niagara the first work in connection with arc lighting which will be set up is the lighting of Buffalo. At present this is done by means of steam engines, developing about 3,000 H.P., and driving arc lighting machines of the Brush, Thomson-Houston, and Wood types. There cannot be a doubt that, financially and practically, the best way of converting this station to enable them to use the power from Niagara Falls is to put in alternating motors in the place of the steam engines; and this will be the case in most of the towns which will be supplied with power from Niagara Falls.

It will be well at this point to say something about the frequency which is required to prevent the arc and incandescent lamps from flickering. I have made a number of experiments on these points, and my conclusions are as follows :—A 16-c.p. 50-volt incandescent lamp shows a flickering almost up to 25 periods per second, at which frequency the flickering ceases when at its normal brightness; but if pushed to an excess of incandescence, the flickering was just perceptible up to 27 or 28 periods. I believe that a 100-volt 16-c.p. lamp shows a perceptible flicker up to 28 periods; but I may mention that this flicker is not nearly so serious or perceptible as that which frequently arises from the employment of certain types of engines, especially single-acting high-speed engines, when sufficient fly-wheel momentum is not provided. As a case in point, I would mention the lighting in the Holland House, one of the best hotels in New York, where, to an experienced eye, the flicker of the lights in the large dining-room from this cause is very objectionable. The thinner the filament, the more liability is there to such a flickering. I have lately examined the thick filament lamps to which the name of "Bernstein" lamps has been given, which consume 6 to 10 amperes at low voltage. It takes so long a time for the incandescence to die out when the current is stopped, that I have little doubt about their being able to work without any perceptible flickering at so low a frequency as even 16 periods per second. I have also made some experiments of a similar nature on arc lamps at low frequencies. At 37½ periods

* Paper read before the Institution of Electrical Engineers November 9th.

* "Impedance," by A. E. Kennelly, American Institute of Electrical Engineers, April 18, 1893.

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per second there was very bad flickering, and this was most noticeable when looking at a piece of white paper illuminated by the naked light, or when looking at an opal shade put on the lamp. At 40 periods it was still bad. Neither at this speed, nor at the previous one, was there any serious noise, but at 40 periods the noise could be perceived by putting a glass globe over the lamp resting on the metal framework directly. At 41·7 periods there was just enough flickering to be objectionable; at 45 periods it was just possible to notice it on a printed page held close to the lamp, but it was not visible when reading at a distance of 10ft. At 50 periods the only means of detecting anything of the sort was by looking directly at the arc; nothing was seen when reading a book, either with the opal shade on or off. At this frequency the noise became much more perceptible, especially with a long arc about one-eighth of an inch. On reducing the length of the arc to one-sixteenth of an inch the noise was much less. In all these experiments the consumption of energy was at the rate of 26 volts and 14·2 amperes at the lamp terminals. The best cored carbons of Siemens and Halske were used.

An objection has been raised to the use of low frequency owing to the fact that a periodical twisting strain is given to the shaft of the dynamo, but this objection disappears almost entirely when we are dealing with a machine generating two phases.

It follows, therefore, that for arc and incandescent lighting at a very low frequency it becomes necessary to use alternating-current motor-generators, or else to use something of the character of a commutating machine to convert into continuous currents. Such machines as those exhibited by Schuckert at Frankfort in 1891 are useful up to a certain extent, but they are expensive, and comparatively inefficient, as their only function is to commutate the current—an operation which ought not to involve any significant loss. At the present moment a good commutator for the alternating current is not upon the market, but the matter is of such prime importance that I feel confident that much will be done in this direction. In fact, I have seen enough with my own eyes to have no fear about our being able to generate continuous current from the two-phase alternating current without serious loss, and with very inexpensive machinery. If, however, the object of our work was mainly, or even to a considerable extent, to provide the means of lighting towns by arc and incandescent lamps, I should have hesitated to recommend a reduction in frequency below 42 periods per second, such as is used by Ganz and Co., and which is operated so successfully at Rome and Tivoli, and at a very large number of other places on the Continent. The officers of the Company and myself considered this matter most carefully, and, looking at the purposes for which our machinery is being set up, we felt sure that the proportion of electricity which would be used for lighting purposes would not be large, and that we must look upon our whole plant as a power producing and distributing plant, and that our object must be to distribute power in the most efficient and economical manner. This being the case, we agreed that it was desirable to lower the frequency so far as the mechanical conditions of the problem would allow. The lowest frequency which had been offered to us by the manufacturers was a very beautiful design of a machine at a frequency of 20 periods per second. This machine had admirable qualities, but was in some points not exactly adapted to the requirements of the situation, as developed by the selection of a special design for the turbine.

I have myself made several trials of designs at very low frequencies, even as low as eight and one-third periods per second, and for this frequency I prepared drawings of a machine which, though by no means perfect, shows a possibility of being worked into a sound machine of good mechanical construction; but further considerations led me entirely to modify the design of the machine, and eventually I arrived at the conclusion that, both from the point of view of design of the dynamo, and also for suitability of applying the current, 16 periods per second was probably as good as could be obtained. The manufacturers to whom the contract has been given were anxious to use a lower induction in the iron of the machine than that which I would have preferred, and this rendered the machine of 16 periods per seconds heavier than could be supported by the hydraulic piston which supports the whole weight of the turbine, vertical shaft, and revolving part of the dynamo. Consequently we have made a compromise, and are going to build our first three dynamos with a frequency of 25 periods per second. In concluding my remarks upon low frequency, I must again repeat that, from a purely practical and commercial point of view, one of the great advantages lies in the fact that for any special purpose for which a motor is required any ordinary direct-current motor may be altered so as to act as a synchronising alternating motor at a very small expenditure of time and money.

Electromotive force.

The question of selecting a suitable electric pressure for working to Buffalo, and also for local purposes, is of some importance. Generally speaking, it is desirable to use as high an electric pressure on the line as is consistent with safe and continuous working, as this effects a great saving in the amount of copper used on the line. In the first report, founded on insufficient data, which I wrote more than three years ago for the Cataract Construction Company, I recommended that 2,000 volts should be used in the neighbourhood, and that the pressure should be raised by means of transformers for the more distant transmission. But the greater portion of our work in the immediate future will have the character of distant transmission. In most of the tenders which were submitted to us the cost of transformers was almost as much as that of dynamos, in some it was more, so that the use of a step-up transformer for distant transmission meant almost double the cost of generating the current. I hold the view that a pressure of even 20,000 volts can be generated as safely in the dynamo machine itself as in the transformers, and that if we used 20,000 volts for the local work as well as for Buffalo we should not be incurring the additional expense and losses of a step-up transformer, while we should be saving enormously in the cost of copper. Unfortunately, American manufacturers have never supplied alternating-current dynamos at a higher pressure than 2,000 volts, and they are not practically acquainted with the experiences which have been gained in Europe at extra high pressures. Most of the manufacturers declared their inability positively under any conditions to go above 2,500 volts, although some of their engineers were willing to go as far as 5,000 volts. This, however, would have been no material gain to us; and the consequence is that to meet the views of the manufacturers in our preliminary work—that is to say, in the construction of the first three dynamos for our power-house—these will be only of such electrical pressure as they are accustomed to deal with. We shall, therefore, be using dynamos generating current at 2,000 volts, and employing step-up transformers for the extra high pressure. This may possibly render it desirable in our first work not to use the extra high pressure for local purposes. Besides the actual cost of the conductors a very serious matter arises when we are dealing with the large currents due to comparatively low electric pressure. I refer to the large quantity of copper which has to be put into the conductors. Working at 2,000 volts, each phase of each of our generators will give nearly 1,000 amperes without considering the effects of retardation of phase, which will increase the current by quite a perceptible amount. So that to put in the most economical section will require 3 sq. in. for each conductor or 12 sq. in. of copper for each 5,000-H.P. dynamo, or 36 sq. in. section of copper for the 15,000-H.P. which is now being supplied. When we remember that even with low frequency the question of skin resistance comes into play when the conductors have a large diameter, it is obvious that we are introducing serious troubles, and if a subway were to be made to carry these conductors it would require to be of very great dimensions. For these reasons I am still anxious to see the extra high pressure used, even for the factories within a distance of a mile. The uniformity of the system would undoubtedly be of great benefit to us if we could generate the whole current for all purposes at the same extra high electric pressure; but, as I have stated, we were obliged to content ourselves with a somewhat less perfect arrangement than would be adopted if we were dealing with the utilisation of a waterfall in Europe.

I wish to lay stress on the importance which I have considered to lie in the fact of having a perfectly uniform system with interchangeable dynamos. Many engineers to whom I have talked have suggested the use of special dynamos at different pressures for special purposes; but if we had a special dynamo for arc lighting, and another for incandescent lighting, a third for street railways, another for electro-deposition, and so on, the possibility of interchanging dynamos would disappear, and the whole system would be much more complicated to work.

I wish now to make a few remarks about the insulation which it has been customary to put upon dynamos and transformers which were to be used with high electric pressure. Many persons who have not given sufficient attention to the subject seem to be inclined to believe that there is something mysterious about the tendency of electricity in a dynamo or transformer to break through the insulation, and which prevents them from being subject to the ordinary laws of electricity. Thus, when building a dynamo for 2,000 volts a thickness of insulation is given which would stand a test of more than 100,000 volts without breaking down, and it has been found from the ordinary methods of using the plant that if something of this sort is not done the insulation will break down. I wish to point out that the reason for this lies in the fact, not that the insulation breaks down with 2,000 volts, but that in a 2,000-volt system, as generally used, electromotive forces are occasionally generated amounting to 100,000 volts or more. These abnormal rises in electric pressure are chiefly due to the resonant effect, which has received so much attention of late years, and may be caused by the sudden breaking of the circuit of the dynamo. If these causes of excess be avoided, the electric pressure will never rise above the working pressure, and the insulation will never break down, even though its thickness be only little more than sufficient

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to stand a test at the working pressure. Dr. Fleming has shown us how to kill the resonant effect, and such a phenomenon never appears now at Deptford. This trouble may also be avoided by having as little capacity on the line as possible, especially when combined with low frequency. As to the cause of trouble mentioned above, I hold that it is a piece of culpable ignorance, ruinous to the machinery, if anyone should ever, on a large power circuit with alternating current, suddenly break the circuit while current is passing. This practice is quite unnecessary, and has given rise to a large proportion of the breakdowns of alternating-current machinery.

(*To be continued.*)

INSTITUTION OF ELECTRICAL ENGINEERS.

ANNUAL DINNER.

The fifth annual dinner of the Institution of Electrical Engineers was held on Wednesday at the Freemasons' Tavern, Mr. W. H. Preece, President of the Institution, in the chair. There were present the Right Hon. Arnold Morley, M.P., the Right Hon. A. J. Mundella, M.P., Prof. G. Carey Foster, Sir Jas. Crichton Browne, Mr. Jacob Brett, Dr. H. E. Armstrong, Prof. W. E. Ayrton, Mr. Latimer Clark, Prof. D. E. Hughes, Mr. J. Wolfe Barry, Prof. G. Forbes, Prof. A. W. Rücker, Prof. W. Crookes, Mr. W. H. M. Christie, Mr. G. Kapp, Sir Thos. Blomefield, Bart., Mr. F. J. S. Hopwood, Mr. W. M. Mordey, Mr. Jas. Swinburne, Mr. A. Wright, Prof. J. Perry, Sir David Salomons, Bart., Mr. Alexander Siemens, Mr. R. E. Crompton, Sir Hy. Mance, C.I.E., Mr. F. Bailey, Mr. Lamb, C.M.G., Mr. Macrory, Q.C., Hon. C. Dillon, Major Holden, R.A., and many others.

The toast of the Queen having been drunk,

The PRESIDENT proposed the toast of the "Learned Societies," coupled with the names of Sir James Crichton Browne and Prof. A. W. Rücker. By singling out a certain class of gentlemen as members of learned societies, they did not by any means wish to imply that the members of the Engineer's Society were unlearned, the distinction which they wished to make was between knowing and acting. There were many of them who were duplex members, and as regarded their guests, there was no doubt that in editorial quarters public officials were considered neither learned nor unlearned, taking up a zero position. The public man suffered very much, not so much from that which he said as from that which he did not say; he was subject to a fiend called the interviewer. There was also the portrait taker, and the biographer who brought to light not only all the things they did, but the things they did not do. The learned man, however, could retire calmly to his laboratory and think out problems, or rule in his class-room an attentive audience of students. There was no doubt that the practical man owed much to the theoretical man, but the theoretical man owed a good deal more to the practical man. Telegraphy, telephony, the electric light, and electric railways owed their development rather to practice than theory. However, theory kept them straight, and told them what to do, and the representatives of the learned societies were doing in their spheres an immense amount of service to the practical men. Sir James Crichton Browne was Vice-President of the Royal Institution, an institution to which he entirely owed his own presence there, as but for the early sparks of electrical lore impressed upon him by Faraday he did not believe he should ever have attained his present position. They were proud also to couple the toast with the name of Prof. Rücker, whose charms as a lecturer they were well acquainted with.

Sir JAMES CRICHTON BROWNE, in response, said that he could safely affirm that they regarded it as a compliment to have their position and work recognised by a body like the Electrical Engineers, and by all those engaged upon electric research, in regard to whom they, the learned societies, were standing on tip-toe eager to see what they were going to do for them next. They were full of gratitude and admiration towards them for their splendid achievements of recent years, but they had a lively sense of favours to come. The Electrical Engineers had festooned their homes with beatified glow-worms; they had stretched their ears—not in any asinine sense—so that they extended all over the town, and even as far as Paris; they kept them in sympathetic vibration with everything that was going on in the uttermost parts of the earth, and elevated or depressed them, as if phantom steeds worked by spectral machinery obeyed their behests; they had performed chemical transmutations like the alchemists; and they had treated them when they were ill like the Royal College of Physicians. They had vastly increased the comforts and conveniences of modern life, added enormously to the means of human communication, and afforded invaluable assistance to students and investigators in every department of science, and to find a parallel to their achievements of recent years, and the expectations they had gathered, it would be necessary to go back to the sixteenth century, when the discoveries Columbus helped

"To fill
The spacious times of great Elizabeth
With sounds that echo still."

When the annals of the present reign were written there would be no more brilliant chapter than the one that recorded the exploits of electrical engineers. As regards the Royal Institution he would only say that he thought it was worthily maintaining the great reputation it obtained by the labours of Davy, Faraday, and Tyndall; work was now being carried out in its laboratories which could not be carried out anywhere else, momentous scientific work of deep interest and far-reaching significance. He had hoped to meet Prof. Dewar there, but he understood he had gone down to St. Andrews to receive a well-earned academical honour.

Prof. RÜCKER said that there was no radical distinction between the learned societies and the Electrical Engineers Society. The pictures that were sometimes drawn both of the theoretical and the practical man contained as much truth as caricatures generally had. After all, the distinction between practical and theoretical work was not a distinction of subject but of the spirit; pure science might be cultivated in the spirit of commerce, and commerce in the spirit of science.

Prof. W. E. AYRTON proposed the toast of the "Engineering Societies," the toast being responded to by Sir FREDERICK BRAMWELL.

Mr. LATIMER CLARK then proposed "Our Guests." They were honoured by the presence of two members of the Government, both equally interested in engineering. He should like also to mention the name of Mr. Jacob Brett, who was undoubtedly the father of submarine telegraph, and who was with them there.

Mr. MORLEY expressed the opinion that no commercial undertaking, certainly no deparment of the State, was more dependent upon or interested in the successful development of electricity than that branch of the service with which the president was connected, and over which he himself had the honour to preside. It was common knowledge that the success of our telegraph and telephone systems was dependent upon the successful utilisation of electrical currents, and he did not think he claimed too much when he said, with regard to the first of those services, that we had at least taken the foremost place among the nations of the world, even if we were not entitled to claim that we had surpassed all other nations on both sides of the Atlantic, and that we had provided a service which was superior to that of any other country. A series of almost unprecedented storms had lately been experienced, and he was glad to be able to report that the telegraphic service of the country had almost without exception been uninterrupted by those serious disturbances. It was not so on the Continent, and two days ago, speaking telegraphically, had once again absorbed Calais within the Empire of Great Britain, because all telegraphic communication with Calais was for a time entirely suspended, except by the wire which connected Calais with London. He did not know that he could say so much with regard to our telephone system, but he had very little doubt that the time was not far distant when that system would be equal if not superior to the telephone of any other country.

Mr. MUNDELLA proposed the toast of "The Institution of Electrical Engineers." He took occasion to mention that the excellent work done by the Electrical Standards Committee had been approved generally by electricians throughout the world. France, Germany, and the United States were prepared to adopt them, and he was so much encouraged by all he heard of the prospects of an international arrangement that it would shortly be his duty to submit an Order in Council to Her Majesty adopting the electrical standards as the standards for this country, and he hoped for the civilised world. He acknowledged the indebtedness of the Board of Trade to the Institution, and cordially desired the development and extension of its operations.

The PRESIDENT, in reply, said he had been associated with that Institution since its start. The slope of energy ascended as they proceeded westward, and contact with the land of the prairie seemed to excite a mental activity, and except in regard to telegraphy they must seem small to their American cousins. Nothing grander had been seen than the World's Fair. They were making in this country great advances; their progress might be slow, but he thought that in the end it was sure, and they might find themselves at the very head. The electric light, he contended, was to become the poor man's light. He had announced that over and over again, and even now it was received with a slight amount of ridicule. Their trouble was that electric light was too cheap, and did not at present produce the revenue some of them had anticipated. Their Society on January 1, 1873, numbered 352 members; now they mustered 2,260, the average number of members per year joining them during the past six years being 225. Turning to the question of the future, there was nothing so sure to happen as the unexpected, but what it was no man could tell. Speech was being extended in all directions, and he saw no difficulty in speaking with America; and they might even be able to see their cousins at the Antipodes. Their Institution dealt with the present, and its object was to collect facts, to circulate truth, and to cement friendship, and when they were called upon by the great Departments of State to assist them in their deliberations, they would do everything in their power with all their hearts and souls to render them that assistance. The President of the Board of Trade might be quite certain that when he got back from them those rules and regulations which he thought they should be able to understand, they would try their very utmost to meet his difficulties, to put them into such a state that he would have no difficulty in understanding them.

The meeting then terminated.

Electricity in Mining.—A Paper presented at the recent Engineering Congress in Chicago stated that there were in the United States 300 mining companies using electricity. Several mines in Colorado are operated by electricity that could not be by steam, on account of their situation on the face of precipitous cliffs, up which the transportation of water and fuel would be nearly impossible.

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LEGAL INTELLIGENCE.

The Medical Battery Company (Limited).

At Marlborough-street Police-court on Wednesday last, C. B. Harness, Managing Director of the Medical Battery Company; J. M. M'Cully, a physician, of Blandford Mansions, East-street, Marylebone; C. B. Hollier, a salesman, of Warley, Sussex; and Dudley Towers, a "masseur," were charged on remand, before Mr. Hannay, with having conspired, by fraudulent advertisements and otherwise, to defraud; also with having conspired to obtain by false pretences the sum of £52. 10s. from Col. Jeremiah Brewer, the sum of £2. 2s. from Theobald Burbage, and the sum of £2. 2s. from William Hibberdine Manners, in each case with intent to defraud.

Mr. Thomas Terrell prosecuted; Mr. Horace Avory appeared for Harness, Mr. A. R. Cluer for M'Cully, Mr. C. F. Gill for Hollier, and Mr. C. W. Inman for Towers. Detective-sergeant Weatherhead, D Division, watched the proceedings on behalf of the police.

WILLIAM LYND, an electrical engineer, said that he had been in practice since the year 1857. In 1887 he met Harness for the first time, who told him that he wanted a gentleman well up in electrical science to deliver a series of lectures on the applications of electricity. He said, "I will be perfectly frank with you; my electrical knowledge would go into a nutshell. I have built up a large business, have got a fine establishment, and if I am not on the right tack just tell me where I am wrong." He entered into an arrangement with Harness to give 12 or 14 lectures, and Harness agreed to pay £2. 2s. for each. On a subsequent occasion he had a conversation with Harness about the bills which were lying in bundles all over the premises, and advised him to make a genuine electric belt. Harness then said, "The belt is good enough for me, is good enough for the public, and all we have to do here is to sell the goods." Harness told him that the belts cost him 2s. 9d. each all round. They sold at that time from £1. 1s. to £5. 5s. each. He knew that Harness had absolutely no knowledge of electricity owing to the ridiculous questions that he asked. Once he inquired, "Do you get electricity from a dynamo by friction?" He had a conversation with Harness about his assistants, and Harness asked him not to talk to them about electricity, for it only embarrassed them. Harness told him that a pushing draper's assistant was a good man to employ because he knew how to sell the goods. In one of his lectures witness referred to distinguished electricians; after the lecture Harness called him on one side and said, "I don't want you to advertise such cattle. You must speak of Harness's electricity. Take my advice, science does not pay. If you will step down from your scientific pedestal to our level and help to sell the goods I will make your fortune." While witness was at the establishment, which was about four weeks, he never found anyone there that knew anything about electricity.

Cross-examined by Mr. GILL: His title to be called an electrical engineer rested upon the experience he had had in electricity. He was manager to J. Lewis Young, of Fore-street, and managed for them the Edison Photograph Department. He also delivered lectures on scientific subjects all over the country on his own account. He did not lecture upon electricity as being a means to cure disease. He did not sell electrical appliances. He had lectured against the appliance of the Harness belts because he wished to expose the fraud. He had for four years studied anatomy and physiology in relation to electricity. In one of his lectures he spoke generally of the advantages of electrical treatment, as applied at the establishment of Mr. Harness. When he was delivering his lectures he did not warn the audience that the brush which was sold downstairs was a bogus one. He meant to expose the affair after he had delivered the lectures he had contracted to give. He did not think that he referred to the "eye battery" in his lectures. He would not swear that he did not speak of it "as being admirably adapted for strengthening the optic nerve." He could not undertake after such a lapse of time to remember the details of his lectures.

Mrs. KATE WILCOCKS then gave evidence as to the effect of wearing one of Harness's belts.

Cross-examined by Mr. AVORY: Mr. Morris, the solicitor for the prosecution, undertook to take up her case for nothing. She did not know that in October, 1893, he had written to the Medical Battery Company claiming damages on her behalf.

The defendants were formally remanded for a week.

The petition against the Medical Battery Company (Limited) came again before Mr. Justice Vaughan-Williams on Wednesday. The petition had been amended by asking alternatively for a compulsory or a supervision order.

After hearing counsel for and against the petition,

His LORDSHIP said he considered it his duty to take care that the case should not be determined by any topics of prejudice or matters foreign to the liquidation proceedings. When the petition was first presented no resolution was passed for voluntary liquidation, but a debenture-holders' action was commenced, in which a receiver was appointed. Subsequently a resolution was passed that the Company could not by reason of its liabilities go on, that it should be voluntarily wound up, and that Mr. Davis, an accountant, should be appointed liquidator. So far as the police court investigation at Marlborough-street was concerned, that ought not to be held to be a ground for saying that the creditors would be prejudiced by the continuance of a voluntary winding-up. The Company had obviously been under the conduct of one man, and the affidavits produced went to show that Harness dealt with the affairs of the Company in a way which was unusual. However creditable it might be that Harness and others should desire that the new Preference shareholders should not suffer, still, there was no right to return their money. It would be very prejudicial to the interests of the creditors that the liquidation should continue under the control of the shareholders, especially as the receiver in the debenture-holders' action was to continue in office, he being the nominee of the shareholders. Under the circumstances the Court would make a compulsory winding-up order.

Elieson Accumulator Syndicate v. the Earl of Galloway.

This case was heard before Mr. Justice Kennedy, without a jury, some days ago, and was reported in our last issue.

His Lordship gave judgment on Wednesday. He said he was of opinion, firstly, that there was no such Company; and, secondly, that, even if there had been a valid application by the defendant for shares, there was a withdrawal of it before there was any acceptance by the Company. Upon either of these grounds the defendant would be entitled to succeed in this action.

CORRESPONDENCE.

THE CANDLE-POWER OF ARC LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the editorial remarks on the candle-power of search lights, I am very sorry that you should have so thoroughly misunderstood the meaning of my letter as to assume that I referred to the surface illumination produced by the beam of light. I precisely meant the candle-power of the search light as measured in the same way as it is done with any incandescent lamp, for instance, by phometric tests at a distance sufficiently large to make the diameter of the light negligible against the distance, so as to make the law of inverse squares applicable.

I think I can trace the source of this error in your editorial remark to a mistake as to the nature of the rays emitted by the light, an error which, by the way, is frequently made. You seem to assume that the rays of the search light are naturally parallel, and that what there is of divergence is due to irregularities, &c. This would, indeed, be true if the light-giving source were a mathematical point in coincidence with the focus. Since, however, the crater of the arc is not a point, but an area, there exists a true divergence in the rays of the search light, and the rays issue from the reflector, not mainly in one direction only as a parallel beam, as you state in your remark, but about uniformly in all directions within a small spherical angle, the angle of divergence of the beam. The result hereof is that the diameter of the beam—except in the immediate neighbourhood of the reflector—is proportional to the distance from the reflector. Hence the illuminating power is inversely proportional to the square of this distance, and the search light acts similar to an ordinary arc lamp, with a screen with a round small hole in front of the lamp, which permits only a beam of small angular diameter to pass, but by no means a beam of parallel rays.

It is certainly not possible, in the short space of a letter, to give a complete treatise on the search light, correcting, for instance, the further error you make in your editorial, that only the solid angle subtended by the reflector needs to be considered, and that the large size of the reflector is, therefore, only for the purpose of avoiding shadows, &c.

I may refer you, however, to a short treatise on this question by Mr. F. Nerz, published in your own paper, *The Electrician*, where I hope you will find all the explanation necessary to understand the fact that the photometrically observed candle-power are, within the beam of light, really of such magnitudes.—Yours, &c.,

November 7, 1893. CHARLES PROTEUS STEINMETZ.

[The "further error" alluded to in the last paragraph but one of the above letter relates to a Note on a totally different subject, viz., the Paper by Mr. B. A. Dobson, on "Artificial Lighting of Workshops." The remainder of the letter is dealt with in our Notes.—ED. *E.*]

A Turin correspondent, asking for information respecting the working of the Rockport-Nova Scotia cable, belonging to the Commercial Cable Company, is referred to Mr. F. Jacob, Ellsdene, Beaconsfield-road, Westcombe Park, London, S.E.

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1893 Edition of "'THE ELECTRICIAN' ELECTRICAL TRADES' DIRECTORY AND HANDBOOK" contains over 1,000 pages, several new and handy features having been added. Price 7s. 6d., post free 8s. 3d.; abroad 8s. 10d. *Comparison with any similar electrical publication is specially invited.*

The 1894 Edition is in preparation, and will be published in January next. New names, alterations of addresses, &c., are received at any time, but the Directory blanks and circulars are not sent out until later in the year, in order that the most recent, and consequently the *correct*, addresses *only* shall appear in the book. Full printed particulars can be obtained, post free, from "The Publisher," *Electrician* Office.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, which has a special interest at the present time, is now ready, and will be forwarded on receipt of the published price, 7s. 6d. (abroad 8s.), or it may be obtained from any bookseller. A prospectus can be obtained on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—This book, written by Mr. F. Marten Weymouth, is also ready, and will be sent direct on receipt of the published price, 7s. 6d. (abroad 8s.), or it may be obtained from any bookseller. A prospectus will be forwarded free on application.

TENDERS INVITED.—The Barnet Local Board invite applications from companies or firms willing to take a transfer of, and to undertake and carry out, the powers granted by the Barnet Electric Lighting Order, 1893. Applications must reach Mr. H. W. Poole. the clerk to the Local Board, not later than December 30th. Further particulars appear in our advertisement columns.

——— The Corporation of Belfast invite, in our advertisement columns, tenders for various work in connection with their Electric Lighting Station. There are eight contracts—for gas engines and dynamos, switchboards and connections, batteries, laying of concrete culverts, cast-iron work, insulators, insulated cable, and copper strip respectively. Copies of the specifications can be obtained from Prof. A. B. W. Kennedy, 19, Little Queen-street, Westminster, S.W., or from Mr. Samuel Black, the town clerk of Belfast. Tenders must reach the latter gentleman not later than Friday, December 15th.

——— The Directors of the North-Eastern Railway Company require tenders for the supply of telegraphic apparatus and telegraph wire and line stores during the six months ending June 30th next. Tenders must be in by December 5th.

TENDERS RECEIVED.—A considerable number of tenders have been received by the Sunderland Corporation Highways Committee for the necessary works for the lighting of the town by electricity. A Sub-Committee has charge of the tenders, and will report to the Committee thereon.

APPOINTMENTS.—Mr. J. D. Bailie (late Installation Superintendent for Messrs. J. D. F. Andrews and Co.) has been appointed Yorkshire Representative for Messrs. C. A. Parsons and Co., of Newcastle-on-Tyne, with offices at Peacock's Buildings, Park-row, Leeds.

——— Messrs. Lazare Weiller and Co., of Paris and Angoulême (France) have appointed Mr. Fernand Espir their sole agent for the United Kingdom and the Colonies for their high conductivity copper wire and strip for electrical purposes.

LIQUIDATIONS.—A meeting of the members of the United Telephone Company of Rosario (Limited) will be held at 78, Coleman-street, London, E.C., on December 18th, at noon, for the purpose of receiving an account of the winding up.

——— The first meetings of creditors and contributories of Elmore's French Patent Copper Depositing Company (Limited) will be held on December 5th, at 12 and 2 p.m. respectively, at the Holborn Restaurant, High Holborn, W.C.

DISSOLUTION OF PARTNERSHIP.—The partnership between William Retallack and Alfred West Thorpe, carrying on business as electrical manufacturers at 36, Moorgate-street, E.C., under the style of Player and Retallack, has been dissolved.

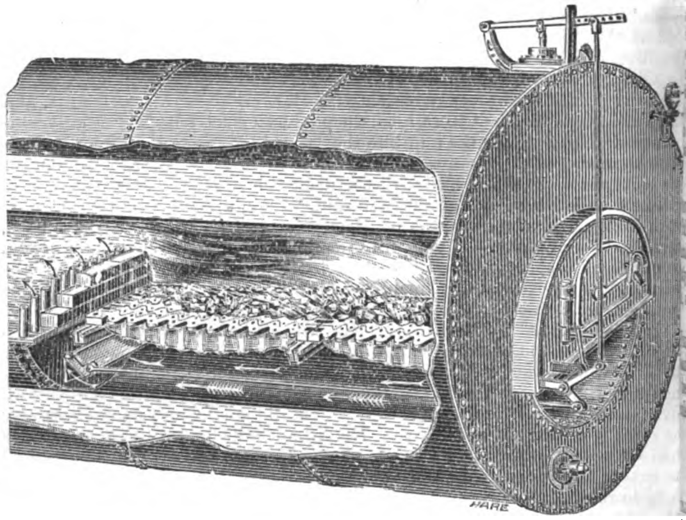
MESSRS. DRAKE AND GORHAM.—As the result of the installation which this firm reconstructed at Effingham for Mr. Czarnikow some years back, they have been entrusted with the extensions at his town house, 103, Eaton-square, and City offices at 29, Mincing-lane. They have also successfully completed the installation of the electric light at Chatsworth, the seat of the Duke of Devonshire.

OMNIBUS AND TRAMCAR LIGHTING.—The Omnibus and Tramcar Electric Lighting Company (Limited) advertise that they are prepared to receive applications for lighting private vehicles under Pitkin's patents, which, the company state, are now supplied on the London street tramways, many of the London General Omnibus Company's vehicles, and a number of private omnibuses.

EXHIBITIONS.—There is to be an International and Colonial Exhibition held at Lyons, France, in 1894, which has the support of the French Government and of the leading Chambers of Commerce throughout France. Applications for space for this exhibition are now being received by Mr. Brandreth, of the Anglo-Continental Contract Association (Limited), 52, Queen Victoria-street, E.C., from whom all further particulars can be obtained. There is to be a British Section at the exhibition.

——— A Mining and Metallurgical Exhibition is to be held at Santiago, Chili, during the year 1894, consisting of eight sections—motive power, electricity, extraction machinery, mechanical preparation of minerals, metallurgy, chemical industries, statistics and plans, and production of the working of mines and metallurgy.

MESSRS. CLARKE AND CO.'S FURNACE BARS.—The patent furnace bars which are specially manufactured by Messrs. Clarke and Co. of Forest-road, Nottingham, and of which an illustration is here given, are said to answer in every way all that is required of them.



It is claimed that as one of these bars fills the space of two of the ordinary kind, and as they are much lighter in weight, the price is little more than for ordinary bars per square foot. At present the firm have supplied eight asylums, including Lincoln County Asylum; Durham County Asylum, Sedgefield; Royal Medical College, Epsom, &c.; the workhouses of Lincoln, Barnstaple, and Ross; and the Dublin Science and Art Museum, Exeter Corporation Offices, Leeds Hospital, and the Nottingham Hospital.

MICA.—We have received from the Lake Girard System of Mines, of Ottawa (Canada), specimens of amber mica, obtained from the company's mines, which they claim to be the largest in the American Continent, and of which they hold a stock of over 1,000 tons.

MANCHESTER SHIP CANAL.—Mr. W. Morton, of Warrington, has, during the past few months, had charge of an electric light plant for night work on the Acton-Grange section of the Manchester Ship Canal, during the process of cutting through the old railway recently given over by the London and North-Western Railway Company. The plant, which comprises a horizontal engine coupled to a dynamo, has supplied light to 12 2,000 c.p. arc lamps, and has been in constant use nightly, enabling the work to be carried on without interruption. Mr. John Jackson, of Westminster, the contractor for the Canal, receives, we understand, a handsome premium for executing this branch of the contract in so short a time.

COLLIERY LIGHTING.—Messrs. Ernest Scott and Mountain (Ltd.) are supplying an electric light plant for the Coltness Iron Company's colliery at Newmains, Lanarkshire. The installation is to include above and below ground, and the lighting of thirty-four workmen's cottages. An electric pumping plant, capable of delivering 100 gallons of water per minute from the river to the colliery, is also to be supplied by the firm.

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A New Microphone.—To make fun of a mistranslation is generally in bad taste. Our excuse for printing the following as we received it is that considerably greater attention will probably be given to it by our readers than if we attempted to put it into English; the intentions of the makers will thus be served. The style gains additional piquancy from the fact that Prof. Von Helmholtz is a perfect master of the English language :—

Establishment for Telegraphic and Telephonic Constructions. Propr., Hammacher and Paetzold, at Berlin, O., Andreas-str. 32. Assented extract from the report of H. J. M.'s Physic-Technic Institute of German Empire as to our quite new by the Patent Office privileged Microphone :—

Charlottenbourg (near Berlin), February 27th of 1893.

This microphone presents constructed very differently from that organisation of the ordinary telephonic stations: It is furnished, to receive sounds, with a thin carbonic plate of 5,5 c m. thickness, that 4 wadcylinders are leaning upon pretended to be filled up with coal dust and connected backwards with another stronger carbonic plate. Particularly the trials extended too to observe the degree of acoustic intensity and distinctness in reproducing by the farhearer of the second station the words pronounced towards the principal station of the microphone, even when the electric current furnished by one or two accumulating cells in the microphone be diminished by diverse resistances intercalated and even the resistance of the transmission between both the apparatusses be raised too. The current's force was appointed with a Weston-Tensivmeter put against an intercalate resistance of 10 Ohm. In applicating intensities of 0,02 up to 0,04 ampere the words pronounced close on the microphone were heard at the other extremity louder than it may be wished for ordinary telephonic communications and may well be understood, even when pronounced in but ordinary conversational manner in a distance of 3 meters from the apparatus. The intensity of the current may be lowered, by means of ballasting resistance to one milliampere without claiming extraordinarily raised voice to facilitate communicating through both the apparatusses. But when reduced to half a milliampere the intensity is debilitating in surh a manner that the voice cannot distinctly be understood. Parallelled with this microphone the other hitherto usuac ones are claiming at least the tenfold intensities of currents in the microphone to reproduce the voice by the far-hearer in the same loudness. This experience proves that the presented apparatus requires but a minimum of current in the microphone even to reproduce the transmitted voice with rather high loudness, and by consequence the battery as well as the microphone-contacts by longer use never will wear out, but present always favorable results. For its high intensity of sound it seems to be well fit for communicating from rather remote distances too.—(Signed) Von Helmholtz.

Installation Work Rules.—We have received from the St. James' and Pall Mall Electric Light Company (Limited) a copy of the latest installation work rules issued by the Company. The rules are neatly printed, mounted and varnished on a stout card 15in. by 18in., and are provided with a hanger.

Messrs. Felten and Guilleaume.—We have received from this firm a beautiful photo-lithographic picture of a train laden with 110 tons of their 5⅛in. wire rope, in one length of 33,000 yards. The rope is coiled in long hanks upon eight 8-wheel bogie trucks.

Chesterfield.—The Town Council have decided to apply for a Provisional Order.

City of London Union.—The Board of Guardians have requested their Consulting Electrical Engineer to advise the Infirmary Committee as to the expediency of lighting the building by electricity.

Clonmel.—The Corporation have decided to apply to the Board of Trade for a Provisional Order.

Derby.—The Corporation have decided to apply to the Local Government Board for permission to borrow £5,000 for the extension of the electric lighting works.

Ealing.—At the last meeting of the Local Board the question of issuing stock in order to raise the £25,000 which it is proposed to obtain for carrying out the electric lighting scheme came up for consideration, but it was thought desirable to postpone the question until the consent of the Local Government Board had been obtained to the expenditure on the works.

Edinburgh.—At a meeting of the Town Council on Tuesday Councillor Mortimer moved disapproval of the minutes of a meeting held on October 31st, at which it was resolved to light certain portions of the city by means of electric light. He objected to the electric light going out to the Dean Bridge when such important streets as George-street were not proposed to be lit by it. Lord Provost Russell moved the adoption of the minutes, which was seconded by Councillor Walker. Councillor Mackenzie, a member of the Electric Lighting Committee, submitted statistics showing the difference in cost between lighting by gas and electric lighting in the various streets comprised in the proposed area. There would be displaced by the electric light, if it was carried out, 782 gas burners, which cost £1,310. 4s. 9d. If they deducted from that the office expenses, which represented £68, being 1s. 10d. per burner, the total saving in cost would be £1,241. 16s. 9d., while 148 or 150 arc lamps would cost £2,960, making an additional cost of £1,718. 3s. 3d. But there was a patent which was being applied to arc lamps, which would, Prof. Kennedy said, permit them to turn off the light half-way, and that would save, perhaps, from £600 to £700 per annum. Mr. John Jamieson said he believed the difference in cost between the two lights would be £1,800, but the electric light would give 12 or 15 times the amount of light. He strongly contended that it would not be possible to improve upon what they had proposed as an electric light area. In reply to Councillor Cranston, Councillor Mackenzie stated that by the wires which would be laid along the streets no provision would be made for the lighting of shopkeepers' premises. The Lord Provost remarked that within the compulsory area they must supply shopkeepers, but the Provisional Order did not include all the street lighting. They were advised by the Cleaning and Lighting Committee to run out the electric light beyond the compulsory area. After further discussion, a division resulted in the minutes being adopted by 26 votes to 9.

Hanley.—The scheme for the lighting of Hanley by electricity is making headway, and according to Mr. Joseph Lobley, borough surveyor, there seems every probability of the central station being ready for work early in the new year. The buildings are nearly completed, and the machinery is ready for putting in. The mains have been laid throughout the cumpulsory area, and the supply mains of the works are now in hand.

Islington.—At the last meeting of the Vestry the Special Electric Lighting Committee reported that they had made exhaustive inquiries as to a site for the proposed central station, and had come to the conclusion that a site on the Great Northern Rail way Company's property in Eden-grove and Bernard-place was the best and most suitable they had seen. The Railway Company were willing to sell the site to the Vestry, and the Committee recommended that they be permitted to carry out negotiations for the purchase of the site. After a short discussion the report was adopted almost unanimously.

Liverpool.—Telephonic communication has lately been established for the Corporation of Liverpool, connecting the offices of the Water Engineer in Dale-street, Liverpool, with the water supplies of Lake Vyrnwy (Montgomeryshire), the Rivington Reservoirs (North Lancashire), and the houses of the reservoir keepers and walksmen along the lines of aqueducts. The work has been carried out to the specification of the City Water Engineer (Mr. J. Parry, M.Inst.C.E.), the contract for the complete installation being carried out by Messrs. W. A. Shaw and Co., of Stockport. The system is entirely on the metallic circuit principle, and the wires are carried as nearly as possible along the lines of aqueducts. The total distance of lines as laid is about 115 miles. The line wire is throughout of 12½ copper, and about 16½ tons of this wire have been used on the work. There are in all 26 stations connected on the system.

Moss Side.—At a meeting of the Local Board on Monday, the Sub-Committee appointed by the General Purposes Committee to make inquiries in reference to electric lighting, reported that they were of opinion that the Board should have the advice of an expert. The Board adopted the report and also a suggestion of the Committee that the proposed application of the Collier Marr Telephone and Electrical Engineering Company for a licence and Provisional Order be opposed by the Board.

Poplar.—The Board of Works last week decided to invite Mr. W. H. Preece to report, at an expense not exceeding 50gs., upon the question of electric lighting and upon the application of the Poplar Electric Lighting Order, 1893, to the district, with particulars of the cost of the installation of the light.

Royal Exchange.—Yesterday afternoon the Lord Mayor performed the ceremony of turning on, for the first time, the electric light at the Royal Exchange. Messrs. J. G. Statter and Co. have carried out the lighting, which comprises eight lamps, viz., four 2,500-c.p. 15-ampere Brockie-Pell arc, and four 100-c.p. Ediswan incandescence lamps. The wiring is carried out with lead-covered cables, with cast iron junction boxes, filled in with bitumen. The current is taken from the mains of the City of London Electric Lighting Company.

St. Asaph.—We understand that some of the principal tradesmen are in negotiation with a firm of electricians with respect to the installation of the electric light, and if sufficient support can be obtained an application will shortly be made for a Provisional Order.

Southampton.—At the Southampton Harbour Board meeting on Tuesday, the Works Committee reported that the Sub-Committee on October 26th witnessed the lifting and slewing of the electric crane, with a weight of three tons in the slings, and

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afterwards the crane was put through severe tests, both as to speed and weight, and both lifting and slewing. All the tests required by the specification were satisfactorily carried out, the speed being in excess of that specified. A report was also received from Mr. J. G. W. Aldridge, the electrical engineer, thereon, with a table of results. He did not certify that day for the crane, as there were some minor points requiring attention by the contractors. The report was adopted.

SWANSEA.—Notice having been given by several companies of their intention to apply to the Board of Trade for a Provisional Order, the Town Council at their last meeting resolved to oppose each application, and to at once carry into effect the provisions of the Electric Lighting Order obtained by the Corporation in 1889.

WHITEHAVEN.—The public lighting and that of a number of business premises at Whitehaven is now done by electricity, the current having been fully turned on last week.

YORK.—At the last meeting of the Town Council some exception was taken to the visits made by the Street and Buildings Committee to inspect the electric lighting stations at Scarborough and Huddersfield. After a lengthy discussion it was resolved as follows:—"That whilst fully acquitting the Streets and Buildings Committee of any irregularity, this Council is of opinion that all expenses of this Committee on city business should be defrayed out of the rates of the city."

COMPANIES' MEETINGS.

Elmore's Patent Copper Depositing Company (Limited).

The fourth ordinary general meeting of this Company was held at the Cannon-street Hotel, London, on Wednesday, under the presidency of Mr. J. Todhunter.

The SECRETARY (Mr. L. J. Langmead) having read the notice calling the meeting,

The CHAIRMAN, in moving the adoption of the report, said that the position of the Company was stated in the balance-sheet as truly and completely as had been possible. He did not think there were many omissions, but when the present Directors took office, the condition of the accounts was such that it was only with extreme difficulty that they arrived eventually at the real position of the Company's finances. There were, in fact, certain undoubted liabilities which did not appear on the books at all, and which it was impossible for them to ascertain at once. The balance-sheet now submitted was that of the past year, for which the present Directors were not responsible. The capital had been increased by the Preference shares, which were issued by the late Board; otherwise the capital account remained practically the same as before, excepting that the royalties received for the copper sheet licences had been reduced by the £1,250 which came into revenue for last year. On the other side of the balance-sheet the land was the same, but the items of buildings and of plant and machinery had received certain additions. The amount written off for depreciation was insisted on by the auditors, and was in the same proportion as that written off in the previous year. The stock-in-trade was slightly increased, and the balance of loss was very considerably augmented. He believed they had now really written off pretty nearly everything that ought to be written off. They only took office on May 26th, and the balance-sheet was prepared on June 30th. After that they had a very short time to organise the factory and put things in order before they were brought face to face with the coal strike, which had ruined many manufacturers in the very district in which the Company worked. They had to face the position of affairs, however, and say whether they would close the works, and thus save expense, or use their utmost endeavours to carry on the works and execute the orders in hand. This was a matter of very serious consideration. The shareholders knew perfectly well what had been the history of the Company before—that excuses had been offered in all directions for work that was not done; and they felt that if they were again to be in the position of offering excuses instead of executing orders, they might as well close the works and for good. They took the course which commended itself to them, and used their utmost endeavours to obtain a supply of coal. They would not have been able to do this but for the intervention of their colleague, Mr. Dale, who was largely interested in the Durham district, and who obtained coal for the Company on exceptionally good terms. They, however, received it only in driblets, and only after great delay and difficulty; but, except on two occasions, they had coal enough to keep their works going, and to an extent sufficient to enable them to execute all pressing orders. No one demanded from them goods which had been ordered without obtaining them. This had involved them in considerable outlay; but they felt that it must be done at any cost. Another source of great anxiety had been their position with respect to the Wire Company. On the last occasion on which he addressed them a question was asked whether they could carry on the Depositing Company alone without the Wire Company. He replied that he thought so, but that it would be very difficult. Further experience, however, had shown him that they were absolutely dependent on the use of the furnaces on the Wire Company's premises for their copper. There had been a fear that the finances of the Wire Company were in such a position that the works would not continue under the control of the present Board of that Company; but he hoped that this matter had now been arranged. There was a debt owing by the Wire Company to this Company, and there was also a bill drawn by the Depositing Company before he was connected with it on the Wire Company. This bill was dishonoured by the latter, and the Depositing Company were bound to pay it. The bill was for £1,000, and the Wire Company became creditors to them for this amount. Shareholders in this Company generally held shares in the Wire Company, and they would know that a sum of £6,000 was raised in debentures by the Wire Company to pay off their creditors. At that time the Directors were called into consultation with the Board of the Wire Company, who engaged with them that the Depositing Company's debt should be liquidated by the Wire Company giving to them copper they had on their works which was of no use to them, and which would amount practically to the sum due to the Depositing Company. Owing, however, he was sorry to say, to a very serious mistake on the part of the trustees appointed under that arrangement, that engagement was not carried out, and the Depositing Company had not received the copper in question, nor had they been paid their debt. The capital possessed by the Company at the time the present Directors took office was reduced by £2,000 in consequence of the non-fulfilment of the Wire Company's engagements to them. With respect to the condition of the Company's works at the present time, they had expended very much less than they thought would be necessary in putting the machinery and works into absolute order. They were now in good condition, and they would be able to execute large orders when they got their coal. He thought that his colleague, Mr. Owen Jones, who had been spending a great deal of time on the works, would be able to tell the meeting that they were now really in such a condition that there was no doubt they would be able to turn out very large quantities of finished tubes as soon as they got the coal they required. Then came the question of orders. He believed that the shareholders, like himself, had been more or less sceptical as regarded promises for their goods, but they had now passed from a state of promise into a state of certainty. They had now on their books absolute orders in hand, which they could execute as they were able, to the extent of 65 tons of finished output. The larger proportion of these orders had come in within the last six weeks or two months, so while they had been practically idle at the works they had not been idle in putting forward the experimental tubes so as to obtain orders. He might tell them that the large shipbuilders in the North—most of the large firms—had had experimental tubes, which had been tested on the Company's works, sent to them to experiment upon, and these tubes had stood all the tests required of them. The consequence was that the Company had obtained from some of these firms very large orders indeed for these tubes, and they had not the least doubt that they would continue getting very large orders for them. They had also been approached by some very large firms who made the shafts for the great ocean steamers. He had satisfied himself on this point—that these firms were clearly of opinion that it would be the Company's process, and the Company's process only, that would cope with the great difficulty of coating the shafts of big steamers. If the coating of these shafts turned out satisfactorily, an immense trade was opened out for the Company, apart from the trade they had expected hitherto. This was a question for the future, but it was a question which shareholders must, he thought, consider extremely satisfactory, and one holding out great promises of extended trade. He had no doubt now that they had orders in hand and in prospect sufficient to keep their works going at their full capacity when they got the coal. At the time the strike occurred they had no idea that it was going to last four or five months, but if they had known this, he was sure that the policy they had adopted was the only policy they could pursue so as to preserve their business. The result of the action which they had taken had been that they had preserved their business and their credit, and had executed every order almost that was pressing at that time. He reckoned, however, that it had cost them between £3,000 and £4,000 to do this. When the present Directors took over the management the whole of the working capital was not more than £9,000 or £10,000, and deducting from this the £3,000 or £4,000 they had lost by the coal strike, the sum paid on behalf of the Wire Company, and the sum of between £600 and £700 which they had had to pay for liabilities not down on the list of creditors when they took over the Company's affairs they would see that the working capital had been reduced to about £4,000, which was absolutely inadequate to provide for the working of such a Company as theirs. He was extremely sorry to come before the shareholders of any Elmore Company with a tale of woe, to which they had been made so accustomed in past years; but he thought he should have their sympathy on that occasion, for they knew perfectly well that what had occurred to the Company in connection with the coal strike was absolutely unavoidable. It now rested with the shareholders to say whether they would provide the further capital which was necessary to carry on the works, now that the position was such that they seemed to see their way, or whether they would let the matter drop. His confidence was unabated, and he was sure that if it had not been for the coal strike they would have been able to go on without any more money. Prior to the strike in July the absolutely finished output from the works had been increased from about one ton per week to two and a-half tons, and this was at the time gradually going on. If they had got the output up to three tons per week he believed it would have met all expenses and have made the concern self-supporting. During the coal strike they had only been able to keep up the output with the greatest exertion to one and a-quarter ton. From the commencement of the coal strike the output fell off, but they believed that if it had not been for the strike they would have been able to have gradually increased the output up to ten or twelve tons a week, and this would have paid them very well. If they obtained money sufficient to carry on, he

could tell them, from what he had seen and what he believed, that they had a good business, and that it only required diligent work and sufficient material to enable them to turn the corner and do well. His proposal was a very simple one. Their capital of £200,000 had been fully subscribed, excepting as regarded 195 of the Preference shares. They had only one means of raising the money they required, which was by debentures. It must be remembered that they paid off debentures of £5,000, forming part of the Company's liabilities when the present Directors took office. They thought it would be unwise merely to issue these debentures again, because if they had to issue more debentures afterwards they would have to be of another class—second debentures. In view of the possibility of orders being received for the coating of shafts of ocean steamers an increased outlay on machinery would be required, and the Directors would not like to be without a little money for this purpose. They therefore proposed that the issue of debentures should be for £10,000, and that they should bear 6 per cent. interest. This amount would enable them to carry on their works and to set their business on a firm and sound basis. He would put his name down for £500 of the debentures, and including this amount there had been promises already to the extent of £1,300. They thought the debentures should run for five years, with an option to the Company to pay them off, on giving six months' notice, at 102. The position of the Wire Company he might describe as one of "suspended animation," and as a sort of menace to this Company. He thought he would have the support and sympathy of Mr. Atkinson in remarking that the time must come before long when a very strong effort must be made to liberate the Wire Company from its position of menace and to set its works going. His (the speaker's) view was that the two Companies ought not to have been separated, which he believed had only been done for speculative purposes. He might add that the capital of their own Company would have to be written down before any dividend would be paid. The amount now standing to the debit of profit and loss was £21,500, and they had also £11,958 standing as the value of the Wire Company's shares, which were worthless. The two sums made £34,000, which would have to be paid off before a shilling of dividend could be distributed to the shareholders; and they wanted to be able to pay the Preference dividend, at any rate, if they earned it. The shareholders need not suppose that the Company was in any sort of difficulty. They had capital and copper sufficient to go on with, but they had not money enough or copper enough to execute the orders in hand and in prospect. They could, however, go on with the works, though not at a profit in their present circumstances.

Mr. J. W. DALE seconded the resolution, remarking that he could endorse everything that the Chairman had said.

Mr. EWEN said that, in his opinion, the amount mentioned by the Chairman was by no means unreasonable, and he was himself prepared to take up his proportion.

Mr. J. ATKINSON expressed his approval of the way in which the business was being conducted by the Directors. He hoped that in a few days the Wire Company would be able to deliver the copper which they had promised. He had been glad to hear the Chairman express the view which he had himself always held, namely, that the two Companies ought never to have been separated.

In answer to Mr. SHURMER (the late secretary of the Company), who said that he did not believe that any Court would entertain a proposal, in the present condition of things, to reduce the capital of the Company,

The CHAIRMAN stated that this question had merely been brought before the shareholders in order that they might understand the position. It was not, however, proposed to take any steps at present in the matter, and the shareholders would be communicated with when the time came.

The report was then unanimously adopted, and resolutions were afterwards passed re-electing Mr. Todhunter to his seat at the Board, and appointing Mr. Close, of Leeds, auditor.

The proceedings terminated with a cordial vote of thanks to the Chairman and Directors.

NEW COMPANIES, STATUTORY RETURNS, &c.

[In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, *pages* 320-348, *&c., &c.*]

JOHN BIRCH AND CO. (LIMITED).—This Company has been registered, with a capital of £40,000, in £10 shares, to carry on business as engineers and contractors, as hitherto carried on by John Birch and Co.

J. DEFRIES AND SONS (LIMITED).—This Company was registered on November 18, 1893, with a capital of £100,000, in £100 shares, to acquire, take over, and carry on the business of chandelier, glass, and earthenware manufacturers, gas, electrical, and general engineers, illuminating contractors, &c., carried on by the firm of J. Defries and Sons, at 147, Houndsditch, London, E.C.

ALF. DOUGILL AND CO. (LIMITED).—This Company was registered on November 14, 1893, with a capital of £12,000, in £5 shares, to purchase or otherwise acquire, take over as a going concern and carry on in all its branches the business of engineer, ironfounder, gas engine maker, electrical crane maker, &c., carried on by Alfred Dougill at Leeds, Yorkshire.

EDWARD HOWELL AND CO. (LIMITED).—This Company has been registered, with a capital of £15,000, in £10 shares, to acquire and carry on the business of engineers and ironfounders, as hitherto carried on at the Waterloo Ironworks, West Quay-road, Poole, Dorset.

GORSEINON ELECTRIC LIGHT COMPANY (LIMITED).—This Company was registered on November 17th, with a capital of £1,000, in £1 shares, to carry on the business of electric lighting in all its branches, and for such purpose to purchase or otherwise acquire all necessary machinery to lay down, establish, fix, and carry out all necessary cables, wires, lines, accumulators, lamps, and works, and to generate, accumulate, distribute, and supply electricity in and about the Town of Gorseinon, near Swansea, Glamorgan.

ALADDIN PRIMARY ELECTRIC BATTERY COMPANY (LIMITED).—The annual return just filed shows that the whole nominal capital of £6,000, in £10 shares, has been taken up, of which 440 shares were issued as fully paid to Theophilus Coad, the vendor. The full amounts have been called and paid on the remaining 160 shares. At meetings, held September 5 and 22, 1893, the shareholders resolved to raise the limit in the number of Directors from five to ten.

ARIEL COMPANY (LIMITED).—This Company has just entered into an agreement with Samuel S. Allen, of 52, Woodstock-road, Bedford Park, Chiswick, London, W., for the acquisition of certain property (particulars of which do not transpire), and in consideration therefor have agreed to pay the vendor £1,000 in cash, and to allot 2,000 Ordinary shares (Nos. 1 to 2,000 inclusive) and 400 Preference shares (Nos. 220 to 619 inclusive) as fully paid.

AURORA ELECTRIC LIGHTING AND DISTRIBUTION COMPANY (LIMITED).—The second annual return of this Company, made up to October 12th, was recently filed. The nominal capital is £25,000, in £1 shares, and 5,935 have been taken up. 5,000 have been issued as fully paid, and the full amounts have been called and paid on the remaining 935 shares.

BERNSTEIN ELECTRIC LAMP COMPANY (LIMITED).—The annual return of this Company, made up to December 31, 1892, was filed on September 18, when 2,814 shares out of a nominal capital of £100,000, in shares of £10 each, were taken up and the full amount paid thereon.

SOUTH-WESTERN DISTRICT AND THAMES VALLEY ELECTRICITY SUPPLY COMPANY (LIMITED).—In connection with this concern no business has as yet been done. When the annual return was filed on October 18th last only the seven signatories' shares were taken up and the full amount paid in respect thereof.

WEST INDIAN DEVELOPMENT COMPANY (LIMITED).—This Company, which has for its objects the supply of electricity for the purpose of lighting the City of Bridgetown, in the Island of Barbadoes, has just entered into an agreement with J. Kenneth D. Mackenzie, of Broadway Chambers, Westminster, S.W., for the acquisition of a concession relating to the above, and in payment the Company has agreed to allot 4,000 shares, Nos. 71 to 4,070, both inclusive, to the vendor.

WEYBRIDGE ELECTRIC SUPPLY COMPANY (LIMITED).—When the 1893 return of this Company was filed 1,487 £5 shares were subscribed for and allotted. Of these 1,480 were issued as fully paid, and the full amount has been called and paid upon the seven signatories' shares.

CITY NOTES, &c.

BRIGHTON AND ROTTINGDEAN SEA-SHORE ELECTRIC TRAMROAD COMPANY.—The prospectus of this Company has just been privately issued. Out of 1,200 £10 shares the Directors have taken up £4,000 worth as Ordinary shareholders, and the promotors will receive 232 fully paid-up shares, leaving the remainder for private investors, but no public appeal for support is to be made. The railway is to run from Kemp Town to Rottingdean, and the Board of Trade have settled the terms of the licence for the ground to be occupied outside Brighton, and now have the general plans under consideration. When these are agreed to, the Brighton Corporation will be approached with regard to the site within their district. The line will comprise two pairs of rails 21ft. apart, to act as a single road, in order to permit of the car being as large and firm as possible. The cars, the dimensions of which will be about 18ft. by 30ft., will be to all intents and purposes a *fac-simile* of the saloon and upper deck of a steamer. It is said that the scheme has received very favourable comment from well-known engineers. The work will be put in hand shortly, and it is expected that the line will be completed by next Whitsuntide.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns for the week ending November 19, 1893 were £879, as against £899 for the corresponding period of last year, being a decrease of £20. The total receipts for the half-year amount to £16,425, as against £16,244 for the corresponding period, 1892, being an increase of £181.

METROPOLITAN ELECTRIC SUPPLY COMPANY (LIMITED).—Notice is given in our advertisement columns that the coupons due December 1st, 1893, on this Company's issue of £100,000 Five per Cent. Registered Debentures (bonds Nos. 1 to 10,000) will be paid on and after that date at Messrs. Prescott, Dimsdale, Cave, Tugwell and Company (Limited), 50, Cornhill, or at the Royal Bank of Scotland, 120, Bishopsgate-street Within, E.C. Coupons must be left three clear days for examination. The register of debenture holders will be closed from the 24th to the 30th inst., both days inclusive.

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WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ending November 17, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited) were £3,115.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the two weeks ended November 15th were £2,237, as compared with £2,154 for the corresponding period of last year. The receipts for July, estimated at £3,658, realised £3,708.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Nov. 15.		Price Wednesday, Nov. 22.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Nov. 22. Highest	Lowest
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,134,640	Stock	12/6	Anglo-American	46	47	44	46	5 19 7	Jan., Apr., July, Oct.	45	..
£2,932,680	Stock	25/0	Do. Preferred	85	86	83	84	6 10 11	" "	85⅞	82½
£2,932,680	Stock	5/0	Do. Deferred	7¾	8¼	7¾	8¼	..	..	7⅞	..
£195,100	100	4%	African Direct Telegraph 4% Deb. (Reg. & Bearer)	100	103	100	103	3 17 8	January and July ..	100½	..
130,000	£10	4/0	Brazilian Submarine ... xd & bonus	11¾	12¼	11¾	12¼	5 6 1	Mar., June, Oct., Dec.	12 1/16	11⅞
£36,400	£100	5%	Do. 5 per Cent. Bonds	100	103	100	103	4 17 1	January and July ..	..	—
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	..	..
$7,716,000	$100	7%	Commercial Cable Capital Stock	140	150	140	150	4 13 4	Jan., Apr, July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11½	12½	11½	12½	6 8 0	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October ..	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	..	..
60,710	20	3/6	Direct United States	11½	11⅞	11½	11⅞	6 3 4	Jan., Apr., July, Oct.	11⅝	11½
400,000	10	2/6	Eastern	14¾	15	14¾	15	5 4 0	" "	15	14¾
70,000	10	6%	Do. 6 per Cent. Preference	15½	16½	15½	16½	3 12 9	" "	15⅞	—
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	113	116	113	116	3 9 0	May and November	..	..
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	108	111	108	111	4 10 1	February & August	..	..
250,000	10	2/6	Eastern Extension	15⅛	15⅝	15⅛	15⅝	4 11 1	Jan., Apr., July, Oct.	15⅝	15⅛
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113	116	113	116	3 9 0	February & August	..	..
£70,600	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	102	105	102	105	4 15 3	January and July ..	..	..
£168,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	101	104	102	105	4 15 2	" "	103¼	102½
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	101	104	102	105	3 16 2	February & August	104	..
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	104%	107%	104%	107%	3 14 9	May and November	106½	104
180,227	10	1/6	Globe Telegraph and Trust	8¼	8¾	8⅜	8⅝	5 4 4	Jan., Apr., July, Oct.	8⅝	8¼
180,042	10	6%	Do. 6 per Cent. Preference	14¾	15¼	14¾	15¼	3 19 4	" "	15⅛	14¾
150,000	10	5/0	Great Northern	20	20½	20	20½	4 3 0	Jan., April, and July	20⅝	20 3/16
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	103	106	103	106	4 14 4	March & September	105¼	..
17,000	25	12/6	Indo-European	40	43	40	43	5 16 3	May and November	41½	—
37,548	10	4/0	London Platino-Brazilian	4	6	4	5	4 0 0	" "	..	—
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	105	108	5 11 1	March & September	..	—
£100,000	£100	4%	Pacific European Telegh. 4% Guar. Debs. "Red' 1942	102	105	102	105	3 16 11	..	..	..
11,802	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October ..	..	..
3,381	£100 Cert.	35/0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	" "	..	..
15,609	10	5/0	West African Telegraph	5½	6½	5½	6½	7 13 10	January and July ..	..	..
£260,900	100	5%	Do. 5 per Cent. Debentures	98	101	98	101	4 19 0	March & September	99½	98½
30,000	10	2/0	West Coast of America	2	3	2	3	..	January and July ..	..	—
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	103	99	103	7 15 4	June and December	..	—
88,321	10	6d.	West India and Panama	1⅛	1⅜	1⅛	1⅜	..	..	1 3/16	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10	10½	5 14 3	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9	10	9	10	6 0 0	" "	..	—
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	107	110	107	110	4 10 11	June and December	110	109
64,242	15	4/6	Western and Brazilian	5½	6½	5½	6½	5 15 7	May and November	96¼	96
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5¼	5¾	5¼	5¾	..	..	..	—
33,129	7½	4/6	Do. 5 per Cent. Deferred	1	1½	1	1½	..	..	..	—
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	103	106	103	106	5 13 2	February & August	..	—
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	103	106	103	106	5 13 2	" "	..	—
$1,214,000	$1,000	7%	Western Union 7 per Cent. 1st Mtge Building	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	105	102	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	—	..	—
224,850	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	5/16	1/16	3/16	..	May and November	..	—
220,000	£1	4·76d.	Oriental (11s. paid)	3/16	5/16	3/16	5/16	7 18 2	Yearly	..	—
458,867	5	2/6	National	4¾	5	4¾	5	5 0 0	June and December	4 15/16	4⅞
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14	15	14	15	4 0 0	" "	14½	14⅜
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	13½	14½	13½	14½	4 2 9	" "	14	..
90,950	5	2/0	Do. 5% Non-Cumulative 3rd Pref.	5¼	5½	5¼	5¾	4 10 11	..	5 7/16	5⅜
726,477	£100	4½%	Do. Deb. Stk. 4½% Prov. Cert. (fully paid)	113	115	113	115	3 18 3	January and July ..	114½	113½
58,000	5	1/0	United River Plate	2	2½	2	2½	—	January and July ..	..	—
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	—	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11½	11¾	11½	11¾	—	—	..	—
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	12¾	13¼	12¾	13¼	..	—	13	—
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	—	—	—
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	—	—
8,322	£5	..	House to House Electric	..		..		—	—	—	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		..	—	—	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July ..	—	—
30,000	£5	3/4 '92	Liverpool Electric Supply (£3 10s. paid)	4½	4½	4½	4¾	..	—	—	—
15,000	£5	5/0 '92	Do. (fully paid)	6⅜	6½	6½	6¾	..	—	..	—
111,000	5	..	London Electric Supply	¾	1	¾	1	—	..	..	—
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	7¼	7¾	7¼	7¾	2 11 8	..	7⅝	7 7/16
£100,000	Stock	5%	Do. 5 per Cent. Debs. (Bonds of £10, £20, & £40)	106	109	106	109	4 11 9	June and December	108	107⅜
6,452	£10	..	Notting Hill Electric	5	6	4½	5½	—	—	..	—
19,980	£5	9½%	St. James' and Pall Mall	6	6½	6	6½	..	—	6 5/16	—
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	—	8¼	8 1/16
59,900	5	1/6	Westminster Electric Supply (fully paid)	5½	6	5½	5¾	3 0 10	—	5½	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
77,978	8	2/1	Brush Electrical Engineering	2¾	3	2¾	3	6 0 0	—	2 15/16	2 13/16
75,000	2	6%	Do. 6 per Cent. Preference	2½	2⅝	2½	2⅝	5 1 1	—	2⅝	2 5/16
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	106	108	106	108	4 3 4	March & September	..	—
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	4½	4¾	4½	4¾	..	January and July ..	4½	—
12,139	5	..	Edison and Swan United	—		—		—	—	—	—
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	—	..	..
49,900	10	12/0	Electric Construction	1¾	2¼	..		..	—	—	..
91,195	2	10/0	Elmore's Patent Copper Depositing	⅜	⅝	¼	½	—	—	—	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	—	—	—
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21	22	21½	22½	5 11 1	February & August	21⅞	21⅝
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	—	—
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	..	—	—
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	—	—
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/0	4/0	3/0	4/0	..		—	..
78,949	5	1/9	Swan United (£3. 10s. paid)	2	2½	2	2½	13 19 8	May and November	2⅝	..
37,350	12	12/0	Telegraph Construction and Maintenance	34	36	35	37	4 17 3	March and July....	36½	35½
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	101	104	104	107	4 13 6	January and July ..	107	..
39,639	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	—		..		—	—	—	—
41,098	£5	—	Do. Preference (fully paid)	—		..		—	—	—	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	¾%	City and South London Railway	28	33	28	33	2 5 5	May and November	..	—
37,500	£10	..	Liverpool Overhead Railway	5⅛	5⅝	5⅛	5⅝	—	—	—	—

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THE ELECTRICIAN:

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NOTES.

According to a statement made in the House of Commons by the Postmaster-General, on Monday last, the loss upon Press telegrams amounts to at least £300,000 a year. We call this a very handsome subsidy to the Press, and one for which it shows its lasting gratitude by an ever-increasing use of the wires. At this rate we may expect to see the cost of Press work swallowing up the receipts from all other sources. Mr. Picton seems to foresee this result, and to discount beforehand any ungenerous conclusions that might be drawn from it by people who do not sell newspapers. He asked Mr. A. Morley to say how much of the deficit was "received back by the public in the shape of cheap news." No answer was given to this abstruse question; and probably none was expected. What Mr. Picton wanted was to assert by implication that the public gets its moneysworth in cheap newspapers. The real truth is, rather, that newspaper proprietors are enabled to get valuable "copy" for next to nothing at the public expense. Reasons of State may justify this arrangement, but it is hard to see why the Telegraph Revenue should be made to pay for it.

That engineers of alternate current stations, in which the alternators cannot be run in parallel, should say, and perhaps think, that they do not want them to do so is only human nature. Those who can run their machines thus are proud of it. There is, however, a drawback to putting the whole plant of an alternate-current station on to 'bus bars. This drawback was felt at the Bankside station of the City of London Electric Light Company on Friday afternoon last week. The field circuit of one of the machines was accidentally opened or broken; the armature thus short-circuited the whole station. The fuse, which was arranged to prevent a 2,100-volt arc under ordinary circumstances, could not stand the strain, with the whole station behind it; an arc was formed, through which the other alternators sent their current; their fuses failed similarly, and for a few minutes the supply was stopped. This difficulty had been foreseen, and suitable cut-outs, similar to those used for charging batteries, were being made. The Thomson-Houston machines, at Wool Quay, amongst their other peculiarities, share a feature for which old-fashioned Brush machines were remarkable—they will stand short-circuiting. Dynamo makers do not all agree that this is worth the sacrifice of other features; but be that as it may, the Wool Quay machines went on with the supply, and no harm was done.

The municipalisation of electric supply is all very well where the ratepayers really wish to embark in industrial undertakings, and it is greatly appreciated by contractors and manufacturers of plant, since it opens a new market, possessing several attractions. But the summary rejection of the proposed electric light scheme by the Kensington Vestry on evening last week shows the unwisdom of attempting to push such ideas through without the support of the ratepayers. There is much preliminary fifing and drumming, advertising and discussing, but the moment the final step has to be taken the movement collapses. Though we are glad to see Local Authorities walking in paths already pioneered and made smooth for them by the enterprise and at the risk of private firms and companies, we have no sympathy with a Vestry that, by way of doing what private capital has left undone, seeks to interfere with existing works. The 13th Clause of the Provisional Order for which the Kensington Vestry was applying ran as follows:—

> To repeal, alter, or amend, if necessary, all or some of the provisions of the Kensington and Knightsbridge Electric Lighting Order, 1889, the South Kensington Electric Lighting Order, 1889, the Kensington, Knightsbridge and Chelsea Electric Lighting Act, 1893, the Notting Hill Electric Lighting Order, 1889, and the House-to-House Electric Light Supply Order, 1889, or any of them, and any other Act relating to or affecting the Vestry or the Undertakers under the above-mentioned Orders.

In some respects this may be as conventional as the suggestion that the Vestry shall construct their own plant and manufacture their own lamps, and that their officers shall be authorised to enter upon any houses or other premises supplied by them for any purpose relative to such supply. But if the Kensington Vestry, or any other local authority, attempts to poach on the property of existing companies they deserve to meet with a stout opposition.

If the system of compulsory areas and permissive areas is not found to answer it had better be altered. The Provisional Order of the Kensington Vestry was not confined to working in permissive areas which had not been covered by existing companies, but it contemplated, in Clause 3, actual competition in streets at present supplied. Competition by a vestry simply means confiscation. Clause 4 of the Order gave a list of streets in which it was proposed to lay mains within a specified time. These streets were all in the Ladbroke-grove neighbourhood, to the north and to the west of the Notting Hill Company's district. This is the second area of the

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House-to-House Company, and one which they have never touched. No objection could have been taken to this, since five years have elapsed since the Company applied for it.

THE letter from Messrs. HAYCRAFT and GAWTHORP, which will be found in our correspondence columns, raises several points of theoretical interest in connection with gas testing, but in the absence of any actual observations, we are inclined to adhere to our opinion as to the importance of corrections for temperature and pressure. It was pointed out by Mr. FRANK WRIGHT, at a meeting of the Physical Society on June 9, 1893, that since about ten volumes of air are consumed by a gas burner for one of gas, the temperature of the air is of considerable importance. Mr. METHVEN, in a Paper read in 1889 before the South-Western Association of Gas Managers, showed the great effect of aqueous vapour in the air on the candle-power of gas burners. The surrounding air, from one point of view, may be said to be the fuel, and the gas only the wick of the flame. We understand that an expert gas tester, if he has time, and the inclination, can dodge a 16-candle gas flame to give 19 candles, or more. A good deal of the secret depends on temperature.

THE standard candle is not, we believe, affected in the same way as a gas-flame by conditions of temperature, pressure, and aqueous vapour, but no complete experiments seem to have been made on this point. The candle-power of a gas flame obviously depends upon two main factors, the size of the flame and its intrinsic brilliance. If changes of temperature and pressure affect these two factors differently, as is probable, an open gas flame tested against a Methven standard will by no means maintain a constant ratio, as suggested by our correspondents. Their argument that the temperature of the flame is high, tends to show that the intrinsic brilliance would, perhaps, not be greatly altered.

THE allusion to wave-motors in the Articles on "Motive Power and Gearing," commenced in our present issue, may seem rather far-fetched, but it helps to make the list complete. We understand, however, that experiments are being seriously carried out by Mr. SCOTT SNELL in this direction. Such a motor has been tried for pumping, and the late Mr. FROUDE believed that under some conditions the device would be feasible. It would not be so regular as a tide mill, and does not appear to present advantages over the ordinary forms of windmill. It is the first cost and maintenance of such motors that settles their value. They enjoy the privilege, common to but few engines, of being destitute of any efficiency in the strict sense of the term.

OUR American contemporary, the *Electrical World*, recently propounded the following riddle, the solution of which it leaves an open question. Suppose that an annular vessel, filled with some electrolyte, were placed inside a solenoid carrying an alternating current; and suppose that the conditions were so adjusted as to give an induced electromotive force in the electrolyte sufficient under ordinary circumstances to produce electrolysis. Would there, our contemporary asks, be any electrolytic decomposition produced? The problem is a curious one; but surely there can be little difficulty in seeing that there would both *be* and *not be* electrolysis. For would not the positive ions march round the annular liquid in phase with the induced current, in a complete chain or circle; and the negative ions in anti-phase, in the same circle but in the reverse direction? The atomic interchanges would go on, but no free ions would be liberated

SINCE $\frac{A \times d \times p \times d \times \sqrt{d}}{p \times A} \times (\cdot 0184\, \alpha\, \beta\, \delta\, v \times 1140) \sqrt{\frac{w\, k)\, \eta}{\epsilon}})$ $= d^2 \sqrt{d} \times (21 \times \alpha \times \beta \times \delta \times v \sqrt{\frac{w \times (k) \times \eta}{\epsilon}}$, and a few other very obvious considerations, Mr. A. E. WIENER shows, in the *Electrical World*, of New York, that the output of dynamos increases as the 2·5 power of their linear dimensions. Is this engineering, is it science, or is it only mixed mathematics? We learn that "this exponent is a very important constant for practical dynamo calculation." When somebody has built one dynamo to his satisfaction, and, to take a pleasant case, has sold it, and has received a repeat order for another of three times the output, is he to proceed to build it, using the old design to another scale? If not, what is the use of two long columns of mathematics? On the other hand, if somebody is inquisitive enough to investigate the relation between dimensions and output, why not take the price lists of one or two good makers, and plot a curve of weights and output? It will be found that this is practically a straight line, tending towards a small constant weight, say 1cwt. to 3cwt., and rising at the rate of 1cwt. to 1½cwt. per kilowatt, more or less, depending on the type and speed of the machine. But a 100 kilo-watt dynamo of the same pattern as a one kilo-watt machine is probably a bad one, if the latter is a good one.

Personal.—We are informed that *Industries and Iron* has lost the services of Mr. James Swinburne as Electrical Editor, but that he will remain a contributor to that journal.

Bleaching by Electric Discharge.—In a Silesian establishment for bleaching linen yarns electric discharges are used to generate ozone. This gas acts on the yarns suspended in chambers.

Obituary.—Mr. James Brand, whose death is just announced was formerly Chairman of the Board of the United Telephone Company, chief of the original undertakings now merged in the National Telephone Company.

Cable Interruptions:

	Date of Interruption.
Cayenne-Paramaribo	October 25th.
Cayenne-Vizeu	November 25th.
Jamaica-Colon	November 25th.
Bissao-Bolamo	November 24th.

Coast Communication.—Telephone communication has now been completed between the Gunfleet lighthouse and the coast guard stations at Harwich, Walton-on-the-Naze, and Clacton-on-Sea. It will be of invaluable service, as by it a message can be sent by voice from the Gunfleet to the stations named, apprising the lifeboats when ships strike on the treacherous sand with which the lighthouse is surrounded.

Test of Gas Burners.—Our attention has been called to a Report by Capt. Webber (now Major-Gen. Webber) and Mr. Rowden, on "Apparatus for Ventilating, Warming, Cooking and Lighting, in connection with the Paris Exhibition of 1867." Tests of many gas burners are given, but 26 years have elapsed

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since they were made, and as Paris gas was used they have lost somewhat in practical interest. The Report is very elaborate, and contains much interesting matter.

Utilisation of Water Power.—A company has been organised to build a wing dam on the Delaware river near Trenton, U.S.A., which will be equipped with a complete outfit of sluice ways and turbines for the generation of power. The works will be located at Morrisville, and the power will be sold to Trenton shops and factories. The Company is empowered, amongst other things, to erect and lay cables and wires overhead, under water, and underground for the transmission of electricity.

Electricity on American Canals.—The Alabama and Georgia Canal and Transportation Company has, says *Industries*, been formed, with a capital of $5,000,000, to build 150 miles of canal between Decatur, Birmingham, and other Alabama towns, with extensions later to Columbus, Savannah, and other towns in Georgia. The propelling power will be a stern screw, which will be operated by electricity. In order to do this the trolley system will be used along the portions where the canal is used. The canals will be the usual width, which will admit of two wires being strung, making a kind of double-track system.

The Moissan Electric Furnace.—In the *Comptes Rendus* for November 20th, M. Henri Moissan describes the latest type of electric furnace employed by him. His first furnace consisted of two hollow blocks of quicklime, which were super-imposed one on the other. In the type of furnace now described by him he has substituted blocks of Coursom stone for the quicklime briquettes, and has lined the interior with four layers of magnesia and carbon, arranged alternately, the first layer of magnesia being next to the arc. By the employment of magnesia higher temperatures can be attained than has hitherto been the case.

Lamp Statistics.—We are all familiar with the singular way an astronomer has of conveying an idea of big numbers. He tells us, for instance, that if a baby had an arm long enough to touch the sun, the baby would be 21 years old before it would feel any pain in its finger. Someone has been putting the statistics of the United States glow-lamp manufacture into a similar form; and he tells us, in an American contemporary, that since the output of one factory is one million lamps per annum there will be five million lamps made, at this rate, in five years, and that if all these lamps are put end to end they will extend along a line 39,457 miles long.

Preservation of Timber by Electrolysis.—The impregnation of timber can, it is said, be very quickly and expeditiously carried out by the aid of electricity. The apparatus comprises, says the *Moniteur Industriel*, two boilers for the preservative liquid to be injected, a circulating pump and its motor, a steam boiler and a dynamo. The saline liquid is heated in the usual manner by means of a current of steam. At the same time an electric current is passed through the impregnating boiler. The combined action of the electric current and the heat causes the timber to be thoroughly impregnated in one hour, while the usual process with heat, but without the electric current, takes from 10 to 40 hours.

Proposed Electric Tramway for Cork City.—Steps are now being taken to introduce electric trams into Cork City. The Privy Council have notified the Cork Corporation that the judicial Committee will sit at Dublin to-day to hear the application for the erection of electric tramways in Cork. A memorandum has also been sent from the Privy Council to the Corporation, in which the Inspector (Major Hutchinson) points out the various objections to the scheme as disclosed in the plans, particularly as regards narrow streets. The Corporation have decided to supply information to the Privy Council on the points raised, and to intimate that the Corporation are willing to fall in with the views of the Board of Trade on the matter in every respect.

Plymouth.—As will be seen by our list of Electric Lighting Notices this week, there promises to be a somewhat amusing competition down Plymouth way. The Corporation have gone in for a Bill to give them the power to supply the electric light in the chief business streets. No sooner had they given in their notices than the Plymouth Gas Company goes in for the same sort of thing, the only difference being that while the Corporation evidently hope to use the water-power of their water system to supply the necessary power, the Gas Company intend to use their gas. It seems a pity that, in view of the well-known *penchant* of Parliament for municipal electric lighting, there is not much chance of this interesting battle ever coming off.

Electric Lighting and Dowson Gas at Cleator Moor.—Last week the Cleator Moor Co-operative Society celebrated the opening of the Society's new flour mill, warehouse, and bakery. The Society formerly possessed a mill and warehouse, which were burnt almost to the ground in July, 1892. This was fully covered by insurance, and with the money received from the insurance companies the Society has been enabled to re-erect the mill and warehouse, substituting more modern machinery and appliances. The mill machinery is driven by two gas engines of 200 aggregate I.H.P. The engines are supplied with Dowson gas. The Society have, further, gone in for lighting by electricity. At present there are about 70 16-candle glow lamps lighting the mill and the warehouse.

The Art of Passing Examinations.—The current number of *The Sphinx*, the University College (Liverpool) Students' magazine, contains a sensible article on this subject from the pen of Dr. Oliver Lodge, who, many-sided as he is, evidently does not appreciate the delights of acting as examiner:—"When an examinee," says Dr. Lodge, "I regarded an examination with a feeling of pleasant exhilaration; as an examiner I loathe its dismal sequel with unmitigated disgust. Little enough time does one find to read the great writings of the masters of one's subject, but to read through piles of manuscript of the feeblest (sometimes of the most idiotic) description, and to keep one's mind on the strain to appraise ever particle of value which can be detected amid the refuse, is an occupation unfit for a scavenger."

Old Students' Association.—The Committee of the Old Students' Association, in presenting the annual report and statement of accounts for the eighth session (1892-93), remark that, "in order to attain a still larger measure of success, the Association should be so developed that its operations do not conflict with those of other bodies. There are equally successful societies for the purpose of reading scientific Papers, and it therefore seems to us that, in the future, greater prominence should be given to the social aspects of our work, a department which has always formed the strongest bond of union between our members." For this reason the Committee have deferred the election of the new officers till such time as they could submit to a general meeting suggestions for the future working of the Association.

Bristol.—There was a meeting of the Electrical Committee of the Corporation last week, when various matters relating to the electric lighting scheme were considered. It was thought that the lighting in Victoria-street and Bristol Bridge had proved successful. The Committee decided to increase the plant by purchasing another engine, and a second additional engine will probably be required before many weeks. The demand for incandescent lighting continues to increase in the most encouraging manner. The Finance Committee of the Town Council have decided that they will not at present light some of the municipal offices by electricity, and that will place something like 2,000 incandescent lamps at the disposal of the Electrical Committee to meet other requirements. The total number of incandescent lamps for which orders have been received is 14,000, or 4,000 beyond the limit of supply contemplated when the present plant was arranged for, and the Committee are commencing with 90 per cent. of their power utilised.

Kensington Vestry Electric Lighting Scheme.—A special meeting was held last week to consider the question of electric lighting to be undertaken by this Vestry. Mr. Ellis ridiculed the whole report, and said the attempt at electric lighting in St. Pancras was a complete fiasco. A more madcap scheme had never been set before the public. He moved the rejection of the report. Mr. Robinson pointed out that not one in four residents in the Lansdowne-road had asked for the electric light. Mr. Blanckensee having spoken against the report, the

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amendment to reject it was put and carried by nearly three votes to one. The following proposal of the Notting Hill Electric Lighting Company was then rejected on the recommendation of the Electric Lighting Committee. The Company's proposal with regard to area "B" was that the Vestry should co-operate with the Company to enable it to obtain the said area, without however putting on it any obligation to wire streets which might appear to be unremunerative, and that the Vestry should have the right of laying down mains in any street or streets which the Company were unwilling to wire, starting from any of their "feeder-points," the Company undertaking to supply the current to such mains at half the cost they were at present authorised to charge, the Vestry to make their own terms with private consumers.

The Official Vocabulary for Code Telegrams.—This vocabulary is now being prepared by the International Bureau of Telegraphic Administrations at Berne, in accordance with the decision of the International Telegraphic Conference of Paris, 1890. It will contain about 240,000 words, selected from the eight authorised languages—English, French, German, Spanish, Italian, Dutch, Portuguese, and Latin. Inflections of words, declension, conjugation, comparative and superlative, will be used, as well as a certain number of proper names. The words will contain at least five and at most ten letters, and will form a single series, alphabetically arranged, and numbered from 000000 to 240,000, the different languages being mingled according to alphabetical order. The words are not to present any distinction showing the language to which they belong, and each page will measure 11·8in. by 7·87in., containing 300 words. The vocabulary is to be printed in clear characters on paper of good quality. Editions containing part of the words, or the words of a single language, will not be published. Three years after publication the use of this official vocabulary will become obligatory for the European Telegraphic Service, and later on, doubtless, for extra-European messages. The vocabulary is the property of the administrations forming the Telegraphic Union, who will bear in the first instance the cost of compilation and printing. It is announced that the official vocabulary will be published some time in 1894.

High-Frequency Currents. — In a recent issue of the *Electrical World*, of New York, Lieut. Patten, following in the footsteps of Mr. Trouton, shows how high-frequency currents may be practically generated by a series of similar alternators with their armatures on the same shaft, and the field of each excited by the current from the armature next before it in the series. As pointed out, however, the electromotive force, if the alternators are identical, is decreased in the same ratio as the frequencies are increased, which limits this disposition for practical purposes. The device might have been useful for the production of very high-frequency currents for theoretical purposes, if it had turned out that the frequency was doubled by each additional armature, as in that case only a few armatures would have been needed to produce very rapid alternations. But, unfortunately, the frequency is simply increased by a constant amount with each successive armature, and the chief value of the method for experimental purposes is found in cases where it is desirable to know the exact frequency. It should be borne in mind, says our contemporary, that, apart from the usual losses in the different fields, armatures, and condensers, there is no loss of energy due to the successive decreases in output. This decrease follows from the character of the field generated by the alternating field current, which reduces the output of the armature, but yet only expends energy in proportion to the reduced capacity.

The Tower Platform for Naval Search Lights.—An important series of experiments in gunnery and kindred subjects has recently been completed at Silloth, on the range belonging to Sir William Armstrong, Mitchell and Co., in the presence of a large number of representatives of several European Powers, of the United States, and of Japan, for the purpose of Exhibiting the latest results which have been obtained at elswick in the improvement of artillery. Amongst other things a new form of naval search-light was exhibited, on the ingenious platform invented by Mr. Beauchamp Tower. This contrivance is of great interest, as it obviated the unsteadiness and uncertain direction of the light ordinarily produced by the rolling of any vessel carrying it. The details of the mechanism have been published in a Paper read some years ago by the inventor. A platform rests upon pistons working in hydraulic cylinders, and a jet of water is directed by a gyroscope into one or more of these cylinders, the jet being in the direction of the axis of the gyroscope. The apparatus was placed on board a small vessel, and a beam of light was directed upon an object in the water. The vessel was then caused to roll violently; but, in spite of the rolling, the beam remained directed upon the object as steadily as if the light had been upon the jetty. The apparatus was then thrown out of gear, so that the search-light became an ordinary fitting; and it was then shown to be useless while the boat was rolling, it being no longer possible to keep the beam directed upon the object even for a moment.

Press Telegrams and the Telegraph Revenue.—In the House of Commons on Monday evening Mr. Picton asked the Postmaster-General whether he had now obtained the information which he was unable to give on June 19th, as to the pecuniary results to the Post Office of the difference in the charges made for Press telegrams as compared with ordinary telegrams; and whether he could say approximately how much of the deficit in the telegraph service was received back by the public in the form of cheap news. Mr. A. Morley said that he found that the cost of an examination of the messages for any lengthened period would be so great as to be prohibitive, and he therefore directed that the calculations should be limited to a particular day. The result was to show that if the Press messages of that day had been paid for at the ordinary inland rate the Department would have received nearly eight times as much as it actually did receive. For the reasons which he gave on June 19th it was impossible for him to separate the cost of dealing with Press telegrams from that of the rest of the Telegraph Service, and he could not therefore state what was the loss incurred by the Department. When the account of the gross amount received and expended on account of the telegraph service for the year ended March last is presented to Parliament it will be found that, apart from the interest on capital, the balance of expenditure over receipts was about £150,000, and the best estimate that could be formed by the officials at the Post Office pointed to the annual loss on Press telegrams being at least double that amount, and probably a still larger sum. He believed the test day selected was July 8th.

The "St. Martin's-le-Grand Magazine."—The occasion of the annual dinner of the *St. Martin's-le-Grand*, the Post-Office magazine, was seized upon as an opportunity to welcome Mr. Spencer Walpole on his appointment as secretary to the General Post Office, and also to gather together a large number of past and present officials of the service. About 260 gentlemen assembled at the Freemasons' Tavern on Tuesday night, among them being the Postmaster-General, Mr. Frank Lockwood, Q.C., M.P., Mr. W. H. Preece, and Messrs. H. Joyce, J. C. Lamb, H. C. Fischer, &c., &c. Mr. W. H. Preece proposed the health of the Postmaster-General. The Postmaster-General, in replying, said he must attribute the cordiality of their reception to the office which he had the honour to hold. The toast had been originally intended for proposal by their guest, Mr. Lockwood; and as it occurred to his mind that his hon. friend was interested in an extension of the telegraphic service, which had not been carried out because the vote of money for the purpose did not permit, he had prepared himself to meet an exposure of the faultiness of the Post Office as a department, and the shortcomings of the Postmaster-General who now unworthily occupied that position. Fortunately they were spared the flow of reminiscence and remark which he had provided himself with against that contingency. He was glad to see they had seized the earliest opportunity of making the acquaintance of the new secretary, who, he was sure, would perform his duties in a manner to hand down to posterity the highest traditions of his predecessors. Postmasters-General came and went, and their official connection with the department was generally under three years. Mr. Lockwood and Mr. Spencer Walpole also spoke.

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MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

Motive Power.—The study of motive power leads us to consider those arrangements of mechanical parts, which are most conveniently called *engines*, in which the energy of some natural source is either directly or through a chain of processes transformed into the energy of mechanical motion. The term engine will, therefore, include in its widest sense all the machinery between the actual natural source or supply of energy, such as the coal in a boiler furnace, and the contrivance in which the required form of mechanical motion takes place. It will, however, be found more convenient to limit the meaning of the term, and to divide the train of mechanical parts under three classes: 1st, the preparatory parts, such as the furnace and boiler in a steam-engine plant, or the races in a water mill; 2nd, the engine proper, in which the energy in a suitably prepared form is finally converted into mechanical motion of machinery; and 3rd, the gearing, in which this mechanical motion is modified to suit the special requirements of the dynamo. Motive power is at once seen to be necessary in electrical engineering, because it is impracticable to derive electrical energy, as such, from any natural source so that it can be conveniently used. The dynamo is the most common mode of deriving electrical energy from suitable prepared mechanical energy.

The need for the third stage in the series of energy transformations arises from the fact that it is often necessary to place the dynamo in connection with an engine running at an unsuitable speed, or to have the engine and dynamo at a considerable distance apart.

It will be convenient to include under the term *gearing* all mechanical parts, whether moving or fixed, which are interposed between the engine proper and the dynamo, and which aid the transfer of mechanical motion from the former to the latter. There is a distinctly different application of gearing in the case where an electric motor is adapted to run any machine through the intermediate action of a train of mechanism, all such mechanism being here also called gearing.

Energy. — There are only two things in the material universe—energy and matter, or—some would say energy and ether—making ether and matter one. Energy, however, is not strictly regarded as a *thing*, that is to say, as having separate existence in itself. Energy is a condition or set of conditions in matter; it is that condition in matter which enables the matter to exert force against any resisting force, and to overcome that resistance through a distance. Energy, then, is that which enables a body to push backwards against a force through a distance along its line of action. Now, when a force is exerted it must be exerted against another force, equally great, arising from the external or internal resistance of the body against which the force is exerted. The measure of the energy exerted is equal to the product of the acting force into the distance along its line of action through which it overcomes the resistance. The product of the resisting force into the distance through which it is overcome is called the *work* done on the resistance.

Work, Power, and Velocity.—It follows, then, that in all cases of the mutual action between two or more bodies, the energy exerted will be equal to the work done, or the energy expended by the acting force will be equal to the work done against the total resistance. So, then, energy is the capacity for doing work. It can be shown that every body which exerts force through any distance along its line of action and in its direction, must expend energy. It is equally capable of proof that every body which opposes a resisting force which is overcome along its line of action must absorb—and retain or dissipate—an amount of energy equal to the amount expended by the acting body. Whence it follows that in none of the mutual actions between bodies is any energy lost, neither is any energy created. This theorem is called the doctrine of the conservation of energy. Work is the transference of energy from one portion of matter to another, and the measure of the work is the measure of the amount of energy lost by one and absorbed (to be retained or dissipated) by the other. The rate at which this transference is taking place at any instant is called the *power*; or the average power is the ratio of the amount of energy transferred to the time taken to transfer it.

Power, in other words, is the rate of working, it is sometimes called the *activity*. If a force, F, is exerted through a distance, L, in a time, T, the amount of energy expended by the body exerting the force, F, is equal to F multiplied by L, and the power is equal to this quantity divided by T, or is equal to the product of the force, F, into the ratio of the distance, L, to the time, T. But this ratio is equal to the velocity of the point of action of the force, F, along its line of action; or, if the velocity is not constant, this ratio is the average velocity and gives the average power. If, however, the velocity is constant during the time, T, this will give the actual power at any instant in that time. Whence, the power at any instant is equal to the product of the force acting at that instant into the velocity with which its point of application is advancing along its line of action at that same instant. Or generally, power is the product of force into velocity.

There are two general kinds of velocity involved in the question of power: linear velocity and angular velocity, or speed. Linear velocity is the rate of motion of any body or point along a line, whether curved or straight; it is expressed in units of length traversed in unit time, assuming the rate to remain unchanged during the unit time. Angular velocity is the rate at which any radius sweeps through an angle, as in the case of a radius of a rotating wheel. If any radius is chalked on a flywheel or pulley, and the wheel is turned round, it will be found that the radius has passed through an angle at the centre of the wheel, the angle being made by the positive inclination of the new position of the chalk line to the old position. If this angle is divided by the time taken to pass through it, the average angular velocity of the radius has been determined. In one revolution, an angle of 2π radians or 360deg. has been passed through. We may express angular velocity as the number of radians, or degrees, or revolutions swept through by any radius in unit time, such as a second or a minute. Speed is usually expressed in revolutions per minute. Let N be the number of revolutions per minute; then the number of radians swept through in a minute will be $2\pi N$, and the angular velocity, ω, in radians per second will be

$$\omega = \frac{2\pi N}{60} = \frac{\pi N}{30}. \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In motive power angular velocity almost exclusively belongs to motion in a circle, in which, of course, there is a constant radius. Let r be the radius of motion. The linear velocity round the circle will be, in units of length per second,

$$v = \frac{2\pi r N}{60} = \frac{\pi r N}{30}. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Substituting the value of N, obtained from this last equation, in the one preceding it we get—

$$v = \omega \times r. \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The above shows that, in circular motion, the angular velocity is the ratio of the linear velocity to the radius of the line. Where power is to be transmitted by angular motion it is often more convenient to express it in terms of angular rather than of linear velocity. This may be done by expressing linear velocity in terms of speed. Thus

$$\text{Power} = P = F.v = F.\omega.r. \quad . \quad . \quad . \quad . \quad (4)$$

The product $F.r$ is called the moment of the force, whether acting or resisting; it is also called the torque, and is represented by the symbol τ; whence the power in units of work per second is equal to—

$$P = \tau.\omega, \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Units.—In mechanical engineering the system of units adopted is based upon different fundamental units to that adopted in electrical engineering. The mechanical

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or gravitation system is derived from the *foot* as the unit of length, the *second* as the unit of time, and the weight of a standard *pound* at Greenwich sea level as the unit of force. From these are derived the following units:—The foot-pound, as the unit of energy and work, being the work done by a force of one pound acting through one foot. The foot-pound per second is one unit of power; but a more common unit is the horse-power, invented by James Watt, which is equivalent to 550 foot-pounds per second, or 33,000 per minute. Velocity is expressed in feet per second; angular velocity in radians per second, or revolutions per minute; and torque as the product of a force in pounds into a radius in feet, usually called pounds-feet to distinguish it from foot-pounds. It is sometimes convenient to express a torque in inch-pounds, where the radius is expressed in inches. The unit of mass in this system is designed to correspond to the units of force and velocity, and is such that if a force of one pound acts on it for one second it will acquire a velocity of one foot per second. Inasmuch as the weight-force of a pound acting on its own mass alone will cause it to acquire a speed of 32·2ft. per second at the end of one second (g), it will be evident that the unit of mass must be 32·2 times more massive than one pound, or will equal 32·2lb. Electrical engineering units are based upon the *gramme* as the unit of mass, the *centimetre* as the unit of length, and the second as the unit of time. From these are derived the *dyne* as the unit of force, the *erg*, or dyne-centimetre, as one unit of work, the *joule*, or 10^7 ergs, as a higher unit of work or energy, and the Board of Trade unit as the commercial unit of work or energy. This last is based upon the *watt*, or unit of power (which watt is equal to one joule per second), and is equivalent to the work done by a power of 1,000 watts lasting for one hour. A kilowatt is equal to 1,000 watts, so that a B.T. unit (Board of Trade unit) is equal to one kilowatt-hour. A simple calculation will show that one horse-power (H.P.) is equal to 746 watts, and that one B.T. unit is approximately equal to $1\frac{1}{3}$ H.P.-hour.

Sources of Energy.—Energy, which as we have seen is indestructible, is capable of numerous transformations. The forms under which it exists in nature and in engineering are many and varied. Yet they may all be classed under two heads; and these two under one great head, energy. In other words, any energy in one class may be so modified that it must be transferred to the other class. There are not two isolated quantities of energy. The two great classes are: energy of motion and energy of stress; or kinetic and potential energy, as they are respectively called. Kinetic energy is the energy which a body possesses by virtue of its motion, and which enables it to do work against a retarding force, as for example the energy of a cannon ball or of a fly-wheel. Potential energy is the energy which anybody possesses by virtue of the stress and strain to which it is subjected by the proximity of some other body. Thus, a raised weight possesses energy even when at rest, because of the proximity of the attracting earth. To be quite exact this form of energy belongs to the medium of the stress and not directly to the bodies between which the stress arises; but because it is possible for either or both of these bodies to acquire this energy at any time, by a relative change of position, this is called their *potential* energy. All the forms of energy with which we are acquainted come under one or the other of these two heads. The immediate sources of energy in nature are numerous, though it is possible to trace the greater number of them to solar heat. The principal forms of energy are as follows:—

Kinetic Energy.	*Potential Energy.*
Moving bodies.	Raised weights.
Sound waves.	Sound waves.
Light (Radiation).	Light (Radiation).
Heat.	Electric stress.
Electric current.	Magnetic field.
	Chemical stress (Fuel).
	Elasticity.

In the case of waves, both forms of energy are alternatingly assumed; while many of the forms of energy have been repeated in the same column for the sake of clearness. Thus the potential energy of waves is due to elasticity, and the kinetic energy of sound waves is due to moving particles. Motive power for machinery is, however, derived from a more limited number of sources than those mentioned, namely, from (1) fuels; (2) water raised to a height by solar heat; (3) the tides; (4) wind power, including wave power, and (5) muscular power. These are dealt with in engines of the following description:—

Fuels	Heat Engines	Steam engines. Hot-air engines. Gas engines. Oil engines.
Water Power	Water Motors	Water wheels. Turbines. Hydraulic motors.
Wind Power		Wind mills. Wave engines.

Machinery for developing useful work by muscular power has not received much attention, except in the case of locomotion, and does not call for any consideration here.

(To be continued.)

TESTS OF GAS BURNERS.

(Concluded from page 96.)

Wenham Gas Burner (burner over lecture table in Room 32). Candle-powers were taken by aid of the mirror. Consumption of gas due to by-pass was found to be 2·07 cubic feet per hour when the flame was turned as low as it could be turned in practice. The average consumption in these burners is probably nearer 2·5 cubic feet per hour.

The candle-power of the Wenham light increases, of course, with the temperature of the regenerative arrangement. It was found impossible to get constant readings for more than half an hour after lighting. Some of the time readings are as follows, the consumption remaining practically constant:—

Candle-power.	Time.	Candle-power.	Time.
55·8	0	100·5	20 min.
67·7	5 min.	100·6	30 „
91·0	10 „	112·0	40 „

The candle-power thus actually doubles in 40 minutes.

Tests of the Governor.

Pressure.	Cub. ft. per hr.	Pressure.	Cub. ft. per hr.
2·5	14·02	0·47	9·57
1·5	14·30	0·4	7·53
0·5	12·35		

The governor thus acts very well over a considerable range, and the candle-power will not vary much as long as the pressure exceeds half an inch. The candle-power having reached its maximum at the end of about 40 minutes the light given in various directions was obtained by aid of the mirror, the photometer bench being placed in various positions in the room. The result of these measurements will be given in a section on spherical candle-power.

It is noticeable that the consumption of gas actually decreases as the pressure increases above half an inch, the governor acting rather too readily. The rise of pressure from 0·55 to 1·2 occurred suddenly somewhere about a quarter to six, and was due to a rise of pressure in the mains.

Time did not permit of a number of observations of relation between candle-power and consumption being taken, as 45 minutes would have to be allowed each time for the burner to reach a constant temperature. These burners are, however, almost invariably turned full on when in use, and such observations would have no practical value.

Albo-Carbon Burner.

The type tested was that in which the albo-carbon reservoir is immediately below the burner, which was found to subtend a solid angle $2\pi \times 0·057$, thus cutting off 2·8 per cent. of the

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light. The weight of albo-carbon consumed in a known time was taken, this being an important item in the expense :—

C.P.	Cubic feet per hour.	Pressure.	Efficiency.	
28·6	5·62	1·5	5·09	Face.
25·8	—	—	4·59	Edge.

Weight of albo-carbon consumed in 90min. = 14·48 grams = 9·65 per hour. Cost of albo-carbon at 2d. per pound = 0·0441d. per hour.

C.P.	Cubic feet per hour.	Pressure.	Efficiency.
20·0	3·85	0·85	5·2

Weight of albo-carbon consumed in 197min. = 26·93 grams = 8·19 grams per hour. Cost of albo-carbon at 2d. per pound = 0·0374d. per hour.

London Argand (Sugg's) Burner, No. 1.

Distance from photometer.	C.P.	Cub. ft. per hour.	Pressure.	Efficiency.	Height of flame.
113·3	19·1	5·90	1·3	3·22	3"
110	15·1	5·2	1·05	2·91	2·1"
106·2	11·8	4·55	0·85	2·59	1·7"
91·2	4·81	3·48	0·45	1·38	1·0"
63·5	1·08	2·4	0·35	0·456	0·6"

The efficiency of the burner increases with the consumption of gas, and at 20-c.p. is higher than is obtained with any other burner except the albo-carbon, Welsbach, and large candle-power burners.

Welsbach Incandescent Burner, No. 2. (New Mantle.)

D.	C.P.	Cub. ft. per hr.	Pressure.	Efficiency.
105·4	11·1	1·4	0·2	7·93
114·3	20·5	2·05	0·55	10·0
115·5	22·4	3·15	1·45	7·12
115·7	22·7	3·15	1·7	7·22

This is by far the most efficient burner tested,* the efficiency being 10 candle-power per cubic foot at 55min. pressure.

Spherical Candle-power of Gas Burners.

Measurements of candle-power in different directions were made with the mirror.

Bray's No. 5 special Batswing was measured in 12 different directions, taken nearly uniformly over a sphere. The mean spherical candle-power was found to be almost exactly that of the edge of the flame in the horizontal plane, or about 92 per cent. of the horizontal candle-power full face. Bray's enamel regulator No. 5, and other fish-tail burners, gave a mean spherical candle-power practically equal to the horizontal candle-power, which is nearly uniform all round.

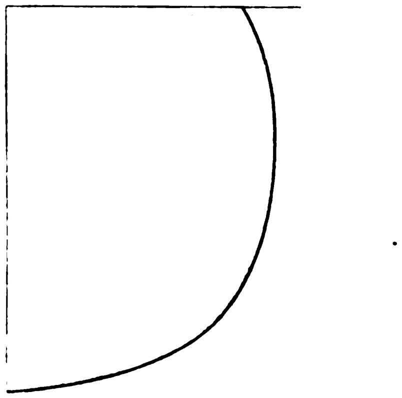

Fig. 6.—Spherical Candle-Power of Wenham Burner.

Wenham Burner.—Large variations of candle-power at different inclinations to the vertical were found.

Angle with vertical	C.P.	Angle with vertical	C.P.
0	110·0	60°	90·3
35°	109·7	80°	76·6

Mean candle-power below the horizontal plane (found) from area of curve = 95·1. Mean spherical candle-power = 47·5.

* Renewals of mantles and glasses, very considerable items, appear to have been omitted.—Ed. *E.*

This gives the mean efficiency as 3·3 candle hours per cubic foot.

London Argand Burner.—The flame being symmetrical about a vertical axis, measurements in only one vertical plane were taken. d_1 and d_2 refer to distances explained in Fig. 2, page 94 of our last issue :—

Angle. deg.	d_1	d_2	Cub. ft. per hr.	Apparent C.P.	Real C.P.
−80	24·5	57·5	6·3	1·88	2·29
−70	28·0	74·3	—	4·57	5·57
−45	36·0	93·5	—	14·2	17·3
0	28·5	99·3	6·3	17·8	21·7
45	33·0	98·6	6·35	18·4	22·5
66	31·0	98·4	—	16·8	20·5

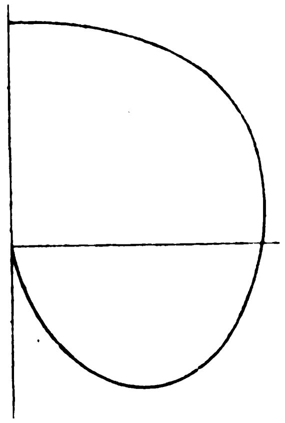

Fig. 7.—Spherical Candle-Power of London Argand Burner.

The value of the spherical candle-power obtained from the curve is 15·1 apparent or 18·4 real. Horizontal C.P. = 21·7, mean spherical = 18·4, or 15 per cent. less.

Spherical C.P. of a Standard Candle.

Angle deg.	d_1	d_2	Apparent C.P.	Real C.P.
−75	24·0	26·8	0·34	0·414
−68	26·0	37·6	0·64	0·78
−60	27·0	40·7	0·76	0·926
−52	35·5	35·5	0·77	0·939
−30	24·7	43·7	0·82	1·00
0	21·5	46·7	0·87	1·06
+15	19·5	49·9	0·96	1·17
45	26·0	44·3	0·89	1·09
60	23·0	48·2	0·98	1·19
69	22·0	46·7	0·88	1·07

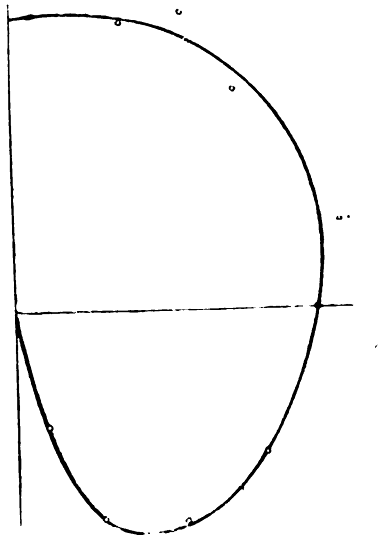

Fig. 8.—Spherical Candle-Power of a Standard Candle.

The curve gives:—Mean spherical C.P. (real) = 0·94, horizontal C.P. = 1·06. The mean spherical C.P. is, therefore, less than the horizontal C.P. by 11 per cent.

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Summary of Results.

Burner.	Max. C. P.	Pressure.	Efficiency.	Max. eff.	C.P.	Pressure.
Bray's Enamel Reg. 6 Union Jet.	14·2	1·1	1·86	2·12*	9·9	0·5
„ „ „ 6 Slit Union.	25·8	1·0	2·66	2·85*	14·8	0·42
„ „ „ 6 Batswing..	21·4	1·1	2·4	2·74*	15·6	0·55
„ "Special" 6 Union Jet.	16·5	1·27	2·14	2·4 *	11·2	0·55
„ „ 6 Batswing..	22·0	1·1	2·74	2·74	22·0	1·1
Sugg's Table Top 5 (Ungovd.)..	25·0*	1·0	2·12	2·77*	18·0	0·44
Bray's Enamel Reg. 5 Slit Union.	15·9	1·25	2·06	2·36*	13·0	0·7
„ „ „ 5 Union Jet.	12·2	1·25	1·68	2·08*	6·2	0·3
Bray's "Special" 4 Union Jet.	11·2	1·3	1·82	2·02*	9·9	0·95
„ „ 4 Batswing..	14·3	1·25	2·3	2·38*	11·7	0·8
„ „ 4 Slit Union.	12·0	1·2	2·0	2·28*	7·0	0·5
„ Enamel Reg. 4 Union Jet.	9·3*	1·3	1·44	1·78*	6·2	0·4
„ „ „ 4 Slit Union.	15·6	1·1	2·04	2·18*	12·8	0·75
Bray's En. Reg. 3 Union Jet. (Spong's attachment).	12·8	1·4	2·1	2·3*	8·8	0·65
Bray's En. Reg. 3 Union Jet.	7·2	1·5	1·14	1·5	3·9	0·33
Bray's „ 2 „	3·6	1·4	0·76	1·11*	1·51	0·2
Sugg's Table Top 1 (Ungovd.).	1·78	1·55	0·55	0·95*	1·32	0·6
„ „ „ 2 (Governed)	3·4	0·95	1·74	1·76*	3·0	0·87
„ „ „ 5 „	18·6	1·43	2·78	2·78	18·6	1·43
„ Dome Top 5 „	12·2	1·6	2·8	2·8	12·2	1·6
Bray's (Street Lamps) „	7·9*	1·0	2·0	2·0*	7·9	1·0
„ Standard 30-c.p.	50·0	1·5	2·8	3·08*	26·0	0·5
„ „ 80-c.p.	80·0	1·3	3·44	3·44	80·0	1·3
London Argand 1	19·0	1·3	3·2	3·2	19·0	1·3
Wenham (Mean Spherical)	47·5*	1·5	3·3	—	—	—
Albo-carbon	28·6*	1·5	5·09	—	—	—
Welsbach No. 1 (New Mantle)..	22·7*	1·7	7·22	10·0*	20·0	0·55

* True maximum. The other figures in this column do not relate to true maximum, but merely to the highest value obtained.

Burner.	Cost of one candle-hour at max. C.P. Gas at 2s. 6d. per thousand. d.	Cost of one candle-hour at max. efficiency. d.
Bray's Enamel Regulator 6 Union Jet	0·0162	0·0142
„ „ „ 6 Slit Union	0·0113	0·0105
„ „ „ 6 Batswing	0·0125	0·0109
Bray's "Special" 6 Union Jet	0·0140	0·0125
„ „ 6 Batswing	0·0109	0·0109
Sugg's Table Top 5 (Ungoverned)	0·0142	0·0108
Bray's Enamel Regulator 5 Slit Union	0·0146	0·0127
„ „ „ 5 Union Jet	0·0179	0·0144
Bray's "Special" 4 Union Jet	0·0165	0·0147
„ „ 4 Batswing	0·0145	0·0126
„ „ 4 Slit Union	0·0150	0·0132
„ Enamel Regulator 4 Union Jet	0·0208	0·0168
„ „ „ 4 Slit Union	0·0147	0·0138
Bray's Enamel Reg. 3 Union Jet, Spong's attachment	0·0143	0·0130
Ditto, without attachment	0·0263	0·0200
Bray's Enamel Reg. 2 Union Jet	0·0395	0·0270
Sugg's Table Top 1 (Ungoverned)	0·0545	0·0316
Sugg's Table Top 2 (Governed)	0·0172	0·0170
„ „ „ 1 „	0·0300	0·0300
„ „ „ 5 „	0·0108	0·0108
Sugg's Dome Top 5 „	0·0107	0·0107
Bray's (Street Lamps) „	0·0150	0·0150
Bray's Standard 30-c.p.	0·0107	0·0097
„ „ 80-c.p.	0·0087	0·0087
London Argand (Mean Spherical)	0·0111	0·0111
Wenham (Mean Spherical)	0·0091	—
Albo carbon (0·0059 Gas, 0·0016 Carbon)	0·0075 or	0·0077 (mean spherical)
Welsbach No. 1 (New Mantle)	0·00415	0·0030

We propose to consider some of the results given in this report in a future article, comparing the cost of gas lighting by different burners with the cost of electric lighting by glow lamps.

CARBONS FOR ELECTRICAL USE.

Abundant evidence exists that such knowledge as has been gained of the principles on which the manufacture of carbons for electrical purposes rests, and of the adjustment of quality to the use to which the carbons are to be put, is scarcely adequate for present industrial requirements. The absence of precise information on many essential points has lately been publicly demonstrated in a case ("Thompson *v.* Cowles") recently reported in these pages. It will be remembered that the question then at issue was whether carbons supplied for the production of aluminium by electrolysis were suited for this purpose, and that, taking the evidence as given without comment, it appeared that carbons which one firm had chosen after extensive practical trials were rejected by another on the ground that they were not fitted for the same work. In view of this direct conflict of experience it is plain that the selection of carbons for a given purpose is more than tinged with uncertainty, and it is reasonable to inquire concerning the chief reasons for this dubiety and the methods by which it may be diminished or removed.

The "carbon points" used by Davy for exhibiting the electric arc were merely sticks of wood charcoal. Retort carbon was soon afterwards used, on account of its hardness and slower rate of consumption; and square rods sawn out of gas retort carbon were in use by several makers of arc lamps at the Paris Electrical Exhibition of 1881. But even at that time very fair arc carbons were manufactured, and gradual improvements have been made since then, until a few brands exist which are nearly perfect under the conditions for which they are intended. Until the use of electrical furnaces, electrolytic or otherwise, had passed the experimental stage, bundles of ordinary arc carbons were used, as in the Siemens furnace shown at a Kensington exhibition some years ago, and on the appearance of a demand, carbon makers began to turn out large carbons made with but trifling modifications of their ordinary process.

As is almost invariably the case in manufactures that have had to be undertaken to meet pressing commercial demands, the practice of carbon-making has far outstripped the knowledge of the principles that should guide the practice, and thus it happens that excellent carbons are made in a more or less empirica way. Equally usual is the occasional failure of these empirica methods without assignable cause. Correspondingly common place are the fallacies that do duty for explanatory truths The very word "carbons," as generally employed, is a unfortunate in its way as "tins" for boxes or canister made of tinned iron, and "brasses" for gun-metal bearings. The fact that the discrepancy between the thing and its nam is less glaring than in the instances given makes the term th more dangerous. Commercial carbons certainly do not consis entirely of the element C. True carbon in any of its allotropi modifications is perhaps the most difficult of all substances t obtain perfectly pure, one most cogent reason for this pecu liarity being that solution and volatilisation without chang are in its case well-nigh impossible by any means at presen known. The manufacturer of carbons, cutting his coat accor ing to his cloth, does not attempt the unattainable, but takin approximately pure carbon in a state of fine mechanical sub division, agglomerates it by any suitable carbonaceous materi which, on heating, will decompose with the liberation of approx mately pure carbon to serve as a cement between the particl constituting the bulk of the material. The composition of th resulting moulded carbon depends in the first place on that the commercial variety of carbon selected as the primary ingr dient; secondly, on that of the agglomerating substance chosen thirdly, on the nature of the decomposition which the latte undergoes on heating; and fourthly, on the time and tempera ture of the carbonising process. It is therefore insufficient t regard the quality of the carbons obtained as depending on an physical property; their chemical composition is at leas equally important. To take the simplest example of the nece sity for looking a little deeper than can be done by physica means, it is sufficient to say that few but those who hav actually made the determination have any idea of the quantit of foreign mineral constituents that are left as ash when an ord nary carbon rod is burnt. Where a special need has arisen, suc as that of the makers of aluminium intended to be free from iron, attention has been directed to the one objectionab impurity, but for most purposes no attempt is made to asce tain how much matter other than C exists in carbon rods fo arc lighting or for electrolytic use. Even granting that th amount and nature of the mineral constituents is known, it b no means follows that the balance may be set down as carbon Carbon, prepared by the decomposition of carbonaceous sub stances, retains the elements, notably hydrogen, with which i was associated before carbonisation with great tenacity, and nothing but a complete analysis will give an accurate know ledge of its composition. When this has been done the next

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step would be to endeavour to distinguish between the various forms of carbon, *e.g.*, graphitic and amorphous, that may coexist in the same rod—a problem of no slight difficulty. With such data as guide, differences in composition of carbons could be recognised as readily as differences in their resistance.

Even when all useful data, chemical and physical, have been obtained, the task remains to correlate these with the properties found most desirable in practice. A method by which to attain this end—quite indefensible scientifically, but promising more tangible results than the strict process of ascertaining the effect of all possible factors alone and together under all conceivable conditions—would be to choose those carbons which have been found of unusual excellence for any given purpose, and to determine every constant at all likely to affect their quality, *e.g,* composition, resistance, specific gravity (apparent and real), hardness and resistance to attrition and oxidation, so that future supplies could be compared with the standard thus created. At present there is an utter vagueness in speaking of the quality of a carbon. Carbons are termed hard and soft, and classed by tentative scratching with a file. There is often confusion between physical hardness and hard-bakedness—if the term may be pardoned—a confusion worse confounded by the partial coincidence of these properties. With a better knowledge of the essential qualities of a good carbon, and the cause of their presence or absence, all looseness of phrase and meaning would tend to disappear. Buyers would be able to say exactly what they wanted, and makers could supply them with a reasonable certainty of satisfying their requirements without undertaking long and costly experiments to decide which grade of carbons would best answer the purpose. The improvement cannot be effected without the expenditure of time, labour, and money; but the interests involved are large enough to make the expenditure ultimately an act of true economy.

ELECTRIC LIGHTING AND TRACTION NOTICES.

The time for giving official notice in the *London Gazette* of Private Bills to be presented to Parliament next Session and of application to the Board of Trade for Provisional Orders expired on Tuesday.

From the following list of notices it will be seen that there are 32 electric lighting notices and 13 traction notices. Compared with the two previous years, the notices are as follows:—

	1891.	1892.	1893.
Lighting	34	20	32
Traction	15	17	13

Of the total of 32 lighting notices 20 are given by local authorities, two by gas companies, and the remainder by electric lighting companies or contractors. Of the 13 traction notices only three are given by local authorities. Most of these propose to use "electricity or other motive power." The Central London Railway does not contemplate any other method of propulsion than electrical, and the Croydon line specifically excepts steam.

Electric Lighting Notices.

THE METROPOLIS.

Districts.	Names of Applicants.
Camberwell	Vestry.
Crystal Palace & District	Crystal Palace District Electric Supply Company (Limited).
Harrow	Local Board.
*Kensington	Vestry.
Leyton	Local Board.

THE PROVINCES.

Districts.	Names of Applicants.
Aberdare	J. C. Howell (Limited).
Barrow-in-Furness	Corporation.
Bedford	Bedford Electric Light Company (Limited).
Birmingham	Birmingham Electric Supply Company (Limited).
Bournemouth	Corporation.
Buxton	Local Board.
Chelmsford	Crompton and Co. (Limited).
Chepping Wycombe	Corporation.
Chesterfield	Corporation.
Grimsby	Corporation.
Guildford	Holloway Electricity Supply Company (Limited).
Monmouth	Corporation.
Moss Side	Collier-Marr Telephone and Electrical Manufacturing Company (Limited).
Oswestry	Oswestry Electric Lighting and Power Company (Limited).
Penrith	Local Board.
Peterborough	Corporation.
Plymouth	Corporation.
Plymouth and Stonehouse	Plymouth and Stonehouse Gas Light and Coke Company.
Preston	Preston Gas Company.
Shrewsbury	Shropshire Electric Light and Power Company (Limited).
St. Austell	Local Board.
St. Helens	Corporation.
Swansea	Crompton and Co. (Limited).
Torquay	Corporation. (Private Bill seeking, *inter alia,* the revival and extension of powers granted by Provisional Order obtained in 1891 and revoked in 1892.)
Wakefield	Corporation.
West Hartlepool	Corporation.
Yeadon	Local Board.

* This vestry last week rejected the proposed electric lighting undertaking by a large majority.

Traction Notices.

Names of Applicants.	Powers Sought.
Abergele and Pensarn Pier Company (Limited)	Construction of tramway. Use of electricity or other motive power.
Barrow-in-Furness Corporation	Construction of tramways. Use of electricity or other motive power.
Bristol Tramways and Carriage Company (Limited)	Construction of tramways. Use of electricity or other motive power.
Central London Railway.	Extension of time.
Company to be formed...	Construction of railway (partly underground) from South-place, Finsbury, to Walthamstow and Epping Forest. Use of electricity and steam or other motive power.
Croydon Corporation ...	Construction of tramways. Use of electricity or other motive power.
Croydon Tramways Company	Construction of tramways in Croydon and Streatham. Use of electricity or other motive power (except steam).
Dudley and Wolverhampton Tramways (Limited)	Construction of tramways in Dudley and Wolverhampton, and from Wolverhampton to Bilston. Use of electricity or other motive power.
Hull Street Tramways Company	Power to transfer part of undertaking. Use of electricity or other motive power.
Liverpool Corporation ...	Construction of tramways. Use of electricity or other motive power.
Liverpool United Tramways and Omnibus Company	Construction of tramways in Bootle and Walton-on-the-Hill. Use of electricity or other motive power.
South Staffordshire Tramways Company	Construction of tramways in West Bromwich and Handsworth. Use of electricity or other motive power.
West London Tramways Company (Limited)	Construction of tramways in Acton, Hammersmith and Fulham. Use of mechanical power.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, December 1st.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting. The following Paper will be read: "The Mechanical Testing of Electro-deposited Films of Metal."

TUESDAY, December 5th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Resumed discussion upon the Papers on:—"Impounding Reservoirs in India, and the Design of Masonry Dams," by Messrs. Clerke, Sadasewjee, Col. Jacob, and Prof. Kreuter. At this meeting the first monthly ballot for Members for the session 1893-94 will be taken.

OLD STUDENTS' ASSOCIATION.

8 p.m. General Meeting to receive Annual Report and Balance-sheet. Address by Mr. Ll. B. Atkinson, "A Trip to Chicago."

WEDNESDAY, December 6th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "An Artist's View of Chicago and the World's Fair," by Frederic Villiers.

THURSDAY, December 7th.

ROYAL SOCIETY.

4 p.m. The following papers are down for reading: (1) "A Dynamical Theory of the Electric and Luminiferous Medium," by J. Larmor, F.R.S. (2) "On Copper Electrolysis in Vacuo," by W. Gannon.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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ELECTRIC TRACTION.

Electrical engineers who are looking forward to the development of electric traction are, no doubt, studying the draft regulations which have been submitted for the consideration of the Board of Trade, scrutinising the changes in existing practice which they entail, and the points on which, perhaps, modifications of the regulations may be urged. We do not propose to discuss the regulations at present; they are evidently the outcome of much careful thought, and therefore demand deliberate study. These regulations have not come too soon, for telephonic disturbances have already been experienced, and it is quite possible that some electrolytic damage has been done, though it has not been detected; they have not come too late, for there will be no need to sweep away existing work in the fashion contemplated, and very properly contemplated, by the overhead wire rules.

We did not expect that the Report of the Joint Committee of the Houses of Parliament would suddenly set free a branch of engineering which had been struggling under vexatious

restrictions, nor do we believe that promoters of electric tramlines have been waiting for these regulations before they spread their rails, conduits, and trolley wires over the length and breadth of the land. They are certainly not waiting for some new invention, some ingenious closed conduit, light and inexpensive battery, or novel gearing. They are only waiting until there is some indication of a demand, and a probability that such lines will pay. To import a complete plant for electric traction from some place, say the United States, where electric traction is popular, and to set it at work in some other place, say on the outskirts of Manchester, where there appears to be enough traffic to make it pay, is not to ensure success. The Traction Notices which will be found in another column show that thirteen applications have been made this year for powers to work tramways by electrical or other power. Some of the proposed routes are of considerable interest. The "other power" is not at present a formidable competitor, and we hope that by the equipment and working of some of these new lines the position of electrical power may be strengthened.

The outside car, the hansom, the gondola, the dromedary and the jinrikisca are each a great success, but they do not seem to yield to acclimatisation. No one can tell why the delights of outside cars are confined to Ireland, or why Paris did not appreciate the hansom, and it is almost as difficult to discover why the English public do not demand electric traction. Almost, but not quite so difficult. One reason for their apathy resembles the reason for the deliberate progress of electric lighting in this country. We have good and cheap gas and well-made duplex and other paraffin lamps. Electric light offers a few advantages in coolness and cleanness, but the main question is the price. Similarly, we have excellent roads and street pavement, and the local railway service in the suburbs of our cities is, with the exception of the South London lines, unrivalled. But electric tramways could not greatly relieve the troubles of those who have no choice but to creep up to town on the South-Eastern; for a speed of eight miles an hour, say twice that of a South-Eastern local train, would be considered "furious driving" by the police.

As with electric lighting, electric traction offers certain conveniences, but the main question is the price. It is highly probable that an electric tramway on a fairly large scale could compete with a horse service. No figures about the Leeds Roundhay line nor about the South Staffordshire lines have been published for a long time. The former is unfortunately dependent on holiday traffic rather than on steady daily work, but the latter ought to give some information both as to comparative working cost and as to popularity. We have no doubt that electric tramways will develop, though we believe much more in electric railways. The unanimous evidence of the mayors and other representatives of municipal authorities before the Joint Committee on Electric Powers Protection Clauses showed a strong feeling in favour of cheap traction. A compromise between the slow speed of horse cars and the reckless rush of American street railways would be a service of express cars stopping only at certain points, say three-quarters of a mile apart, running at as nearly a uniform speed between those points as the traffic will permit. A speed would probably be possible such that jumping on or off the car while in motion would be strictly prohibited. Some system of points would be wanted at the turnouts to allow an express car to pass an ordinary car, and these might be worked from either car while in motion, or by the conductor of the ordinary car standing in the turnouts.

It would of course be a great boon if the artisan could live in a neat villa in a smiling suburb, as he does at Pittsburg, and come in by electric tram to his daily work, instead of being housed in overcrowded slums. But as this was not contemplated when the "living wage" was defined, we suppose that the State would be expected to carry him free. It only remains to find the necessary capital to lay down and equip the lines. This difficulty might be solved by the betterment principle being applied to the unhappy inhabitants along the route. They would be annoyed by the clanging of bells, and their children might be run over, but the principle is, we are informed, quite right. Fortunately, however, we have a Board of Trade.

THE CONTINUOUS CURRENT ARC AS A STANDARD LIGHT.*

BY ANDRÉ BLONDEL.

The nature of the continuous current arc has been much discussed, especially of late. The phenomenon which has attracted most attention is the production of the light at the positive crater and the marked fall of potential which occurs at the same time at this surface of passage. The constancy of the intrinsic brilliancy (the light emitted by unit surface) had been announced as very probable by Rosetti, and in a more recent communication Prof. Silvanus Thompson has stated this to be the case on the strength of some unpublished experiments of Captain Abney, and referred it to the boiling point of carbon. Captain Abney used this property to make a standard which he considered suitable for determining the colour of other lights but he did not care to announce it as a standard of light, owing to the variations produced by the flame passing in front of the crater.† Finally, about a year ago, in the course of a discussion at the Institution of Electrical Engineers, Mr. James Swinburne suggested idea, that by placing a screen pierced by a pin-hole in front of the crater it would be possible to construct an absolute standard of light, and Prof. Silvanus Thompson made a few remarks to the same effect. But the authors did not follow up their proposals with experimental proofs, and the echo only reached France when M. Violle‡ undertook a series of experiments on the light of the arc more complete and accurate than those of any of his predecessors, and when I exhibited an apparatus capable of being employed as a secondary standard of light. The experiments of M. Violle were carried out in two different ways, viz., by the fringe spectrophotometer and by photography.§ The learned professor found the brilliancy of the positive carbon to be independent of electric power dissipated (current and voltage). But he did not establish that it was independent of the kind of carbon. To elucidate this point M. Le Chatelier and I carried out some tests on different makes of carbons. As the instrument employed, the pyrophotometer, showed no difference, we thought ourselves justified in concluding, whilst reserving to ourselves the right to make more accurate experiments, that the nature of the carbons had no sensible influence. Later experiments, carried out in the manner described further on, have revealed variations which escaped the pyrophotometer on account of its lack of sensitiveness. These experiments have not, however, modified my conclusions as to the utility and correctness of employing the arc standard as a *secondary* standard for the photometry of arc lamps. I propose in this Paper to detail the reasons which call for the adoption of, or at least for a trial of, this system, and to describe the *modus operandi* and the possible degree of accuracy.

Units and Standards of Light.

It is an error to think, as is sometimes done, that the unit of light can be defined in an absolute manner as a function of the

* Paper read before the International Electrical Congress at Chicago, August, 1893.

† British Association Report, 1882, "On Fixing a Standard of Light," by Captain Abney.

‡ *Comptes Rendus*, January, 1893.

§ The first of these methods only should inspire perfect confidence, since it is only possible to photograph the crater across the arc which rises from it, and this latter, although transparent and hardly luminous, has considerable actinic power, comparable, indeed, to that of the crater itself, and consequently capable of wiping out to a large extent photogenic differences. For my part, even when employing the very short exposures that are necessary, I have never been able to obtain upon photographs the effect of the crater apart from that of the arc.

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ordinary physical elements, and therefore brought into connection with the C.G.S. system. Light, considered from the photometric, that is to say from the practical measurement point of view, is not a physical but a physiological quantity, and cannot be reduced to the other quantities dealt with by physicists. The unit of light can, therefore, never be defined in any way other than by a concrete standard, and the only measuring instrument used in photometric determinations will always be a normally-constituted human eye.

As a result of the beautiful researches of M. Violle, the International Commission of 1883 adopted as an absolute standard the standard which bears his name, and fulfils all the necessary conditions as to fixity. There is no reason in blaming this standard if the little platinum standards of Siemens, constructed with a view of reproducing it, have not been successes, nor is there any cause to question our choice of an absolute standard. All measurements should be expressed in *bougies décimales*. Each country and laboratory is evidently at liberty to do as it pleases, and employ such and such a lamp as a secondary standard, but on the condition that they transform the figures obtained into *bougies décimales** instead of, as is too often done, taking the secondary standard as a unit.

The Insufficiency of the present Methods and Standards for Arc Light Photometry.

But the Violle standard and the secondary standards at present in use only lend themselves to the measurement of sources of light having about the same tint. As soon as we come to arc lamp photometry we are met by theoretical and practical difficulties. Assuming that one is not stopped by the practical difficulty of equalising two sensations as different as those produced by the two lights on the photometer bar, it is none the less impossible theoretically to estimate in a simple manner the ratio of the candle-powers of two different sources of light. This theoretical impossibility which, *à priori*, renders illusory all the methods at present known, and all that may ultimately be suggested, arises, as is well known, from three main causes, all having a physiological origin.†

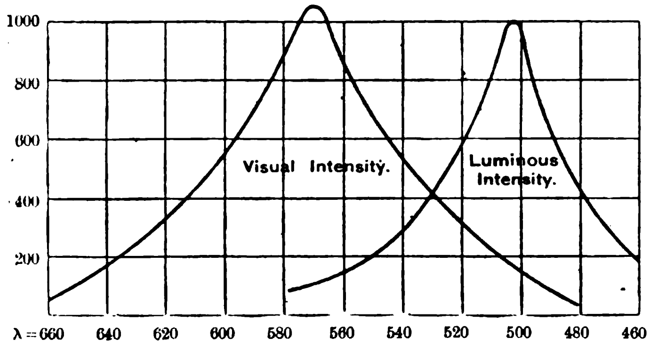

Fig. 1.

(1) A light interests us practically by its luminous and by its visual intensity, that is to say, by the ease with which it allows us to distinguish details. Now, as numerous scientists, and more especially Dr. Charpentier, MM. Macé de Lépinay and Nicati, and Prof. Langley, have shown, these two values do not vary proportionately when we pass from one source of light to another, and the difference is the greater the more refrangible the rays. For instance, Fig. 1 gives the curves showing the distribution according to Charpentier of the luminous and visual intensity in the spectrum.‡ Charpentier holds that vision comprises three distinct processes—the perception of light, the picking out of details, and the perception of the colouration. These results are confirmed, if not numerically, at any rate qualitatively, by Prof. Langley's experiments. A comparison, therefore, of two lights not having the same spectral composition yields different results, according as we measure the luminous or the visual intensity.

(2) The experiments of the investigators whom I have just quoted prove, moreover, that a comparison of two heterochromatic sources of light leads to different results, depending on the dimensions of the surfaces compared. These phenomena are too complex for me to discuss in this Paper.* They were, indeed, partly made known by the famous experiment of Weber.

(3) The intensity of the luminous sensation varies as a function of the absolute luminous intensity, and according to a different law for each colour.† In Fig. 2 I reproduce "sensation" curves for the different colours of the spectrum, based on the experiments of M. Charpentier. It will be observed that the sensations grow less rapidly as the colour becomes more refrangible.‡ This is the well-known phenomenon discovered by Purkinje, and investigated by several experimenters, especially by MM. Macé de Lépinay and Nicati, who have compared the intensity of the Purkinje phenomenon in both visual and luminous perception by successively measuring the amount of light required to produce the same luminous effect, and then the same visual effect as a monochromatic light taken as a standard, the impression produced by it being taken as unity.§ This investigation enabled them to formulate two very important laws:—

(*a*) The ratio of the luminous and visual impressions is independent of the actual intensity in the first half of the spectrum, and only increases slowly with the refrangibility.

(*b*) Beyond the radiation the ratio of the visual and luminous impressions increases very rapidly, and the more rapidly the greater the actual intensity of the source of light.

On account of all these physiological effects it appears without a doubt that the definition of the candle-power of an arc lamp in terms of the candle-power of a yellow or red standard, such as those actually in use is *à priori* impossible‖, and that all methods of heterochromatic photometry are illusory. The result of all of them is merely to shuffle out of the real difficulty by basing the photometric readings on one or two easy determinations with monochromatic light. These determinations once made, they are

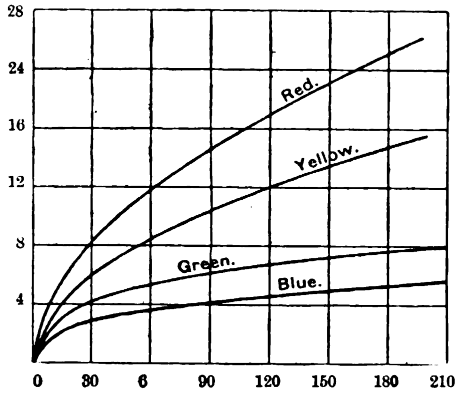

Fig. 2.

multiplied by a suitable coefficient, and a figure representing the so-called candle-power is obtained, and the investigator who wishes for nothing more declares himself satisfied. But the theoretical difficulty is only moved on slightly; it still exists in its entirety in the determination of the reduction coefficient. Moreover, the measurements obtained by several of these methods are rarely concordant.

First of all, if this coefficient has been determined by the method of equal visual impressions (for example, that of M. Crova), it is inapplicable to the comparison of *luminous* intensities. The reverse is the case if the coefficient has been arrived at by the method of equal luminous impressions (for example, that of M. Macé de Lépinay). It is, therefore, always necessary to specify the meaning of this coefficient, unless we make two calculations, one by each method. In the second place, let us see how this calculation has been carried out. In the otherwise ingenious method of M. Crova, the visual intensities of the radiations from the two spectra were set down as a function of one of the radiations, which was taken as unity. That is a very delicate operation, and the figures obtained by different observers do not usually agree well. The curves of visual intensity once obtained it is assumed, according to Roof's law, that the total impression of the spectrum is equal to the sum of the impressions of the radiations; then the two impressions are reduced to the same value by changing

* The use of the carcel is, nevertheless, advantageous in cases where we are dealing with huge candle-powers, such as those of lighthouses. In the case of French lighthouses, in order to avoid unmanageable figures, we express our measurements in carcels of 10 *bougies décimales*. It is under consideration, moreover, to adopt a larger unit of 1,000 *bougies décimales*, and to give it a special name.

† I take no notice of secondary effects, those due, for instance, to the yellow colour of the *forea centralis*, and to the possible "daltonism" of the observer.

‡ *Archives d'Ophtalmologie*, March-April, 1886.

* *Vide* Prof. Charpentier on "Light and Colour."

† This statement is nearly the same as that of Helmholtz.

‡ According to Helmholtz, Macé de Lépinay and Nicati the curves would cut at a certain distance from the origin, which would exaggerate the phenomenon. But Helmholtz's curves are purely hypothetical, and those of MM. Macé de Lépinay and Nicati rest on Fechner's law, which is no longer believed in.

§ The source of comparison was the yellow radiation of the solar spectrum.

‖ Helmholtz has stated ("Physiological Optics," p. 420) that "any comparison of two sources of light of different colour is impossible." Nothing has arisen to invalidate this high opinion since the date of its expression.

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the scale of the ordinates of one of the curves in order to arrive at the common ordinate. It is this process which is not legitimate, since in virtue of the Purkinje phenomenon the relative impression of each radiation varies with the absolute intensity. In the very seductive method of M. Macé de Lépinay (*Comptes Rendus*, Vol. 97, p. 428), it is first of all assumed in opposition to Kirchoff's theory, which is only applicable in this case to black bodies (*vide* Le Chatelier, Société de Physique, March 4, 1893, p. 134), that "bodies of the same temperature and different emissivities, placed in a dark room, emit light of the same spectral composition," and that consequently it is sufficient to measure two radiations in order to deduce the absolute intensity. But here again, in order to determine the coefficient K, radiations of different tints are compared without taking into account the variation undergone by the ratio by virtue of the Purkinje phenomenon. This coefficient does not, therefore, appear to be determined in a legitimate manner. In the same way it is possible to find the weak point of every so-called heterochromatic method of photometry.

Generally speaking, the expression "an arc lamp of such and such candle-power" has no definite meaning, for it neither indicates how the measurement was made nor to what standard it refers. A first reform would therefore be to demand that all measurements should be made under identical conditions, simply and clearly specified.

(To be continued.)

THE ELECTRICAL TRANSMISSION OF POWER FROM NIAGARA FALLS.*

BY PROF. GEORGE FORBES.

(Continued from page 100.)

Parallel Working.

Engineers in America have had no experience in actual commercial conditions of parallel working with alternators. This is partly because the machines which have been made in that country do not work so well as some others in parallel. In the case of the transmission from Niagara Falls my opinion is that parallel working will give the best results. If this arrangement were not adopted it is obvious that when the dynamos are loaded up as much as possible they could never be all fully loaded. It is also quite obvious that if our conductors are to be carried through subways the space required becomes quite excessive unless we adopt parallel working. The complete success of parallel working between Tivoli and Rome left no doubt as to the feasibility, besides the desirability, of adopting parallel working. The reduction in frequency which we have made assists very considerably in this result, and it says much for the American manufacturer who has received the contract that, although parallel working with multiphase machines has not been adopted in the past, he is ready to guarantee the performance in this respect of the machines which are to be built for us.

The rules which govern the construction of machines which shall work well in parallel are not very clearly understood. The only fact which has been perfectly established in practice is that the lower the frequency, the more efficient and sure is the parallel working. It certainly depends to some extent upon the amount of self-induction and the amount of mechanical momentum in the machines. It is also certain that if the self-induction of the machines is too high they will not work well in parallel. Of all machines which have been constructed, those which work the best in parallel appear to be those of Ganz and Co., Mordey, and Elwell-Parker, but there are many others which do extremely well. It is, at present, not possible to state exactly the conditions which are necessary, but I may say that, generally, a machine with a stiff magnetic field works better than one where the iron is far below magnetic saturation. In judging whether a machine of a particular type will or will not work in parallel, I think one must be generally guided largely by one's own personal experience in the matter, combined with a knowledge of the effects of self-induction, mechanical momentum, and magnetic saturation as deduced from theoretical considerations. I do not think that anyone who knows anything of the working of the Tivoli-Rome plant would for a moment hesitate in saying that on a large and important station like that at Niagara Falls parallel working is essential; and this is the opinion of Prof. Mengarini, who has so ably directed the works at Rome.

Motors.

Under this section it may be as well to discuss some of the different purposes for which the electric current will be required. With regard to arc and incandescent lighting, if the frequency be high enough, the current can be used directly for this purpose; although most people would prefer that, in the case of arc lighting, the current should be commutated or converted in some manner, so as to give a continuous current. That this is unnecessary, however, is amply proved by the perfect success of the arc lighting by alternating currents in Rome and many other large cities, especially those which have been established by Messrs. Ganz and Co. At the present time, one of the largest applications of electricity in the United States is for street railways, which require a continuous current. Another similar purpose which we shall have to consider is the application to canal boats, since it is intended to work the Erie Canal by electricity. This canal starts from the Niagara River, and reaches the Hudson River at Albany, 350 miles distant. For these purposes some sort of commutator or motor transformer will be desirable. Some of the first work which will be done is the supply of much direct current at 150 volts for the production of aluminium. This also requires the continuous current, and similar means must be used for obtaining it. Among the large class of mills which will be established at Niagara Falls, one of the most important kind is wood-pulp mills, one of which is already working on our land, and will be the first to receive water-power from our canal. This type of mill uses many thousands of horse-power, and is worked continuously day and night. In this feature it resembles, probably, a large number of the mills which will take advantage of the cheap power at Niagara Falls. Such mills are working continuously day and night, and do not require to be ever stopped or reversed. This is an important class of work in our case, because current can be supplied to such mills by means of synchronising alternators whose efficiency is extremely high, and this may, perhaps, be done in some cases without transformers. We require also to consider the case of small motors for use in shops, and for elevators, cranes, and a large number of other purposes. In this type of motor frequent stoppings and reversals are necessary. Hitherto direct-current motors have generally been employed for this latter purpose, but the rotating-phase induction motors are distinctly suitable, and when these have been fully developed they will probably be largely used for this purpose. The commutated current is a thing which is sure to be in common use before long, and although our arrangements at Niagara Falls are perfectly complete without a machine for this purpose, still its employment has been considered by us, and the probability of its future use has influenced our judgment in some points. There are so many purposes for which the direct current is most convenient, that people would generally accept it for transmission if it were capable of being economically transformed up and down to different pressures. The direct-current dynamo is really an alternating dynamo with a commutator placed upon it. If the commutator, instead of being placed there, be placed in the neighbourhood of the motor, we obtain most of the advantages both of the continuous and of the alternating current. This is one of the advantages of having two phases generated by the dynamo, because it is much easier to rectify a two-phase current than a single-phase current. In addition to the motors above specified, there are a large number of single-phase motors which start with a powerful torque which have been invented by different electricians, but which are not yet put upon the market. There are also machines with commutators like a direct-current dynamo with laminated field. These all become very efficient and useful when the frequency of alternations is sufficiently diminished.

Line Construction.

A great deal of attention has been given to the different methods by which current can be conveyed to the points of consumption, whether on our own property or at Buffalo, or even further. Naturally the pole line was first dealt with, in which the poles might be constructed of either wood or iron. This is the cheapest type of construction, and has some advantages, but we must consider the climatic conditions in the neighbourhood of Niagara Falls. We are subject there to severe thunderstorms, and troubles from lightning have already been serious in several parts of the United States in connection with electrical machinery. Snow and frost are very severe, and sleet forming upon the wires and insulators may cause a great amount of trouble. There are also at times very violent gales sweeping from over Lake Erie. All these difficulties can be counteracted to some extent, but it is nearly certain that with overhead construction occasions would arise when the continuity of operations would be interrupted, and this would be a very serious matter. The next system to be considered in order of cost would be underground cables, but I am strongly opposed to the adoption of these for any considerable length. It is true we are able to deal with their capacity so as to reduce its injurious effects, but surely the best plan of all is to abolish the capacity itself as far as possible. The most satisfactory method of proceeding is to build a subway of sufficient size to enable a person to walk along it and to carry bare copper conductors in it, but this a matter of considerable expense. I am glad, however, to be able to inform you that the officers of the Company resolved last summer that a subway such as I have

* Paper read before the Institution of Electrical Engineers November 9th.

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described should be constructed from the power-house up to the Pittsburg Reduction Company's works, where aluminium is to be produced, a distance of 2,500ft. In accordance with their instructions I prepared plans, which are now exhibited, and which give space enough to carry the conductors at 20,000 volts for all the power that will be developed by the present tunnel, parallel working being adopted. The subway is built of concrete having a minimum thickness of 10in. The height inside is 5ft 6in. Wooden beams are embedded in the concrete on both sides every 30ft. When the concrete is set these beams are removed, and iron castings for supporting the brackets that hold the insulators are put in their place, and these are then grouted in. Iron brackets, as shown in the drawings, are bolted to these castings, and the oil insulators placed upon them. Copper wires are shown as being supported on these insulators, but we shall probably adopt copper strip. The bottom of the subway is always on an incline, and is of curved shape to drain off any water of condensation, but it is also proposed to force air through the subway so as to keep it dry. The 2,500ft. now being completed is all drained at the power-house end by a boring into a water-bearing stratum. At the bottom of the subway the concrete is formed in two steps, the lower one of which supports sleepers for a very light tramway upon which a truck can run to carry supplies, and also to carry the inspector. At first this can be moved by a hand lever, but arrangements are made for eventually driving it by electricity, the conductor being carried on the floor, between the stringers (placed on the ties or sleepers), which form a platform running along the length of the subway. On the stringers outside the rails is placed a screen separating, mechanically and electrically, the part of the subway where the conductors are from the part where the inspectors walk. This screen is formed in 10ft. lengths of wood supporting expanded metal, covered over with plaster up to a height of within one foot of the top, the upper part being left open in the form of a network, through which the inspector can look at the conductors and their supports. These screens are held by iron supports fixed by expanding bolts into the concrete, and can easily be removed. The top of the arch is 3ft. below the surface of the ground, so that it will not be affected by frost. According to the last report, it appears that on October 21st 1,590ft. of this subway had been completed; the total length being put down at present is 2,500ft. Each of the iron castings has a wire attached to it which passes through the concrete, and is soldered to a copper wire running outside the subway along its whole length, and connected to a plate sunk in the water at any suitable points. At every 400ft. cross streets will be made, and at these points there is a manhole. Also at these points, on each side of the subway, four drain pipes, 3in. in diameter, are let in, closed at their outer ends. When the subway is to be tapped for use on the side streets, or for intermediate points, wires can be laid through these pipes. Between Niagara Falls and Buffalo there is very little rock, but the part where the subway has now passed through has been chiefly in rock. This involved blasting out a channel larger than was required. In this case the part of the trench outside of the subway has been built up of stone. In the construction of this subway American Portland cement has been used, and a very suitable sand from the neighbourhood, which contains its own gravel. The whole of this work has been done by Mr. Humbert, and up to the date of my last inspection every part was thoroughly and satisfactorily done. This work is of great importance as conveying to the minds of those who intend to use our power some idea of the desire to ensure continuous working.

With regard to the electric pressure that is to be used for distant transmission, this will undoubtedly advance with experience. Some manufacturers in Europe who tendered for the work proposed to adopt 25,000 volts; but we have considered that at present 20,000 volts is not likely to be exceeded by us, and we may work at a lower pressure at the commencement. When it is remembered that the Deptford machines have one terminal connected with the earth, and are working satisfactorily at 10,000 volts, and when it is noticed that, in consequence, our work would be under exactly the same conditions as regards insulation when working at 20,000 volts, it is easy to see that we are not risking anything experimental in our first work.

With regard to the size of conductors, I worked out the economical size at different current densities for the whole distance. In doing this I took the following data:—I took the cost of copper at 12½ cents per lb., and the annual charge on this cost at 5 per cent. I then computed the power loss in the line, and the amount of power which was left available for delivery. I took the value of this power at the distant end of the line as being $15 per horse-power. This is something more than what it costs us to produce it, but when the power available from our tunnel is nearly all consumed this quantity will have to be increased. It must also be remembered that I have not allowed for the increased size of the conductors required by the retardation of phase, which is an unknown quantity. Still, it will be seen that from these considerations we may be able to work economically at a slightly higher current density than is obtained from this investigation. From this work it appears that the most economical density to work at is 350 amperes per square inch. If this density is used, the fall in volts between Niagara Falls and the northern boundary of Buffalo is only 3½ per cent.—a matter which makes regulation extremely easy.

With regard to the efficiency of the system, it is remarkable how high the efficiency of the dynamos comes out when we are dealing with the large units of 5,000 H.P. There can be little doubt that the efficiency, electrical and mechanical, of our dynamos may reach at least 98 per cent. Taking off 3½ per cent. for losses on the line, we would have 94½ per cent. delivered electrically at Buffalo if no transformers were required to raise the electric pressure to the full 20,000 volts. In cases at Buffalo, where the power consumed is very large, the motor can be constructed on the same principles as the dynamo; and if in this case it be ever possible to work at the full pressure without a transformer, it is obvious that the total efficiency of the system—that is, the power delivered by the motor to the shaft of the machinery, divided by the power delivered by the shaft of the turbines to the dynamo—will be certainly over 90 per cent. As a matter of fact, if we were to use a higher density of current, and were to use step-up transformers at Niagara Falls and step-down transformers at the northern boundary of Buffalo, and other step-down transformers in the town of Buffalo itself, and were to use motors of small power, and consequently less efficiency, in this case the total efficiency of the plant might be reduced to 80 per cent., or even lower.

I have given these figures, not as indicating precisely the lines on which we have determined to work at Buffalo, but because the present Paper is intended to embrace the subject of the general distribution of power, and I thought it desirable to lay before you certain facts in this connection in a definite form.

Description of Machinery to be used.

Under this heading I shall deal chiefly with the type of dynamo which has been finally decided upon. It will suffice to say of the turbines that they are each of 5,000 H.P., that they revolve at 250 revolutions per minute, and were designed by Messrs. Faesch and Piccard, of Geneva. All the principal parts of this machinery were constructed by the I. P. Morris Company, of Philadelphia, but the governors of the turbines are of Swiss manufacture, and part of the steel fittings were constructed in France.

With regard to the dynamo, the Cataract Construction Company at first invited many different manufacturers in Europe and America to submit plans. The number of these that were submitted altogether amounts to 24, some of the manufacturers having taken a great deal of trouble to submit a series of designs, in order to be able to meet different requirements. Many of these designs were extremely good; but it was determined, after estimating the increased cost of using the European designs, owing to the high tariff in America, and owing to transport, to have the machines manufactured in America. Among the designs from American manufacturers there were none which fulfilled all the requirements of the case, and eventually the Cataract Construction Company decided to get out their own designs, and to submit them to the American manufacturers for tender. I had been for some time previously engaged in working out a design which I am confident none of the manufacturers who had sent in designs could say was in any way borrowed from their ideas. We had received suggestions of an external armature with internal revolving fields, and also of external fixed fields and internal revolving armature. We naturally had a preference for a dynamo with a fixed armature, because the coils can be more securely wound, and are not subjected to the mechanical stresses induced by centrifugal force. But all the designs with revolving fields which had been submitted to us contained a weak feature: the field coils were held in by pole faces secured by bolts or keys to the poles, and this seemed an element of weakness when we considered the enormous centrifugal forces to which the machinery would be subjected. At the same time the turbine makers had insisted upon having a certain momentum, or fly-wheel effect, which was not given by the revolving parts of any of the dynamos submitted to us, and it was found that if anyone of these had been accepted it would have been necessary to add to the design a fly-wheel of large dimensions. Centrifugal force was one of the most important matters to be considered, because at 250 revolutions per minute this force assumes considerable magnitude in the large masses with which we had to deal. Moreover, in all the designs which had been submitted, the magnetic pull between the poles and the iron of the armature assisted the centrifugal force. The principal feature of the design upon which I was working, consisted in having the armature fixed, and inside the machines, with the fields revolving outside; the fields being formed of a ring of iron with the poles projecting radially inwards. One advantage is that we are able to get the full fly-wheel effect that was required by the turbine makers. This requirement was that in the revolving part the sum of the weight

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in pounds of each part, multiplied by the square of its velocity in feet per second, should equal 1,100,000,000. The design also gives an extremely good mechanical construction for the revolving parts. The iron ring which forms the yoke of the fields serves as a support to hold in the pole-pieces and the exciting coils, and no part is held in against centrifugal force by bolts or keys. Moreover, the magnetic pull between the fields and the armature acts in opposition to, and does not assist, the centrifugal force. The armature is fixed, and a large space is available inside it for the workmen to attend to the bearings, and to reach any part of the armature. It is obviously possible to insulate the armature coils for any electric pressure. With a large machine of this kind, the space occupied by insulation has not the same importance in reducing the output of the machine as is the case with machines constructed in the past. In fact, the armature coils can be wound with the same insulating properties as a transformer, and hence the necessity for using a step-up transformer can be avoided.

Starting with this general principle, I first got out designs of a machine at 33 periods per second, in order that I might compare the general appearance of such a machine with those of other types. The next point was to design a machine of as low a frequency as was possible under the limiting conditions as to weight. The revolving parts of the turbine and dynamo, and the shaft connecting them, are supported by a hydraulic piston, and it was the desire of the Cataract Construction Company not to use a thrust bearing of any kind to support the weight, although there is a thrust bearing at the top of the shaft, which simply acts to retain the apparatus in a fixed position in a vertical direction. Owing to this decision, it was necessary to limit the weight of the revolving parts of the dynamo to 80,000 lbs. In getting out the design for this machine it was desirable to select such a form of winding as past experience led one to believe would be most efficient for parallel working, and I judge from past experience that this is best attained by having the number of coils per pole very small. The 33-period machine which is shown in the drawings has only been sketched out with a view of getting at the general dimensions of the machine. It is not suitable for our special purpose, because it is essential that, without taking the dynamo altogether to pieces, we should be able to lift up through the centre of the dynamo any parts of the turbine shaft which may require repair.

It will be seen that from the necessities of the case at Niagara Falls, the dynamo which was required differed in some respects from what would be necessary in many other cases, but it is equally obvious that in any case of so large a transmission of power the conditions must be thoroughly considered beforehand, and the dynamo specially designed for the purpose. At the meeting of the Board of Directors of the Company, in May, 1893, I was instructed, with Dr. Sellers, to get out plans for an alternator of the type which I have described.

I am not able to lay before you now plans of the machine as it has been finally adjusted by conference between ourselves and the manufacturers. In the plan which we prepared, the frequency was 16⅔ periods per second, there being eight poles. The armature coils were so wound that they might be connected to give either 2,500, 5,000, 10,000, or 20,000 volts, and the coils were limited in number so as to give the best assurance of good parallel working. For various reasons we decided eventually to raise the frequency to 25, and to lower the volts to 2,000, without the means of connecting the coils to give a higher pressure; and instead of winding the armature on the conductors in a limited number of coils, to adopt the methods more commonly used in some of the large types of generators. But since in any future work which is done, the dynamo will be required to be modified for the special purpose, a description of the machine—of which I am able to show you the drawings†—is sufficiently representative of the type of machine for our purpose.

General Description of a 5,000-H.P. Alternator.

On the bed-plate a vertical cylinder is bolted, with projections to support the fixed armature and the bearings of the revolving part. The armature coils are wound independently and can be removed and changed. They are fixed in slots in the fixed armature. They are encased in an oil-tight casing through which oil can be circulated. The field magnet is external to the armature, and has the poles pointing radially inwards. It consists preferably of forged steel supported by a spider with eight arms, which may be of steel with a covering of thin sheet metal, on which cups are provided for forcing air into the interior of the machine. The pole-pieces are bolted on to the steel rim. The field coils are of copper strip, two coils being wound upon each pole, with a space between them for air circulation. The exciting current is applied by rings of tempered copper on the spider, having fixed brushes rubbing on them. The hub of the spider is firmly fixed to the upper end of the shaft. The spider supports the heavy rim by 16 studs and nuts. The shaft is supported by two bearings, each of which has four radial arms, which are bolted to four corresponding projections on the cast-iron cylinder. This cast-iron cylinder is bolted to the bed-plate, and adjusted thereon by wedges. Besides having on it the projections for carrying the bearings on its inner side, it has on its outer periphery a series of vertical ribs against which the stampings, or sheets of iron forming the armature, rest. It also supports the lower end plate on which the armature is built up, and the armature is keyed to it by a single key. The armature is wound drum fashion—that is, all on the outside. This enables the coils to be wound independently and laid in their place, and also to be easily replaced in case of accident. In order to do this satisfactorily, the slots for each coil in the iron are cut, not radially, but parallel to each other. Each coil is encased in insulating material, which forms a tube through which oil may flow as in a transformer, but may be forced, in which case its circulation is maintained by a pump. Round the base of the machine there are two oil pipes, one being the inlet, the other the outlet. The inlet pipe is connected with a reservoir of oil in the power-house. The outlet pipe leads by another pipe to cooling arrangements in running water, from which the oil is pumped to the reservoir. From the inlet pipe 16 brass tubes are led to the junction boxes at the bottom of the 16 coils; the 16 other brass tubes are led from the junction boxes at the top of the coils through the interior of the fixed armature and bent over the foundation plate, and so connected to the outlet pipe which surrounds the bed-plate. The bed-plate is a single iron casting, and in order to enable it to be transported over the railways it was necessary to limit its diameter, as shown in a supplementary drawing, which shows the improved oiling arrangements, which were worked out by my chief draughtsman at Niagara Falls, Mr. Baumann. The armature is built up of thin sheet iron, with ventilating spaces, as shown on the drawing. The bolts which hold the armature together are eight in number, to be made of nickel steel, a metal which has the great advantage of being non-magnetic, and of very high electrical resistance and great mechanical strength. The amount of nickel is 25 per cent.

There are 16 armature coils, eight being of one kind, called "short" coils, and eight of another kind, called "long" coils, the length of wire on each coil being the same. The short coils are bent over at the end plate, and the long coils are wound in one plane, and enclose the short coils. I find that if we are to have a very stiff field, with first-class quality of iron in the fields, each coil would consist of 72 turns of pure copper wire, No. 0 of the Brown and Sharpe gauge, which gives a very low density of current, and reduces the heating. In fact, it has been my view that in designing the machines for so great and permanent a work every effort should be made to reduce the rise in temperature, even to far below what has ever been done in the past. The unequal expansions and contractions of materials in a machine of this kind are very injurious to its permanence, and affect the insulating material seriously. The layers of wire in the coils are separated by mica. Each coil when wound has strips of insulating material laid spirally round it, so that oil may circulate freely in the intervals, and the whole is encased in a casing of strong insulating material. The material which I prefer for this purpose is certainly woodite, an eighth of an inch of which will not break down with 30,000 volts, and which is not acted upon by oil even at high temperatures. I have a record of tests with oil which are conclusive on this point. It is quite the best material I have seen for the purpose, though costly, and, being a secret process, it may be difficult to ensure uniformity.

The frames of the bearings are of cast iron, with four radial arms, which rest upon four projections cast on the vertical cylinder, and are bolted to them. By this means, when the field magnet with the shaft have been lifted out of place, the bearings can be twisted through an angle of 45 degrees in a horizontal plane and then raised out of place, leaving a space of five feet in diameter through which portions of the turbine shaft can be raised for repair. The bearings are oiled at the centre by oil forced under pressure through a pipe. The oil is then distributed over the bearings by spiral grooves. A spiral groove is also cut in the hub of the frame, with a pipe at each end to admit of water circulation to cool the bushing. At two opposite sides of each bearing the bushing is made thin, and a rod of bismuth is soldered thereto; so that if the bushing is heated a thermo-electric current shall be created which, by means of a relay, can ring a bell in the power house. When this occurs, water can be immediately admitted to cool the bearings, and the attention of the workmen is drawn to the necessity of an examination.

One of the parts which required most consideration was the material of which the spider supporting the field magnets should be constructed. The best plan is to make it of steel, for the sake of lightness, and to cover it with a copper covering, which might, I think, be spun; or, perhaps better, electro-deposited nickel might be used.

† [Diagrams were shown at the meeting, but none of them have been received by us for publication.—Ed. *E.*]

Between the pole-pieces the space is filled up with a screen or plate of metal so as to direct the air ventilation only upon the parts which most require cooling.

The methods finally selected for oil circulation are shown in a separate drawing.

It will be obvious from this design, considering that the speed of revolution is 250 per minute, that great care has to be devoted to the balancing of the revolving parts ; everything has to be calculated not only for a speed of 250 revolutions, but for double that amount, which is the maximum speed at which the turbines could possibly run—at which speed they might run through a breakdown of the governor, although this is an accident almost impossible to occur. Each of the revolving parts will of course be balanced individually, and I have suggested a plan for the final balancing which seems likely to be effective. A temporary bushing would be put in the bearings, of india-rubber lined by a thin metal tube. The dynamo would then be rotated slowly and the balance adjusted in the usual way. The speed of revolution would be gradually increased—a new adjustment being made at each speed—until a speed of 500 revolutions a minute is attained, and when an adjustment has been made at this speed it is pretty sure that the balance at 250 revolutions per minute will be very perfect, and the mechanical friction reduced to a minimum.

As stated before, the oiling arrangements have been introduced not only to ensure higher insulation and to preserve the insulating material, but also to lower the temperature as much as is possible, because every step we take in the reduction of temperature is an advance. These oiling arrangements may perhaps be adopted in the future, but at present we are not making use of them in the machines which are in process of construction. When we have had experience with these we may in future adopt the oiling arrangements ; and as there is likely to be a great development in the direction of electric transmission of power in connection with the utilisation of water power in many parts of the world, it has seemed well to me to put before you these details, so that they may be considered in other cases that may arise.

At a meeting of the Board of Directors in New York lately it was resolved, on the recommendation of the consulting engineers of the Company, that the contract for two or three alternators, each of 5,000 H.P., should be assigned to the Westinghouse Electric and Manufacturing Company, of Pittsburgh. I would wish to state how much we owe to Mr. Westinghouse, and to his chief engineer, Mr. Schmid, for the zeal with which they have taken this matter up, and their desire to meet our views and to secure for us machines of which they felt they could guarantee the satisfactory performance.

Before leaving the subject of the dynamo, I would wish to point out that it has been designed for special circumstances in connection with the Cataract Construction Company's work. If a dynamo of the same type were being constructed for another place, it is certain that modifications would have to be introduced. I particularly draw attention to the fact that some trouble in getting out a good mechanical design arose from the necessity which existed of being able to provide a clear space of about 5ft. diameter in the middle of the machine without taking the whole machine to pieces, the object of this being to enable us to lift up portions of the turbine shaft which it might be required to put into repair. In any case, where the long shaft existing in our case is not required, the design of the dynamo is much simplified, and would more nearly approximate to the first design of which a drawing is shown, but arranged for 33 periods a second.

If the present Paper were intended to relate solely to the subject of the utilisation of power at Niagara Falls I would be content with describing what has actually been done; but I foresee that there is going to be a great development in utilisation of water-power and its electrical transmission. I am, therefore, inclined to say a few words on some other details which we have been carefully considering, but about which no definite decision has been arrived at.

Before doing this I would direct your attention to the drawing representing a plan of our power-house, in which you will perceive the inlet passages, A, from the great canal, B, which draws its supply of water from the upper river. From these inlet passages the iron pipes, or flumes, C, pass vertically downwards to the bottom of the great wheel-pit, which is a slot cut in the ground to a depth of nearly 200ft., at present large enough to contain four turbines in line, but which can be extended to a much greater length, the whole capacity of our tunnel being 100,000 H.P. The drawing shows circles, D, in the plan, which indicate the position of the turbine and dynamo above it, and the position of a hatchway, F, by which material can be raised or lowered. It will be noticed that between the inlet channels and the wheel-pit the flumes are bent downwards, and thus leave a V-shaped space, G, which I have appropriated to make a subway, running along the whole length of the power-house, to carry the high-pressure conductors. It will, of course, be understood that the slot forming the wheel-pit is arched over at the top to form the floor of the power-house, upon which the dynamos rest. It will be noticed that at the north end of the power-house there is a large square chamber, H, in which I propose that all the measuring instruments and other apparatus under the control of the chief electrician shall be assembled. Underneath this chamber there is a cellar in direct communication, first, with the subway which I have described as existing in the power-house ; and, second, with the subway which leads outwards from the power-house at present as far as the Pittsburgh Reduction Company's works, and may possibly eventually lead to Buffalo. In this cellar all the high-pressure wires, the transformers, the artificial load, and other high-pressure machinery will be placed. It will be noticed that other spaces are left in the floor forming trenches along which the conductors can be carried. With these arrangements there can be no possibility of danger to any person in the power-house ; and if any wires are to be found laid along the walls of the power-house or elsewhere, I wish it to be a maxim that we shall be able to place upon these wires a card marked "No Danger," so that there will be no possibility of danger from any person touching anything in the power-house.

With regard to the exciting current, the best plan available at this moment is to use one of the machines which are generally known as the Schuckert machines, for converting the alternating into a continuous current, transformers being inserted in order to lower the pressure. In order that the exciting current may increase with the load, it would be well to make these transformers of special construction, each having two primaries and one secondary. One of the primary coils would be in series with the main circuit, and the other in shunt. I would furthermore make these transformers sufficiently large to deal with all the dynamos which are in the central station, and I would subdivide the secondary coil into sections, to enable us to cut out a section of the transformer when we cut out one of the dynamos. When we wish to cut out a dynamo, a switch would be worked which would at the same time short-circuit the field coils of that dynamo and also cut out one section of the secondary of the transformer which is supplying the exciting current to all the dynamos. This plan allows the fields of all the alternators to be put in series—a desirable arrangement for parallel working. A resistance may, of course, be put in circuit with the fields of the alternators for regulation.

I presume it will be taken for granted that in any large work of this sort the primary circuit should never be broken when in action. For my part, I hold that this should be the case even in smaller stations.

An important feature for putting the dynamos in parallel, and for removing a dynamo, is an artificial load. It is desirable that this artificial load should consist partly of a resistance and partly of self-induction. It is only by this means that the dynamo which is going to be put in circuit can be brought to exactly the same condition as those which are working, both as regards volts and amperes. It may be well to describe the operations which take place when a dynamo is switched in parallel with the others. First, connection is made between the armature and the artificial load ; then the exciting switch is turned so that an extra section of the transformer is put into play, and the short-circuit on the field coils of the dynamo is broken. The dynamo being excited, the turbine is then started, or this may be done at first. The artificial load is then adjusted until the dynamo is giving the same volts and amperes as the others. A synchroniser is then placed between the artificial load and the external circuit, and so soon as synchronism is attained a switch is closed which connects the artificial load with the external circuit. Resistance is then put into the artificial load until there is very little current going through it, when it is switched out, and the dynamos are all working in parallel. To cut out a dynamo from the circuit the operations are performed in the opposite order. The artificial load with high resistance is put in connection with the external circuit ; this resistance is gradually diminished until it indicates the amount of work that is being performed by one dynamo ; the connection between the artificial load and the main circuit is then broken, leaving the dynamo (which is being switched out) feeding the artificial load. The resistance of the latter may then be increased, and the exciting switch actuated so as to short-circuit the fields of the dynamo, and to remove one section from the secondary of the exciting transformer. The supply of water to the turbine may then be shut off.

If machinery is worked, even at 20,000 volts, in the manner I have described, there is no possibility of injury from any great rise of electrical pressure, unless the external circuit be by any means accidentally broken. To provide against this sort of trouble I would have wires coming from the external circuit where it enters the power-house, connected through a large resistance, or through the primary of a transformer the secondary of which contains a resistance. In circuit with it I would have a break consisting of two carbon points at a distance of about half an inch apart if we were dealing with 20,000 volts, so that an arc could not be formed unless the pressure rose above the normal value. Under these circumstances, so soon as any resonant effect due to the

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breaking of the circuit or due to any other cause raises the electric pressure above the normal, an arc is established across the carbon points, and so a load is put on which removes the cause of the extra high pressure. This is the only automatic means which I have been hitherto able to think of which is sufficiently rapid in its action to overcome any possibility of injury to the dynamo or transformers.

I have attempted in the course of this Paper to give you some idea of the work which has been actually done or decided upon at Niagara Falls, and also to show you the views to which I have been led by any special experiences which I may have had as to the general ideas which ought to guide us in the construction of plant in the future for transmitting power to a distance electrically.

In describing the different plans which are available I have avoided mentioning the names of those numerous electrical engineers and manufacturers who, by their inventions, researches, or applications have advanced the art; or discussing their claims to priority; but I cannot conclude this Paper without mentioning the names of some of those who, in one way or another, have made great steps in the applications of alternating currents to power purposes. I would particularly mention the names of Messrs. Ganz and Co., Mr. Schuckert, the Allgemeine Electricitäts Gesellschaft (of Berlin), the Oerlikon Fabrik, and Messrs. Brown, Boveri and Co.; also Mr. Eickemeyer, Mr. Ferranti, Prof. Ferraris, Prof. Fleming, Dr. J. Hopkinson, Messrs. Hutin and Leblanc, Mr. Rankin Kennedy, Prof. Mengarini, Mr. Mordey, Mr. Tesla, Prof. Elihu Thomson, and Mr. Henry Wilde. I feel that all of us owe a great deal to their work.

In conclusion, I wish to draw attention to the figures which show the relative merits of high and low frequency with polyphase motors.

Everything is identical in the two figures, except that, the frequency of one (*a*) being double of the other (*b*), *a* has 16 poles, *b* has 8. The armature is identical in both, and revolves at the same speed and does the same work; and the field revolves at the same rate in both, and the induction and current-density are the same. The differences are that *a* has more copper and less iron than *b*. The comparison of efficiency depends on the depth of both. As an example, assume that *a* has 50 per cent. more copper in the fields than *b*, the ampere-turns per pole being necessarily the same in both, and that *b* has 50 per cent. more iron than *a*, and that the hysteresis loss in *b* ($=H_b$) is equal to the resistance loss in its copper coils ($=C_b$). The values for *a* are—

$$H_a = 2 \times \frac{2}{3} \times H_b;$$

$$C_a = \frac{3}{2} C_b;$$

$$H_a + C_a = \left(\frac{4}{3} + \frac{3}{2}\right) \frac{H_b + C_b}{2} = 1{\cdot}42 \times (H_b + C_b).$$

Thus the total losses in the field of higher frequency (neglecting eddy-currents) are 42 per cent. more than in the field of lower frequency.

PHYSICAL SOCIETY.

At a meeting of this Society, on November 24th, Prof. S. P. Thompson occupied the chair, whilst the President read a Paper

"On the Magnetic Shielding of Concentric Spherical Shells."

In this mathematical investigation the author considers cases in which the equipotential surfaces are surfaces of revolution about a line through the centre of the shells, and the permeability (μ) of each shell is constant. Taking the common centre as origin, the potential within any shell is expanded in terms of zonal spherical harmonics, and the ratio of the shielded to the unshielded field determined. The following important result is arrived at, viz., if the permeabilities of the enclosed and external space be the same, then the ratios of the shielded to the unshielded fields are the same *for each harmonic term*, whether the part shielded be external or internal. It is also shown that the shielding effect on external space when a small magnet is placed at the centre of the shell is the same as the shielding effect on the enclosed space when the shells are placed in an uniform magnetic field. If the inner and outer diameters are given, then, when the difference in these diameters is small, one continuous shell gives the best result. For a larger difference two shells separated by an air-gap are much more efficient than a single one, and filling up the air-gap would appreciably diminish the screening effect. When the permeability of the substance is high the best shielding is obtained when the radii of the bounding surfaces of the shells are in geometrical progression. The main results of the investigation are that with thin shells lamination is useless, whilst with thick shells it is essential, if the best effect is desired. Experiments made on actual shells had fully confirmed the theoretical conclusions.

DISCUSSION.

Prof. MINCHIN said: Although the work was apparently restricted to zonal spherical harmonics, some of the important formulæ apply equally to general spherical harmonics. He thought that the Paper was very clear.

Mr. EVERSHED said he had been engaged for the last two years on the subject of magnetic shielding, with a view to screening measuring instruments from external fields. In such cases it was not possible to use closed shells, and this introduced trouble. The best result he had yet obtained was to reduce the disturbance to about one-fifth. Another difficulty was introduced by the fact of the shield being magnetised by the current passing through the coil, and, owing to hysteresis, the permeability was different according as the magnetisation increased or decreased. By using an outer iron shell a great improvement had been effected. To obtain the best results it was important to have no joints in the shields. A coil frame with two shields of bent iron was exhibited.

Mr. J. SWINBURNE remarked that the subject divided itself into two—shielding of instruments and shielding sources. If a dynamo itself be shielded this did not prevent the currents in the leads producing magnetic disturbances. This was very important in ships. By using an alternator with revolving fields all disturbances could be avoided.

Dr. C. V. BURTON inquired whether, by considering the hydrodynamical analogue of a porous material, the case of perforated shells could be elucidated.

Mr. A. P. TROTTER asked whether Prof. Rücker's investigation could be applied to the homogeneity of the shield. Small scrap iron had been used at Oxford as a magnetic screen in preference to boiler plate.

Mr. BLAKESLEY asked if the effect of moving a magnet sideways in a sphere had been observed.

Prof. S. P. THOMPSON thought that taking the permeability as constant would not be quite correct, for μ was a function of the magnetisation. Hence, in the cases considered, the outer shell would be the more permeable.

In his reply the PRESIDENT said scrap iron in contact was not like clear space, for there were comparatively free paths for the induction at the points of contact. As regards the shielding of the dynamo at Greenwich, Mr. Christie had written to say that the credit was due to the makers of the machine and shields, Messrs. Johnson and Phillips.

Prof. G. M. MINCHIN, M.A., then read a Paper on

"The Action of Electromagnetic Radiation on Films containing Metallic Powders."

After noticing the resemblance of the phenomena exhibited by tubes containing metallic filings shown by Mr. Croft on October 27th, to those of photoelectric impulsion cells, he described films of gelatine and collodion containing metallic powders. Directions for preparing the films are given in the paper. On inserting such a film in circuit with a battery, key, and galvanometer it acts as an insulator. To render a small portion conducting, the electrodes on the surface of the film are brought very close together, and one of the wires touched with an electrified body. (An electric gas-lighter was often used.) This caused a current to pass. The electrodes may then be separated a little further and the process repeated until any desired portion is rendered conducting. The peculiarity of such a film is that, if the circuit be broken at the film, the film becomes an insulator, whereas breaking the circuit at any other point leaves the film conducting.

A short discussion followed, and Prof. MINCHIN, in his reply, maintained that the phenomena were due to electric impulses.

LEGAL INTELLIGENCE.

Electric and General Contract Corporation v. Thomson-Houston Electric Company.

This case, heard on Saturday in the Queen's Bench Division before Justices Wills and Wright, raised a question as to the right to retain a large sum paid by purchasers under a contract. It was an action brought to recover the sum of £1,000 paid to the defendant Company by the plaintiff Company under a contract for the purchase and delivery of certain electrical machinery and plant which were to be delivered to the plaintiffs at Liverpool from the defendants' factory in America. The terms of the contract contained in letters of May last were that the defendants were to deliver at certain prices (over £6,000) the electrical machinery specified "on ship's rail at Liverpool," the goods to be shipped from America by June 13th last. The plaintiffs were to pay for the apparatus and machinery £1,000 with the order confirming the contract and 33 per cent. on the invoiced amount on delivery of bill of lading and the rest on starting of the apparatus. The £1,000 was sent by the plaintiffs (the purchasers) with their confirmation of the order, and certain apparatus and material were shipped and the bill of lading sent, but the sellers stopped the goods as the 33 per cent. was not sent on delivery of the bill of lading, and the purchasers now sued for the recovery of the £1,000, which the sellers resisted on the ground that it was a deposit or "earnest" and forfeited by the breach of the contract. The plaintiffs claimed to have summary judgment under Order XIV., but there was a counter-claim by the defendants, and an order was made at Chambers giving the defendants unconditional leave to defend, against which the plaintiff Company appealed.

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Counsel having been heard on both sides, the learned Judges conferred, and Mr. Justice WILLS said he came to the conclusion that the order at Chambers was right. He did not think that Order XIV., providing for summary judgment, applied to cases like this, raising what might turn out to be a difficult question of law. It was never intended to throw on the Judge at Chambers such a burden. It was impossible that such questions could be satisfactorily dealt with at Chambers. This very case had been so argued as to occupy about two hours, and yet no time was wasted. Such questions were not meant to be dealt with summarily at Chambers. And on that ground alone he should uphold the order, allowing leave to defend. But, on the merits, he was not satisfied that the defendants—the sellers—were not entitled to retain the £1,000. When the plaintiffs—the purchasers—renewed the bill of lading, they had not remitted the amount due under the contract, and, though they had properly returned the bill of lading, the sellers might contend that they were entitled to retain the money. He certainly was not satisfied that the defendants were not entitled to retain the money. At all events, it was far too disputable a question to be decided summarily. To decide such cases satisfactorily at Chambers was not possible, and it only tended to put the Judge at Chambers in a false position. Further, in the present case, there was a substantial counter claim. The order, therefore, made at Chambers was right.

Mr. Justice WRIGHT was of the same opinion. It was not shown that the defendants had not from the first conceived that they had right to retain the £1,000, making, as they did, a claim for substantial damages.

The appeal was therefore dismissed and the order upheld.

Hoerter and Another v. Hanover Caoutchouc Gutta-Percha and Telegraph Works.

This case was heard in the Court of Appeal on Monday, before the Master of the Rolls and Lords Justices Lopes and Kay, and was an appeal from the Divisional Court refusing to set aside the writ of summons and service of the notice thereof on the defendants. The plaintiffs, who carried on business in London as C. F. Mumm, brought this action for commission on the sale of goods, as agents for the defendants, who were a foreign company carrying on business at Linden, near Hanover, and for an account. By a contract in writing made at Linden, in the German language, on June 21, 1890, as modified by another contract of December 4, 1891, the defendants appointed the plaintiffs, who were described as trading as C. F. Mumm, of London, their sole agents for the sale of their goods in the United Kingdom, Canada, and the United States of America until October 1, 1892, the plaintiffs to receive a commission of 5 per cent. "upon all net amounts of invoices received after deducting freight, duty, and packing," on all sales by them of the defendants' goods. The commission was to be accounted for quarterly, and the collection of the amounts of the invoices was to be made by the defendants alone. The contract further provided that in case of disputes the plaintiffs' firm was to submit to the laws and jurisdiction in force in Hanover. On February 27, 1893, the plaintiffs issued an ordinary writ against the defendants for service within the jurisdiction, and the writ was served upon one Gilbert, on the ground that he was an officer of the defendants, who had a place of business and carried on business within the jurisdiction. The defendants entered a conditional appearance, and on March 20th the Master, on the application of the defendants, set aside the service of the writ on the ground that the defendants had no place of business here, and that Gilbert was a mere agent of the defendants. On May 2nd the plaintiffs applied *ex parte* to Mr. Justice Mathew, at Chambers, and he gave them leave to amend the writ by making it a writ for service out of the jurisdiction, and to serve notice thereof on the defendants out of the jurisdiction. Notice of the amended writ was accordingly served on the defendants abroad, and they entered a conditional appearance, and applied at Chambers to set aside the writ and all subsequent proceedings. Mr. Justice Wills set aside the notice of the writ and service thereof, upon the ground that the contract provided for the determination of disputes between the parties by the Courts of Hanover. The Divisional Court discharged this order, upon the ground that there was a breach of contract within the jurisdiction—namely, non-payment of the commission, and that the clause in the contract did not give the Courts of Hanover exclusive jurisdiction. The defendants now appealed, and counsel were heard on their behalf, but their Lordships, without calling on the plaintiffs' counsel, dismissed the appeal.

The Medical Battery Company (Limited).

At Marlborough-street Police-court, on Wednesday, C. B. Harness, J. M. M'Cully, C. B. Hollier, and Dudley Towers were charged on remand, before Mr. Hannay, with having conspired to defraud; also with having conspired to obtain by false pretences £52. 10s. from Colonel Jeremiah Brasyer, C.B., and other sums from other persons, in each case with intent to defraud.

The depositions which Mr. William Lynd made last week were read over by Mr. Lyell, the chief clerk, and at Mr. Lynd's suggestion the following words were added to them:—"I wish to state that when Mr. Harness said that he did not wish me to advertise Thomson and such cattle he said so in a jocular manner, and with no intention of depreciating that gentleman."

Mr. LYND was then further cross-examined by Mr. Avory: Every allusion in the lectures to Harness and to his appliances was discussed and dictated to him at a meeting held at No. 52, Oxford-street. After he delivered the lectures he did not, to the best of his belief, ask Mr. Harness to give him an appointment at the establishment. He should have been very pleased to accept an appointment if Mr. Harness had accepted his conditions. He was very glad when he had finished with the affair. After he had delivered his lectures he did not set up a rival establishment. He did, however, set up an establishment for the treatment of persons by electricity in conjunction with the members of the medical profession. It was called the Electro-Dynamic Medical Institute, and was in Bloomsbury. He was not the proprietor of the concern. He was the electrician to it. From the institute advertisements were issued stating that consultations were free. They were always held in the presence of a medical man.

Mr. AVORY: Perhaps there were not many consultations? The witness: The place was too genuine to be a success.

Continuing, the WITNESS said that electrical belts were sold at the place, the price being from one to two guineas. Only a few belts were sold at the place, which he soon left, as he saw it would not be a success. The material of which the belts were made would cost about 5s. or 6s. The witness made the belts himself. He had heard that Mr. Dale, the proprietor, had got into trouble; that he was tried and convicted at the Old Bailey. He had not seen him since 1887.

Mr. FREDERICK THEOBALD BURBAGE, a provision dealer and grocer at Liphook, Hants, and Mrs. KATE WILCOCKS were then called and repeated the evidence given on the occasion of the arrest of Dudley Towers as to the mode of treatment and payment in force at Mr. Harness's establishment.

Mr. HANNAY remanded the prisoners until Thursday.

THURSDAY, NOVEMBER 30TH

On the hearing of the case being resumed, the first witness called was Mr. T. E. Gatehouse. He said he was editor-in-chief of the *Electrical Review*, and had had 20 years' experience as an electrical engineer. He had taken a great deal of interest in the question of the so-called electropathic belts, and he had written articles with regard to them in the *Electrical Review*. In consequence of these articles the Medical Battery Company brought an action for libel. The libel action was dismissed with costs for want of prosecution, under an order. His firm brought an action against the Medical Battery Company for libel, and the libel complained of was a letter, dated September 16, 1892, sent out to newsagents, alleging that their paper contained libels.

Mr. GATEHOUSE said that Mr. Harness was present in Court when that action was heard, the result of which was that his firm was awarded by the Lord Chief Justice £1,000 damages, and costs. He (Mr. Gatehouse) had examined a great number of belts, which he found absolutely valueless, and nobody with the slightest knowledge of electricity would sell such an article as being of any curative value whatever. An ordinary incandescent lamp of 16 c.p., such as is to be seen alight in the London shops, required an electrical energy of 60 watts to keep it at 16 c.p. To produce this amount of electrical energy by means of the Harness electropathic belts, as worn on the average human body, would require the employment of more than 8,000,000 belts.

Mr. AVORY (for Harness): But they were never advertised as being of 16 c.p. (laughter.)

A number of belts were handed to witness, and he declared that not one of them would give the slightest electrical effect.

After some further evidence the case was adjourned till to-day (Friday).

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *November* 18, 1893.

Incandescent Lamp Litigation.—The Federal Court of Appeals of New York has modified the injunction restraining electric light companies competing in New York City against the Edison Illuminating Company, so far as to require the latter company to furnish lamps at a reasonable price for such buildings lighted by the competing companies prior to the decision of July 14, 1891, sustaining the Edison lamp patent. This, by implication, sustains the general right of a patentee to absolutely refuse to sell a patented article if he so chooses. The Oconto lamp case has been argued on appeal at Milwaukee, and is now in the hands of the Court, which will meet for consultation on November 30th.

The American Institute of Electrical Engineers.—At the meeting of the Institute, on Wednesday, November 15th, a scheme was finally adopted providing for local meetings. Upon the application of not less than twenty members residing in any stated locality, the Council shall authorise the holding of local meetings in that locality, and appoint a local honorary secretary residing there. Such meetings shall be for the purpose of reading, by the author or by proxy, and discussing, papers accepted by the Institute, and such papers only. Such local meetings shall be held simultaneously with the Institute meetings, or subsequently, and no papers shall be read or discussed in a local meeting in advance of its reading at the Institute meeting. The local honorary secretary will transmit to the secretary of the Institute a report of the discussion at the local meeting, together with any written discussions or comments on the papers that he may receive from members in his locality. The publication of the discussions in the *Transactions* shall be subject to the regulations and restrictions as govern the discussions of the regular meetings of the Institute. No publication of papers or discussions at local meetings, in local or other journals or newspapers, will be permitted without the sanction of the Council or the secretary of the Institute.

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CORRESPONDENCE.

DEFINITION OF ELECTROSTATIC POTENTIAL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I venture to call attention to the definitions of Electrostatic Potential found in most English text-books, as they appear to me in danger of misleading students with respect to the *dimensions* of potential.

The definitions referred to commence with the statement:—"The potential at a point is the work which would be done on a unit of positive electricity," &c. The student might thus suppose it to be implied (by the words "*is the work*") that potential is of the dimensions of *work*, whereas, of course, it is of the dimensions of *work divided by quantity of electricity*. Would it not, therefore, be preferable to define potential as a particular ratio, somewhat as follows?

Suggested definition of Potential.—Suppose an indefinitely small body to carry a quantity, Q, of positive electricity, and let W denote the work done by the electric forces upon this body when it moves from any point, P, to an infinite distance. *Then the electrostatic potential at the point P is the ultimate value of the ratio W/Q* in the limit where Q is so small as not to disturb the electric distribution due to the other charges in the field.

Possibly an objection similar to that just urged against the definition of potential might apply in the case of definitions of other quantities, but I now mention potential as that is the one whose definition first struck me as capable of improvement.

The importance of a correct knowledge of the dimensions of physical quantities is now being very strongly insisted upon. It therefore seems to me highly desirable to avoid, as far as possible, all risk of being misunderstood in this respect, at any rate in the *definitions* in *scientific* books, even though, for brevity's sake, a little looseness of expression may be tolerated elsewhere.—Yours, &c., EDWIN H. BARTON.

Nottingham, November, 1893.

TESTS OF GAS BURNERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In connection with your reference in the last issue of *The Electrician* to corrections for variations of atmospheric pressure and temperature in reducing photometric tests of gas-burners, we venture to submit the following considerations:—

(1) The illuminating power of gas is not so much affected by the temperature of the air surrounding the burner as by that of the gasometer, mains, &c., through which the gas passes. The temperature of the flame is of the order of 1,000°C., and the variation in the heat expended in warming the air used for combustion up to that temperature is not a big item in the thermal balance-sheet for ordinary variations of temperature. In "regenerative" burners, where the air or gas, or both, are warmed some hundreds of degrees, the efficiency is considerably altered, as seen in the Wenham and other burners of this character.

On the other hand, it is well known that the illuminating power of coal gas depends mainly on the percentage of volatile hydro-carbons, chiefly benzol and naphthalene. These are condensed in the mains and pipes exposed to cold, and the illuminating power is thus impaired. It is also an important fact that water largely dissolves out these constituents. We have found that coal gas if passed into a gas bag loses a considerable percentage of these illuminants, apparently by condensation on the sides of the bag; and not until the bag has been many times emptied and refilled does this deterioration cease. Hence it would appear that a correction for temperature is practically an analysis of the gas reaching the burner, as the effects will depend on diameter, length, and exposure of mains, &c., and can hardly be reduced to a simple factor.

It is highly probable that the Welsbach incandescent burner and the albo-carbon ones are very little affected by change of temperature, while the regenerative gas burners would be almost equally affected with those burning cold air. Similarly one would expect the pentane and amyl-acetate lamps to be little affected, though the temperatures are rather lower than those of gas burners. We can find no record of tests to ascertain this somewhat important point in the report of the B.A. Light Standards Committee.

It is worth noting that the density of gas will vary some 10 per cent. with changes of temperature.

(2) With regard to pressure. A variation of 3in. in the barometer changes the mass of gas in a cubic foot by 10 per cent. but in photometric tests, where a gas standard is used, one would expect the standard to vary as much as the burner under test, and keep the ratio unaltered. Indeed, it is probable that all flame sources of light are affected. An alcohol flame is brightly luminous under four atmospheres pressure, and in Mr. Vernon Harcourt's tests of his pentane standard it was found that 1in. increase in barometric pressure required the height of the flame to be reduced about 3 per cent. to keep the light constant (B.A. Reports,'85). No details are given, however, as to what standard was used in these tests, and it appears very difficult to investigate the matter as long as we have no reliable standard other than a flame one. If incandescent, arc, and platinum standards are all to fail us, the pentane and gas standards will be able to vary considerably with atmospheric pressure without much risk of being found out.—Yours, &c.,

City and Guilds of London Institute, Exhibition Road, London, S.W. — H. C. HAYCRAFT, C. A. GAWTHORP.

November 28, 1893.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, which has a special interest at the present time, is now ready, and will be forwarded on receipt of the published price, 7s. 6d. (abroad 8s.), or it may be obtained from any bookseller. A prospectus can be obtained on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—This book, written by Mr. F. Marten Weymouth, is also ready, and will be sent direct on receipt of the published price, 7s. 6d. (abroad 8s.), or it may be obtained from any bookseller. A prospectus will be forwarded free on application.

TENDERS INVITED.—The Vestry of St. Pancras invite tenders for excavating and constructing an underground water tank in connection with the electric lighting and refuse destructor station in King's-road, Camden Town, London, N.W. Drawings can be seen at the offices of Prof. H. Robinson, C.E., 13, Victoria-street, London, S.W., where copies of conditions, &c., can also be obtained. Tenders must be sent in to Mr. Albert E. Pycraft, chief clerk, before 12 o'clock on Friday, December 8th. Further particulars are given in our advertisement columns.

———— The Town Commissioners of Fermoy, Ireland, invite proposals and specifications for lighting the town by electricity for twelve months, or such longer period as may be agreed upon. Some further particulars will be found in our advertising columns, and other information can be obtained of Mr. P. J. Lane, Town Clerk's Offices, Fermoy, co. Cork.

———— Tenders are required for fitting up the electric light in a small steam yacht. Applications to be sent to Messrs. J. and H. M. Paterson, 32, Eldon-street, Greenock.

TENDERS ACCEPTED.—The Halifax Corporation have accepted the following tenders in connection with their central station in Cripplegate:—Engines, Messrs. Pollit and Wigzell, Sowerby Bridge; boilers, Messrs. Yates and Thorn, Blackburn; and mains, Messrs. Siemens Bros. and Co. (Limited), London.

TENDERS RECEIVED.—At the meeting of the Sunderland Corporation Highways Committee on Friday a sub-committee presented a report on the tenders which have been received from contractors to lay the necessary plant for the introduction of the electric light in the main streets of the town. There were eight different contracts tendered for, as follows:—(1) For Lancashire boilers, 28 tenders, prices varying from £1,235 to £2,500; (2) engines and dynamos, 16 tenders, prices from £4,640 to £6,015; (3) motors and alternative switchboards, 15 tenders, prices from £1,100 to £3,000; (4) main switchboard instruments and connections, 19 tenders, prices from £575 to £1,350; (5) batteries, seven tenders, prices from £763 to £2,260; (6) installation couples, seven tenders, total prices to be ascertained on measurement; (7) roadwork, prices to be ascertained on measurement; (8) copper strip, 11 tenders,

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prices from 5⅝d. to 7½d. per pound. One firm, Messrs. C. A. Parsons and Co., of Newcastle, tendered for the whole of the work for £19,044. The differences between the amounts for the various contracts decided the Committee on sending the whole of the tenders to Prof. A. B. W. Kennedy, their consulting engineer, who will go through them and report on them.

Sale of Stores.—Mr. Charles E. Stuart, Controller of Stores, announces that by command of the Postmaster-General tenders are invited for the purchase of about 30 tons of gutta-percha in various forms, old india-rubber, old copper, and other metals, mercury deposit, ebonite, &c., &c., all arranged in convenient lots. Forms of tender, containing all particulars, can be obtained of Mr. Charles E. Stuart, Controller of Stores, General Post Office, Telegraph-street, London, E.C., and tenders must be sent in by noon on Thursday, December 14th. Further particulars are given in our advertisement columns.

Appointments Vacant.—The Manchester Corporation Gas Department require a thoroughly practical and experienced foreman, accustomed to dealing with workmen and competent to undertake all classes of cable work, &c. A permanent position is offered to a good man. The Department also requires several good vulcanised rubber curers and jointers, as well as a meter inspector and tester. Written applications for these appointments must be sent in to the Chairman of the Gas Committee, Town Hall, Manchester. Further particulars are given elsewhere.

Change of Address.—Messrs. Tickner and Partington, art metal manufacturers and electric light contractors, have removed their offices to their manufacturing premises, Vulcan Works, Kensal Rise, London, N.W.

———— Messrs. Marryatt, Lillywhite and Co. announce that their only address is now 57D, Hatton-garden, E.C.

Fire.—On Saturday last the old factory of the Zurich Incandescence Lamp Company at Birmensdorf, Zurich, was almost entirely destroyed by fire. The fire was discovered about 3:30 a.m., and the alarm at once given by the watchman on the premises, and in response to his call the village fire brigade promptly arrived, followed by those of the surrounding villages, and owing to their exertions the new factory, which was nearly completed, escaped with only very slight damage; the books of the Company and a part of the stock were also saved. As the Zurich Company have, in addition to the stock saved from the fire, large depots of lamps in various European centres, it is expected that deliveries of existing orders will be resumed in a few days, and that the interruption to the manufacture will be of very brief duration. We learn that the loss is fully covered by insurance.

Venus Glow Lamps.—Mr. G. Straus, the sole representative of the Hamburg Incandescent Lamp Company in this country, is removing from the temporary premises at 158, Strand, W.C., to larger offices and show rooms at 130, Queen Victoria-street, E.C.

Messrs. Redpath and Paris.—This firm send us their new illustrated catalogue of patent high-speed noiseless engines—simple, compound, or triple expansion, condensing or non-condensing—for which a claim is made that they are specially adapted for driving dynamos for electric lighting or other high-speed machinery.

Mr. Fernand Espir.—We last week announced that Mr. Espir had been appointed sole agent for Great Britain and the Colonies for Messrs. Lazare Weiller and Co.'s specialities, and we are requested to state that stocks are to be kept in London, so that prompt delivery may be ensured.

Standard Electrical Time-Recording Company (Limited).—This Company are exhibiting some new time-recording instruments which have just been introduced into this country. By the Company's system, time-recorders to any number can be governed by a self-contained installation, and every station clock upon the greatest railway system in the world can be controlled, or a few clocks in a country house can be kept uniformly correct by a simple battery. The receivers are placed in circuit with the regulator clocks, and there is only one contact for the entire circuit. This contact is of short duration, being only one-eighth of a second; but the working of all the receivers within the circuit is perfect and their synchronisation absolute. By a special arrangement, the movement of the hands of all the receivers takes place before the complete break of the current in the regulator. The contact is made in the regulator clock every half-minute, the current winding up the main spring simultaneously. From a single regulator clock any number of receiver dials can be worked.

"Constantinople in London."—Messrs. Benham and Froud (Limited), of the Chandos Metal Works, Chandos-street, London, W.C., are making for the exhibition of Constantinople in London a number of large handsome brass domes, perforated and lined with ruby, and with outer brass work, to carry the arc lamps for the electric light, as well as a large number of copper, brass, and wrought-iron lanterns for the incandescent lighting of the streets, bridges, &c., in the exhibition, from original Moorish designs by Mr. R. W. Laws, who is superintending their manufacture.

Chelmsford.—The Town Council on Wednesday referred to a Committee of the whole Council the consideration of the offer of Messrs. Crompton and Co. (Limited) to renew the contract for lighting the town by electricity and of the draft Provisional Order which the Company are endeavouring to obtain from the Board of Trade.

Dolgelly.—The electric-light installation has not been giving satisfaction lately, the whole of the town not having been lit at one time for some while, and the Local Board have had the subject under consideration at two or three meetings. At a meeting on the 13th inst., after a long discussion, the Authority resolved to communicate with Messrs. Hall and Co., asking whether they had any proposals to make before the Board made other arrangements, and also to inquire of the Gas Company their terms for lighting the town. At the meeting held last week Messrs. Hall and Co. wrote that the lighting would henceforth be satisfactory, as they now had plenty of coal, the scarcity of which was the cause of the previous failure to light the town. The Board, however, postponed a final decision on the matter.

Electricity and the Price of Gas.—The price of gas at Aberdare has been 4s. 3d., but an electric light company having intimated that they were about to apply for a Provisional Order the price has been reduced by 3d.

Galashiels.—The Caledonian Electric Supply Company having asked the Corporation to consent to their application to the Board of Trade for a Provisional Order, the local Gas Company also wrote to the Council, stating that they were prepared to supply the electric light if there were a demand for it. The Corporation decided to remit both communications to a committee to consider and report upon.

High Wycombe.—The Town Council at their last meeting appointed a Committee to carry out the provisions of the Provisional Order they have applied for.

Huddersfield.—At a meeting of the shareholders of the Huddersfield Industrial Society, on Saturday, the Committee were authorised to light up the premises of the Central Store with electricity. It was stated that the estimated cost would be £1,600, that 550 lights would be put in, and that, considering that the engine and boiler which they proposed to put in would do other work besides supplying motive power to the dynamo, there would be a direct saving (besides a large indirect one) upon the present cost of gas, and an estimated direct saving of nearly 50 per cent. by working their own plant rather than taking electricity from the Corporation.

Ingleton.—A meeting of ratepayers was held on the 16th inst., to consider the question of introducing the electric light. Mr. T. Preece, of Messrs. Andrews and Preece, Limited (not Mr. W. H. Preece, F.R.S., as has been erroneously reported), submitted a scheme which would cost £1,500, exclusive of land, buildings, Parliamentary and other professional and legal expenses. A committee was appointed to consider the scheme and report thereon.

Lectures.—A series of University Extension lectures on electricity is being delivered at Spalding by Mr. W. Cassie.

Mevagissey.—The Lighting Committee submitted to the Vestry at the last meeting estimates for lighting the town by oil, gas, and electricity. They reported in favour of the latter, but recommended that the matter be deferred for the present.

Monmouth.—Mr. Thomas Codrington held an inquiry on behalf of the Local Government Board at the Shire Hall on Friday, respecting a proposed loan of £18,000 by the Corporation for the purpose of carrying out a complete scheme of drainage and electric lighting for the borough.

Pontypool.—Dissatisfaction was expressed at the last meeting of the Local Board with respect to the present lighting of the town by gas, and a Committee was appointed to consider whether better gas lamps should be placed at the more important parts of the town, or whether the Board should adopt the electric light.

Reading.—The temporary electric lighting of the Town Hall, on the occasion of the visit of H.R.H. Princess Christian, to open a Bazaar on the 23rd and 24th inst., was carried out by Messrs. T. C. Williams and Sons, Electrical Engineers, of Reading, by means of 17 high c.p. incandescent lamps, the current for which was supplied by the Reading Electric Supply Company (Limited).

Shanklin.—The Local Board have appointed a Committee to consider the advisability of lighting the town by electricity.

Smoke Abatement.—It is rumoured that Mr. Samuel Elliott, of Newbury, Berks., is about to give the investing public an opportunity of taking an interest in an invention in which Mr. Elliott turns to profitable account the residual products of coal. Mr. Elliott claims that his new invention goes far towards solving the great smoke problem. Interesting experiments have, we understand, been carried out at the Birmingham Mint, and excellent results are stated to have been obtained.

St. Mary, Islington.—The following is the report of the Special Electric Lighting Committee recently appointed to inquire into the

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subject of electric lighting :—The Committee has made exhaustive inquiries for a site for the proposed electric lighting works, and, as it has had considerable difficulty in finding suitable sites in the parish with the obvious requirements for a central station, its labours have extended over a longer period than was anticipated. The Committee recognised the supreme importance of obtaining a site adjoining one of the lines of railway running through the parish, so that siding accommodation for coal could be provided. It has, therefore, confined its inquiries to sites adjacent to the Great Northern and North London Railways. The Great Northern Railway Company's property in Eden-grove and Burnard-place, Holloway, was brought to the Committee's notice, and its suitability was immediately appreciated. The site is bounded on two sides by the Great Northern Railway. Your Committee has had lengthy negotiations with the Company, and is now informed that the Directors have expressed their willingness to sell the property. The land covers an area of about 32,400 sq. ft., and the sale would include the buildings existing on the same at the present time, the annual rental of which is estimated at £335. The price required for the property would, the Committee understand, be about £8,500. The Company also agree to depart from their usual practice by constructing the proposed siding to the works free of cost to the Vestry. The property is freehold, and is subject only to tenancies, all of which can be determined not later than March 25th next, if required. The site is almost in the centre of the parish, and although of not so large an area as your Committee would desire to secure, is capable of easy development by the acquisition of adjacent property should it be necessary hereafter to extend the works. Its situation makes it most convenient for the supply of electricity to any part of the parish, and considerable saving in the cost of "feeder" mains and in the loss of electrical energy will thereby accrue. Engine rooms can be erected capable of containing at least 11 sets of plant for incandescent lighting (allowing full room for slow-speed horizontal engines), and six sets for arc lighting; ample accommodation will be available for offices, switch room, workshops, coal stores, &c.; and easy means of obtaining coal direct from trucks into the works can be secured. This latter advantage is in fact more important than is at first apparent. For instance, by the end of the third year it is probable that the coal consumption will exceed 4,000 tons per annum. This quantity, if carted in the usual manner, would probably cost not less than £200 per annum for carting alone, which, if capitalised at 3½ per cent. would be equal to an outlay of nearly £6,000. Again, in the site in question, in consequence of the trucks being able to run right into the stoke hole, cost of labour in wheeling coal will be avoided, and a saving of at least £100 per annum for the first three years effected. For some time the three houses known as Nos. 25, 27, and 29, Burnard-place, included in the proposed site, can remain standing, and the rents of these houses (about £80 per annum) would consequently be received by the Vestry so long as the houses remain and their value is not deteriorated. It is possible also that for the present No. 50, Eden-grove (the estimated value of which is £55 per annum), might be allowed to remain, although probably at a reduced rent. Delay in commencing the supply of electricity means the loss of certain large customers who are hesitating to put down their own plant in the anticipation of obtaining an early supply from the Vestry, and even if the work is commenced immediately current will not be available until some twelve months have elapsed. Having regard to all these circumstances, and to the fact that there is no other available site, so far as your Committee is aware, adjoining one of the railways in the parish which would be suitable for the erection of the proposed central station, and also to the fact that there are no other interests to acquire in the property under consideration, the Committee unhesitatingly recommends the Vestry to refer it to the Committee to carry out the negotiations for the purchase of the site upon the terms and conditions named.—At the meeting of the Vestry called to consider the report, Mr. Lambert moved its adoption. The Committee were unanimous in its recommendation. Mr. Vine seconded. In the purchase of the Eden-grove site they would only have to deal with one vendor, whereas in the other sites a number of vendors, leaseholders, and freeholders would have to be considered.—Ultimately 38 voted for, and only 2 against, the adoption of the report.

WEYBRIDGE.—The Weybridge Electric Supply Company have informed the Vestry that they have now received Prof. A. B. W. Kennedy's report as to placing their wires underground, and that it will be immediately considered by the Directors, who hope very shortly to be in a position to state when the wires would be altered.

BOOKS RECEIVED.

"Standard Tables for Electric Wiremen." By Charles M. Davis. Fourth edition. (New York: The W. J. Johnston Company, Limited.)

"Helical Gears." By A Foreman Pattern-maker. (London: Whittaker and Co., 2, White Hart-street, Paternoster-square.)

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

October 25, 1893.

20,069. R. LUNDELL and E. H. JOHNSON. London. Improvements in apparatus for controlling the application or use of electric currents of high tension and great quantity.*

October 25, 1893.

20,116. L. MOND and R. L. MOND. Liverpool. Improvements in electrolytic cells.

October 26, 1893.

20,155. G. G. TURNER. Newcastle-on-Tyne. Improvements in or relating to electric bell ringing.

20,191. E. TWEEDALE, S. TWEEDALE, and J. SMALLEY. Manchester. Improvements in electric stop motion drawing frames for fibrous materials.

20,226. G. HERVIEU. London. An improved electric clock.

20,229 A. J. BOULT. London Improvements in electric arc lamps. (La Société Mailhabuan and Fritsch, France).

20,231. F. PANTER and G. HILL. Manchester. Improvements in electric clocks and electric meters.

October 27, 1893.

20,325. W. R. WEBB. London. Improvements in the manufacture of electric pushes, pulls and switches.

October 28, 1893.

20,381. E. A. CLAREMONT. Manchester. Improvements in joints for electric light fittings.

20,384. G. HOOKHAM. Birmingham. Improvements in electricity meters.

20,408. J. W. KINNIBURGH. London. An improvement in or applicable to ear-pieces for telephone receivers.*

October 30, 1893.

20,432. E. TWEEDALE, S. TWEEDALE, and J. SMALLEY. Manchester. Improvements in electric motion drawing frames for fibrous materials.*

20,458. E. C. DE SEGUNDO. London. An electric switch.*

20,459. E. REDANTZ. London. Improvements in suspension devices for electric crown lights and the like.

20,471. J. G. TATTERS. London. Improvements in incandescent electric lamps.

20,493. H. Y. DICKINSON. London. An improved electric flash-light clock.

October 31, 1893.

20,551. H. BIRKBECK. London. A new or improved combined switch and cut-out for electroliers. (The Universal Pull-socket and Switch Company, United States.)

SPECIFICATIONS PUBLISHED.

All Specifications price 8d. each.

1892.

18,700. POOLE and OTHERS. Electrical ceiling roses.

19,393. FROGGATT. Electric battery apparatus.

19,959. HUMPHREYS and FRIESE-GREENE. Measuring electricity.

20,372 ESPENT. Electric insulators.

20,488. WEBB and THOMPSON. Closing an electric circuit by the passage of a train over a line of railway.

20,598. THÉRYC and OBLASSER. Electric accumulators.

20,789. LORRAIN. (Clamond.) Transmitting sounds electrically.

21,602. SCOTT. Electric meters.

22,719. GEIPEL. Underground distribution of electricity.

23,290. ARNOLD. Alternate current motors.

23,539. SPENCE and OTHERS. Dynamo-electric machinery.

23,658. EDMUNDS. Electrical cables, &c.

23,675. RAWORTH. Electric switches.

23,892. HUTIN and LEBLANC. Telephony.

1893.

516. LAKE. (Weston.) Measuring and recording electric currents.

6,935. BROOKES. (Wirt.) Electrical meters.

10,533. JOHNSON. (McCaskey.) Electrical signalling and printing telegraph systems.

10,843. CLARKE and WIULLEUMIER. Electric railways and tramways.

15,906. YOUNG. (Société Outherin, Chalandre Fils et Cie). Electrolytic apparatus.

16,562. WILLCOX. (Esmond.) Electric motors.

17,127. CRANEY. Electrolytic cells.

17,646. NESS. Telephone switch.

18,710. RAWORTH. Electric contacts.

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COMPANIES' MEETINGS.

International Okonite Company (Limited).

An extraordinary general meeting of this Company was held on Saturday at Cannon Street Hotel, Mr. Samuel Pope, Q.C., presiding.

The CHAIRMAN said they were probably aware that the object of the meeting was to confirm, or otherwise, certain resolutions passed at an extraordinary general meeting held about a month ago (and reported in *The Electrician* of November 3rd). It would be within the recollection of some present that when they came to discuss these resolutions they found that the shareholders on the other side of the water commanded, and were represented at the meeting by, so large a preponderance of proxies, that they were practically at their mercy, and whatever view might be entertained by them, the resolutions would be carried if the American votes were given in their favour. But, as the result of the discussion, there were objections taken by various English shareholders to some of the propositions which had been sent from the other side, notably to one for abolishing the power of the Company to purchase its shares, and which would affect their standing on the Stock Exchange. The resolutions were passed on that occasion, but the gentleman who held the American proxies intimated that he would represent to his *clientèle* the feeling which prevailed amongst a considerable bulk of the English shareholders with regard to some of the suggestions. Since that meeting a letter had been received from the other side, saying that, although they themselves remained of opinion that the whole of the resolutions, as submitted, would be for the general interest of the Company, yet that, in deference to the strong feeling on this side, they would modify them to the extent of not interfering with the existing article with regard to the purchase of shares of the Company by the Company itself; therefore the resolutions would be submitted for confirmation minus that particular part which had met with considerable criticism. Speaking for himself, he confessed that, although he did not see how they could avoid confirming the resolutions if they wished, he was by no means dissatisfied with them now that the alteration he had mentioned had been agreed to. His whole interest, with the exception of debentures he had bought from time to time, was in Ordinary shares, and as a holder of such he felt that the best thing that could be done was to pass the scheme embodied in the resolutions before them.

Mr. WILLIAMS moved that the whole of the resolutions be confirmed, with the exception of sub-section A of clause 2, which read as follows:— Rescind article 35 and substitute the following: "The Directors may accept surrenders of shares on such terms as they think fit."

Mr. VAUGHAN STEVENS seconded the motion.

Mr. E. GLADSTONE thought the clauses or resolutions should be put *seriatim*.

The CHAIRMAN said he was quite willing to do so, but it would have no effect, because there was a large block of American shares that would enable them to be carried.

Mr. STEVENS remarked that the capital of the Company was £340,000, and that Mr. Williams had duly lodged proxies in proper order to the value of £165,490 in favour of the resolutions.

The CHAIRMAN said as a Board they had no proxies, and added that the effect of the resolutions was to transfer the management of the Company to America.

Mr. GLADSTONE said he thought they ought to take a poll on the resolutions. The Americans sold their property at ten times its value, and now they were asked to place it at their entire disposal.

The CHAIRMAN replied that that was no doubt the individual opinion of a great many, but the question was how, in the constitution of a company, that individual opinion was to make itself felt. They had heard that they were faced by a solid block of shares equal to about half the capital. In the face of that he felt himself powerless.

Mr. HOPPS said he thought that as the American people had played the game so cleverly they should be compelled to lodge their proxies for every resolution.

The CHAIRMAN said the American business of the Company was making profits, and those interested in it on the other side objected to having those profits taken from them to make up losses on this side. The English Directors had not been able to make the business on this side pay as soon as they had hoped, and they had therefore followed the suggestion of the American Directors and closed the Manchester works. At some future time it might be possible to reopen them; but just now they were depending upon the profits made in the United States. Speaking as an ordinary shareholder, he felt that the only chance he had of getting a dividend lay in the surplus profits of the American business after meeting the expenses there. As to taking a poll, if a requisition were handed him by five shareholders holding one-fifth of the capital he must grant it.

Mr. CLEMENTS, the solicitor for those representing the American block of shares, said that, as those on the other side had given way on the point principally objected to at the last meeting, he hoped there would be no attempt, although it must be useless, to defeat the resolutions.

Mr. GRIFFITH said he thought the policy they were asked to adopt was one that must commend itself to thinking minds. The one question that arose in his mind was whether it would not be wise to sell their magnificent works at Manchester, and so bring money into the coffers of the Company.

Mr. CLEMENTS replied that it was the intention of those responsible to wait until better times, and, if it should then be possible to resume business at Manchester profitably, to do so.

The resolutions were eventually confirmed, and the proceedings concluded with a vote of thanks to the Chairman.

Elmore's French Patent Copper Depositing Company (Limited).

Mr. C. J. Stewart (Official Receiver and Provisional Liquidator) on Tuesday last issued his summary of the affairs of this Company.

Mr. Stewart says the Company was incorporated September 10, 1890, for the purpose of acquiring and working in France certain French patents relating to an improved process for manufacturing copper articles, "discovered" by Messrs. F. E. and A. S. Elmore, and patented by them in or about the year 1885. In 1889 a company was formed to acquire and work their patents relating to Great Britain and Ireland. At the date of the formation of the French Company Elmore's Foreign and Colonial Patent Copper Depositing Company (Limited) (referred to hereafter as the Foreign and Colonial Company) were the owners of all the existing patents for other parts of the world than Great Britain and Ireland relating to the Elmore copper process. On September 4, 1890, the Foreign and Colonial Company agreed with Woodhouse and Rawson United (Limited) that the latter should form a company for the purpose of acquiring the patents for France in consideration of £15,000 in cash, the whole of a premium of 10s. on each of 51,750 shares if subscribed for by the public, and half of a like premium on any further number of shares allotted to the public. The benefit of this agreement was transferred by Woodhouse and Rawson United (Limited), on September 9, 1890, to the Phœnix Trust Company (Limited), which company appears to have actually promoted the French Elmore Company. On September 10, 1890, the French Elmore Company agreed to purchase from the Foreign and Colonial Company the French patents for £83,500 in cash, £66,500 in the form of 33,250 £2 shares credited as fully paid up, and the premium of 10s. on each share subscribed for by the public. This agreement was duly carried out; the purchase price paid to the vendor company was £183,375, of which £66,500 was in shares and £116,875 in cash. A prospectus was issued to the public in September, 1890, containing extracts from various reports speaking in favourable terms of the Elmore copper process, and the whole of the original capital of £66,750 offered to the public was at once subscribed for, and was allotted on September 19 and September 22, 1890. Mr. F. L. Rawson, a Director of the Foreign and Colonial Elmore Company, of Woodhouse and Rawson United, and of the Phœnix Trust (though not a Director of the Elmore's French Company), appears to have frequently attended the French Company's Board meetings, and to have exercised great influence in the management of the affairs of the Company. In order to meet increased outlay owing to various undertakings entered into by the Company, an agreement was made on October 29, 1890, with the Foreign and Colonial Elmore Company to issue debenture stock for £50,000 at 6 per cent., redeemable at £105 on November 1, 1893. In pursuance of this agreement, the Foreign and Colonial Company appears to have advanced £50,000 to the Company in various sums as required. The debenture stock for the most part seems to have been taken up by the shareholders of the Foreign and Colonial Company. The payment for all expenditure in France, including the cost of the erection of the buildings and the machinery at Dives, was in the hands of M. Secrétan and the Paris committee, who drew upon the Company's bankers in France, the latter being supplied from time to time with funds from the London bank of the Company. No accounts in detail of such expenditure appear to have been furnished to the Board in England, but the books in France were audited annually by Messrs. Deloitte, Dever, Griffiths and Co., the Company's auditors, and a summary of the assets and expenditure in France was supplied to the Board, and included in the annual balance sheets. The Directors seem to have disregarded the suggestion of the auditors that the total of the cash-book expenditure should be initialled by M. Secrétan as an indication of his approval of the payments made. It was stated by M. Secrétan at the first general meeting of the shareholders, on January 9, 1891, that works constructed to produce 370 tons of copper articles per month would commence manufacturing on July 1, 1891, and would, at the end of three months, have reached their full production. In consequence, as it is represented, of defects in the soil on which the works were being constructed, and of the difficulty in finding suitable machinery for working the Elmore copper process, which necessitated a considerable expenditure of time and money in experiments, in order to discover such machinery, the cost of the works largely exceeded the original estimate, and the manufacture of copper articles for sale does not seem to have commenced until April, 1892, between which date and December 31, 1892, the total sale of such articles was under 100 tons. At a general meeting of shareholders on April 22, 1892, it was decided to increase the capital of the Company by the creation of 100,000 Preference shares of £2 each, to be entitled to a priority on a distribution of assets, and to a preferential dividend of 10 per cent., and to a further dividend of 5 per cent. after a dividend of 15 per cent. should have been paid on the Ordinary shares. In pursuance of this resolution a prospectus was issued on April 23, 1892, offering 60,000 such shares for subscription, of which 40,000 were reserved for the holders of Ordinary shares of the Company and 20,000 were offered to the public. The same prospectus stated that the interest of 10 per cent. was guaranteed for one year by the Foreign and Colonial Company. On July 16, 1892, of the issue of 60,000 shares, only 13,250 had been applied for and allotted, and on that day another prospectus was issued, offering for subscription on the same terms 20,500 Preference shares, forming part of the 60,000 shares, and on November 19, 1892, a circular was sent to the shareholders in the Elmore Companies offering 10,000 Preference shares on the same terms. The total number of Preference shares allotted is 22,516, on which £44,707 has been paid, and £325 remains due on unpaid calls. At a general meeting of the debenture stock-holders on February 20, 1893, the Directors were empowered to issue new debenture stock to the amount of £100,000, bearing interest at the rate of 7 per cent. Circulars were

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accordingly issued stating that it was proposed to extinguish the existing debenture stock of £50,000 by conversion or redemption, and offering for subscription £65,000 of the new issue. It was also stated in the circulars that unless £30,000 of the new debenture stock should be subscribed for in cash at par within two months no allotment should be made. The secretary states that applications were received for only £8,533, on which £2,747. 8s. was paid. This amount was placed to a separate account at Martin's Bank, and has not been returned in the statement of affairs, an injunction having been granted by the High Court restraining Martin's Bank from parting with the same. The applicants for the stock are apparently entitled to a return of the moneys. The whole of the Company's monetary resources were exhausted in connection with the establishment of the works in France, and it was unable to meet the interest falling due upon the debenture stock on November 1 1892; under the powers contained in the debentures, Mr. J. H. Duncan was appointed as receiver on behalf of the holders thereof on March 28, 1893, his appointment being confirmed by the Court on April 14, 1893. The Company being unable to continue its business, an extraordinary general meeting of the shareholders was held on May 8, 1893, when it was resolved that the Company should be wound up voluntarily, with Mr. F. W. Pixley as liquidator. On the same day, at an ordinary annual general meeting of shareholders, a resolution was passed approving of an agreement, dated April 29, 1893, by which Mr. Duncan, as receiver for the debenture holders, agreed to sell to M. Secrétan the Company's works, patents, and business in France, the land at Bellegarde being excepted. The sale is now in course of completion. No dividends have been paid on the Ordinary shares. The dividend of 10 per cent. on the Preference shares, which was guaranteed for one year by the Foreign and Colonial Company, appears to have been paid by that Company. Among the unsecured creditors are included four Directors, whose claims in respect of fees amount to £798. 7s. 8d. The claims of the creditors partly secured (£76,081. 19s. 7d.) include one of £27,000 by three persons who hold as security £11,900 debenture stock of the Company, and collateral security of the Foreign and Colonial Company; they appear to have advanced £23,000 to the Company in December, 1892, and received the Company's acceptances for £27,000, payable at intervals until February, 1894, the balance of £4,000 being charged as interest at an average rate of 18 per cent. There is also included a claim of Elmore's American and Canadian Patent Copper Depositing Company (Limited) for cash lent to the Company between October, 1892, and February, 1893, amounting to £7,261. 17s. 4d., to secure which it holds a first charge for £2,000 upon the whole of the Company's property, in addition to collateral security of the Foreign and Colonial Company. The other creditor partly secured is the Foreign and Colonial Company, which holds a mortgage registered in France upon the whole of the Company's property for £95,000 (subject only to the charge of £2,000 above mentioned), the first £50,000 of which is held in trust for the debenture holders. The sum now due in respect of advances upon this mortgage, over and above the amount so held in trust, is returned as £41,784. Of the £50,000 debenture stock issued as before mentioned, in pursuance of the resolution of October 29, 1890, £12,000 appears to have been redeemed by the Company in December, 1893, of which £100 was cancelled and £11,900 transferred as collateral security to the three partly-secured creditors, as before stated. The liability upon debenture stock is thus £49,900, with interest due thereon to the amount of £2,360. 15s. 5d. Some difficulty has been experienced in investigating the Company's transactions with respect to bills, which have been of considerable magnitude. One bill-book has been used in common by all the Elmore Companies, and the Official Receiver has not been able to obtain possession of it. The correspondence, also, of all the Elmore Companies has been kept on a common file. No seal register was kept by the Company.

A summary of the general financial position of the Company is appended to Mr. Stewart's report, which is very voluminous and gives evidence of much labour and research.

Some severe strictures passed by the Press upon the methods adopted by the management of the Company, has drawn from the Secretary (Mr. W. Shurmur) an announcement to the effect that a "scheme of arrangement whereby the Company is to come out of liquidation and to be resuscitated" is under consideration. He concludes:—"I must not now forestall what will probably be announced on this subject at the meeting on the 5th proximo, except to the extent of saying that such scheme, if carried out—about which I have no doubt whatever—will not only satisfy the debenture holders and the unsecured creditors, but will also provide for an annual dividend of 10 per cent. on the Preference shares, and an annual dividend of, probably, 4 per cent. or 5 per cent. on the par value of the Ordinary shares. If there was ground for hope in April last, then that ground has become infinitely stronger now, by reason of what we know is being done at Dives to-day."

NEW COMPANIES, STATUTORY RETURNS, &c.

[In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in "The Electrician" Electrical Trades' Directory and Handbook, 1893, pages 320-348, &c., &c.]

FARRINGDON WORKS (LIMITED).—This Company was registered on November 23rd, with a capital of £40,000, in £10 shares, to carry on the business of engineers, iron founders, brass founders, millwrights, steam engine and boiler makers, machinists, copper smelters, antimony smelters, metal workers, white lead makers, &c.

GAS TRACTION COMPANY (LIMITED).—This Company has been formed with a capital of £100,000, in £1 shares, to purchase certain patented inventions relating to the traction of vehicles by means of gas, and the objects further include the carrying on of the business of gas engine makers, manufacturers of all kinds of apparatus connected with the generation, storage, compression, supply, application and distribution of gas and electricity, gas, electrical and mechanical engineers, &c. J. Fletcher Moulton, Q.C., one of the vendors, has accepted a seat on the Board.

NEW QUAY GAS COMPANY (LIMITED).—Capital £10,500, in £1 shares. Although this concern has been formed primarily for the purpose of supplying New Quay, a township in Cornwall, with gas, powers are retained for the carrying on of the business of an Electric Light, Heat and Power Supply Company, should that step be deemed by the Directorate to be advisable.

PAYTA TO PUIRA RAILWAY (LIMITED).—This Company was registered on November 23rd, with a capital of £100,000, in £1 shares, to acquire and deal with an important concession relating to the construction, maintenance and working of railways, tramways, telegraphs, telephones, and other means of communication in certain parts of the Republic of Peru.

SMOKELESS HEAT AND LIGHT SYNDICATE (LIMITED).—This Company was registered on November 24th, with a capital of £20,000, in £1 shares, to acquire certain inventions relating to improvements in the production of heat and light for which patents have been granted in most of the more important countries, and to develop and deal with the same.

ELECTRIC ANTI-CORROSION COMPANY (LIMITED).—The solicitors to this Company state that no business has ever been carried on, and its removal from the Register is requested.

ELECTRICAL COAL-CUTTING CONTRACT CORPORATION) LIMITED).—The first annual return of this Company, made up to November 6th, has been filed. The nominal capital is £402,000, divided into 60,000 Ordinary shares of £5 each, 20,000 Deferred shares of £5 each, and 2,000 Founders' shares of £1 each. 9,531 Ordinary, 20,000 Deferred, and 2,000 Founders' shares have been taken up, of which all the Deferred and 4,000 Ordinary have been issued as fully paid. The full amounts have been called on 4,082 Ordinary and the Founders' shares, while a call of £3. 15s. per share has been made upon the remaining 1,449 Ordinary shares. The calls paid amount to £26,563. 15s., leaving £1,280 in arrears.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The Directors of this Company have declared an interim dividend of 3s. per share (at the rate of 6 per cent. per annum) free of income tax, for the quarter ended September 30th last, and payable on December 21st. The transfer books of the Company will be closed from December 14th to 20th inclusive.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic receipts for the week ended November 26th were £895, as against £893 for the corresponding period of last year, being an increase of £2. The total receipts for the half-year amount to £17,320, against £17,137 in the corresponding period of 1892, being an increase of £183.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announce that telegraphic communication has been established between the Company's station at Lisbon and the island of Graciosa in the Azores. The following islands in the Azores are also open for telegraphic traffic:—San Miguel, Terceira, San Jorge, Pico and Fayal. Messages are accepted by this Company at the rate of 10d. per word.

ELECTRIC CONSTRUCTION COMPANY (LIMITED).—Notice is given that a drawing of the Six per Cent. Second Mortgage Debentures (to be paid off on January 1st next) will take place at the registered offices of the Electric and General Investment Company (Limited), the trustees for the debentures, 1 and 2, Great Winchester-street, London, E.C., on Friday, December 8th, at three o'clock.

KELVINSIDE ELECTRICITY COMPANY (LIMITED).—The Directors of this Company have issued a prospectus during the past week, inviting subscriptions for £10,000 in Five per Cent. Debentures, redeemable at the option of the Directors, at 20 per cent. premium, any time prior to November 11, 1898, and with the right of conversion into Ordinary shares at the option of the holders any time after the latter date. The Managing Director of the Company is Mr. J. M. V. Money-Kent, of Connaught Mansions, 34, Victoria-street, S.W., and the trustees for the debenture holders are Lord Kelvin, Sir John N. Cuthbertson, and Sir Renny Watson. Dr. J. T. Bottomley, F.R.S., is consulting electrician, and Mr. J. M. M. Munro is electrical engineer to the Company, which was incorporated in 1889, and whose first installation is now nearly completed, and will ultimately cost about £20,000, £17,000 of which has already been expended in buildings, machinery, plant and mains. The central station is designed and built for three times the plant at present installed. The offices of the Company are at 28, Renfield-street, Glasgow, and Mr. W. H. Watson is secretary.

PANULCILLO COPPER COMPANY.—At an extraordinary meeting of this Company, held at Winchester House, E.C., on Friday last week, Sir John Pender, G.C.M.G., M.P., said that the Directors had been disappointed at the very small support they had received from the shareholders in connection with the continuation of the working of the Panulcillo Mine. If those who still held an interest in the mine would go into the new scheme proposed by the Directorate he thought there was still a very good prospect of recouping themselves. The mine had been closed since June 20th owing to want of funds. The present meeting was called to consider an arrangement by which it was proposed to transfer the undertaking to a new company for £22,000, andthe Directors urged the acceptance of this

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scheme upon the shareholders. The prospectus will be issued early next month, and will only be kept open for subscription for a few hours. The motion proposed by the Chairman was adopted, and a further resolution to wind up the Company voluntarily was also passed.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ending November 24, 1893, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited) were £3,379.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price, Nov. 22		Price Wednesday, Nov. 29		Rate per Cent. Yielded (£ s. d.)	Dividend Due	Business Done During Week Ending Nov. 29: Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	12/6	Anglo-American	44	46	43	45	6 2 3	Jan., Apr., July, Oct.	45	43¾
£2,932,680	Stock	25/0	Do. Preferred	83	84	82½	83½	6 11 9	" "	83½	81½
£2,932,680	Stock	5/0	Do. Deferred	7¾	8¼	7½	8	..	..	7⅜	7⅜
£195,100	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	100	103	100	103	3 17 8	January and July	..	..
130,000	£10	4/0	Brazilian Submarine xd & bonus	11¾	12¼	11¾	12¼	5 6 1	Mar., June, Oct., Dec.	12⅛	12
£36,400	£100	5%	Do. 5 per Cent. Bonds	100	103	100	103	4 17 1	January and July	..	—
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	..	—
10,000,000	$100	7%	Commercial Cable Capital Stock	140	150	140	150	4 13 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11½	12½	11½	12½	6 8 0	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	..	..
60,710	20	3/6	Direct United States Cable, 1877	11½	11⅝	11½	11⅝	6 3 4	Jan., Apr., July, Oct.	11⅝	11 9/16
400,000	10	2/6	Eastern	14¾	15	14¾	15	4 6 8	" "	14 15/16	14¾
70,000	10	6%	Do. 6 per Cent. Preference	15½	16½	15½	16½	3 12 9	" "	16⅛	16
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	113	116	114	117	3 8 5	May and November	116	115
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	108	111	108	111	4 10 1	February & August	..	..
250,000	10	2/6	Eastern Extension	15½	15⅝	15¼	15½	4 10 4	Jan., Apr., July, Oct.	15⅝	[illegible]
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113	116	114	117	3 8 5	February & August	116	114
£70,600	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	102	105	102	105	4 15 3	January and July	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	102	105	102	105	4 15 2	" "	103½	
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	102	105	102	105	3 16 2	February & August	103½	102½
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	104%	107%	105%	108%	3 14 1	May and November	107	..
180,227	10	1/6	Globe Telegraph and Trust	8⅜	8⅝	8⅜	8⅝	5 4 4	Jan., Apr., July, Oct.	8⅝	8½
180,042	10	6%	Do. 6 per Cent. Preference	14⅞	15⅛	14⅞	15⅛	3 19 4	" "	15⅛	14 13/16
150,000	10	5/0	Great Northern	20	20½	20	20½	4 3 0	Jan., April, and July	20 1/16	20 1/16
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	103	106	103	106	4 14 4	March & September	105½	..
17,000	25	12/6	Indo-European	40	43	40	43	5 16 3	May and November	41½	—
37,548	10	4/0	London Platino-Brazilian	4	5	4	6	3 6 8	" "	..	—
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	105	108	5 11 1	March & September	..	—
£100,000	£100	4%	Pacific European Telegh. 4% Guar. Debs. "Red" 1942	102	105	102	105	3 16 2	..	103¾	..
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	..	..
3,381	£100 Cert.	35 0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	" "	116½	..
15,609	10	5/0	West African Telegraph	5½	6½	5½	6½	7 13 10	January and July	..	..
£249,900	100	5%	Do. 5 per Cent. Debentures	98	101	98	101	4 19 0	March & September	99	..
30,000	10	2/0	West Coast of America	2	3	2	3	..	January and July	..	—
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	103	99	103	7 15 4	June and December	..	..
88,321	10	6d.	West India and Panama	1⅛	1⅜	1⅛	1⅜	..	..	..	..
84,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10	10½	5 14 3	May and November	10⅛	10
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9	10	9	10	6 0 0	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	107	110	108	111	4 10 1	June and December	109	..
64,242	15	4/6	Western and Brazilian	5½	6½	5½	6½	3 9 4	May and November	6⅛	..
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5¼	5¾	5¼	5¾	..	..	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1	1½	1	1½	..	..	..	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	103	106	103	106	5 13 2	February & August	..	..
£222,700	100	6%	Do. 6 per Cent. Mort. Debs. Series "B" 1910	103	106	103	106	5 13 2	" "	..	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	105	102	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	—	..	—
224,800	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	—
220,000	£1	4·76d.	Oriental (11s. paid)	3/16	5/16	3/16	5/16	6 7 9	Yearly	..	..
458,867	5	2/6	National	4¾	5	4¾	5	5 0 0	June and December	4 15/16	4¾
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14	15	14	15	4 0 0	" "	14¾	14½
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	13½	14½	13½	14½	4 2 9	" "	..	..
90,950	5	2/0	Do. 5% Non-Cumulative 3rd Pref.	5¼	5½	5¼	5½	4 10 11	..	5⅜	5 5/16
925,017	£100	4½%	Do. Deb. Stk. 4½%	113	115	113	115	3 18 3	January and July	113½	113
58,000	5	1/0	United River Plate	2	2½	2	2½	..	January and July	..	—
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	—	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11½	11¾	11½	11¾	..	—	11⅝	..
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	12¾	13¼	12¾	13¼	..	—	13¼	13
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	—	..	—
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	—
8,322	£5	..	House to House Electric	..		..		—	—	—	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		..	..	..	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	—	—
30,000	£5	3/4 '92	Liverpool Electric Supply (£3 10s. paid)	4½	4¾	4½	4¾	..	—	..	—
15,000	£5	5/0 '92	Do. (fully paid)	6¼	6¾	6¼	6¾	..	—	..	—
111,000	5	..	London Electric Supply	¾	1	¾	1	..	..	..	—
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	7½	7¾	7½	7¾	2 11 8	..	..	—
£100,000	Stock	5%	Do. 5 per Cent. Debs. (Bonds of £10, £20, & £40)	106	109	106	109	4 11 9	June and December	108	..
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	—	—	..	..
19,980	£5	9½%	St. James' and Pall Mall	6	6½	6	6½	..	—	6 1/16	..
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	—	8 3/16	8 1/16
59,900	5	1/6	Westminster Electric Supply (fully paid)	5¼	5¾	5	5½	3 3 8	—	5 3/16	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	2/1	Brush Electrical Engineering	2¾	3	2⅝	2⅞	6 5 8	—	2 15/16	2¾
90,000	2	6%	Do. 6 per Cent. Preference Non-Cumulative.	2⅛	2⅜	2¼	2½	4 16 0	..	2⅜	2 5/16
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	106	108	106	108	4 3 4	March & September	108	106½
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	4¼	4¾	4¼	4¾	..	January and July	..	—
12,139	5	..	Edison and Swan United	—		—		—	—	—	—
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	—	..	—
49,900	10	12/0	Electric Construction	..		..		..	—	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	½	¾	½	¾	—	—	—	—
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	—	..	—
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21½	22½	21½	22½	5 11 1	February & August	22	21½
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	—	—
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	..	—	—
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	—	—
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/0	4/0	3/0	4/0	..	—	..	..
78,949	5	1/9	Swan United (£3. 10s. paid)	2	2½	2	2½	—	May and November	2¼	..
37,350	12	12/0	Telegraph Construction and Maintenance	35	37	35	37	4 17 3	March and July	37	36½
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	104	107	104	107	4 13 6	January and July	..	—
39,639	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		—	—	—	—
41,098	£5	..	Do. Preference (fully paid)	..		..		—	—	—	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	¾%	City and South London Railway	28	33	28	33	2 5 5	May and November	..	—
87,500	£10	..	Liverpool Overhead Railway	5¼	5⅝	5¼	5½	—	—	—	—

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THE ELECTRICIAN:

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NOTES.

The decision of the City Commissioners of Sewers to remove the gas standards from the streets lighted by the City of London Company's arcs, is, as was said at the meeting "the legitimate outcome of the report of the Engineer on electric lighting." When the percentage of failures in lamp hours has been brought down to 0·047, it is certainly no very rash step to remove lamp-posts, which cost nearly £1,200 a year to maintain, and consume only twenty-eight pennyworths of gas per annum. At the same time, the gentleman who urged further delay, and remarked that the City would be "in a dreadful state" *if* the light failed, need not be scoffed at. We can only trust that the record of the City lighting during the dark days now upon us will be such as to give the public entire confidence in the reliability of electric street lighting when carried out in a workmanlike fashion.

Judging from the graphic account given by a correspondent of the *Standard* yesterday, the hygienic value of the Hermite process of sanitation is one of considerable importance. The deodorising and bacillus-slaying propensities of electrolysed salt water appear to be both prompt and perfect. From the experiments now being carried out at Lorient, it would appear that the worst kinds of sewage may be allowed, after passage through the Hermite syphon, to flow in an open drain along the public street with every appearance of being a limpid and colourless stream of pure water. It is also stated that some of the fever dens of Lorient have been appreciably improved by an application to them of this electrolytic process. It seems that there are two classes of bacillus, those which like oxygen and those which do not like it; but neither of these classes appears to like electrolysed sea water.

The mystery which, notwithstanding the extensive and deep researches of Ewing into the subject, still surrounds the behaviour of the molecules in a mass of iron placed in a varying magnetic field, is very strikingly exemplified by the apparently anomalous results obtained by Mr. S. J. Lochner in his researches on the elongation produced in soft iron by magnetism. Some account of Mr. Lochner's experiments is given in another column this week. A sample of soft bar iron was subjected to a gradually increasing magnetising force, and was found to increase in length up to a certain point. Beyond that point an increase of magnetising force produced actual decrease of length of the bar; while, remarkable to relate, a decrease of the magnetising force caused the bar to continue to grow longer. Further than this, the amount of elongation of the bar in any field was found to depend on the way in which the bar was subjected to the magnetising force, as to whether the force was applied suddenly or gradually, and whether the final strength of field was attained by increase from a lower or by decrease from a higher value. This latter might have been predicted from Ewing's results, for a bar of unmagnetised iron is a disorderly collection of an immense number of molecules; and it might be expected that a very great variety of arrangements of these molecules might each and all correspond to the same intensity of magnetisation, while each would give a different alteration in the length of the bar.

The existence of a critical point in the elongation of the bar, under increasing magnetising force, would seem to point to the existence of two opposing tendencies to change of length. What are the precise causes of this critical point and of the apparent anomaly in the behaviour of the iron can only be settled by very carefully arranged experiments; but we may call attention to the existence of two well defined phenomena in a magnetised iron bar, which may throw some light on this obscure action. It has long been recognised that the rotation of the iron molecules on their axes may account for the increase in length of the bar. On the other hand, the mutual attractions between the adjacent molecular poles would tend to shorten their centre distances. The two effects would occur simultaneously, but it is evident that the former would produce the greater effect at first, while the latter would become more marked when the iron approached a higher degree of magnetisation.

A very high tribute of praise was accorded to Prof. Hertz and his researches by the President of the Royal Society, at the anniversary meeting of that Society last Thursday week. Lord Kelvin, in the opening part of his speech, referred to the recent publication of these researches in the original German, as well as in an English translation by Prof. D. E. Jones. The value of these researches as an experimental contribution to the ether theory of electro-magnetism is universally admitted. In order to give some idea of the position which this theory takes in the evolution of ideas about force and matter, Lord Kelvin sketched the successive hypotheses which have been considered orthodox from the time of Newton to the present day. Sketches of this sort

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always make one inclined to wonder if the particular hypothesis which happens to be orthodox at the moment may not, after all, be as chimerical as its predecessors. This is the nightmare of science; and when we have shaken it off with a gasp, we try to comfort ourselves with the thought that none of our predecessors followed the "true scientific method" as we moderns do! Descartes, Newton, Boscovitch, Maxwell, and the rest may spin theories; but only in the experimental evidences of a Faraday and a Hertz have we something which looks like solid rock.

Some of the difficulties in the design of arc lamps which are enumerated by Mr. W. A. Turbayne, in his article which we publish this week, are undoubtedly of importance; the others are rather trite. It is the fashion to say that the mechanism of arc lamps has been neglected; but, while this would have been true a year ago, it is not by any means true now, at any rate, as regards English lamps. During the last twelve months considerable attention has been given to arc lamps, both by makers, in regard to their mechanism, and by physicists, in regard to the distribution of light and the relation between watts, volts and carbons. However, it is quite true, as Mr. Turbayne points out, that there are still some important difficulties in the way of making a perfect lamp. But it is by no means clear how any of these difficulties are to be got over, in the case of running lamps in series, by a return to the old-fashioned series-coil method of feeding the carbons. To us, Mr. Turbayne's assertion that "the best foundation design for an arc lamp for direct-current working would undoubtedly be that of the *non*-differential variety," is simply unintelligible. The essential property of lamps run in series is that they shall regulate without influencing one another, and without any change of current. How can any such independence be obtained where there is a series feed?

Under the pretext of overhauling their International telegraph system, the French authorities are apparently projecting some scheme of submarine cable laying, which will require to be carefully watched. The Ministers of War, of Marine, and of Foreign affairs are represented on a commission, which includes some "superior functionaries" of the Colonial Department. The matters discussed are described as "particularly urgent," and a Sub-Commission has been already charged with elaborating a comprehensive plan of submarine telegraph cables. It has not transpired what peaceful purpose these cables are to serve, and it would be hard to discover any colonial or commercial interests pertaining to France that are not amply guarded by existing cables. All the same, we can take no exception to her laying a few more; and as she has been spending large sums of money on subsidies to enable French makers to manufacture their own cables at home, and to support existing French lines, we are content to let them continue trying their hands at it, and shall grudge them no success. But this is a matter which does not concern British cable interests alone. The British Government ought to have their eyes open as to these "urgent" French enterprises.

The Hutin-Leblanc Patents.—The Maison Farcot has purchased the Hutin-Leblanc patents, and are about to build a 750 kilowatt alternate-continuous-current transformer.

The Late Mr. Henry Weaver.—Probate of the will, dated March 24, 1887, of the late Mr. Henry Edward Weaver, who died recently at Folkestone, aged 68 years, leaving personalty valued at £83,965, has been granted to the executors.

Appointment.—The Indian Government have selected Mr. G. Church for the appointment of Mechanical Engineer to the Indian Telegraph Department. The intention to appoint an Electrician to the same Department has been abandoned.

Finsbury Technical College.—Prof. A. B. W. Kennedy has arranged to give a special course of two lectures on "Engine and Boiler Testing." The first was delivered last night, and the second will be delivered on the 21st, at 8 o'clock.

Compensation for Hysteresis.—We have received, too late for publication this week, some further contribution from Mr. Vignoles on the subject of compensation for hysteresis (see *The Electrician*, November 3rd, p. 11), which we hope to publish next week.

Telephonic Communication between Denmark and Sweden. The telephonic service between Denmark and Sweden was formally opened at two o'clock on Tuesday last by King Christian and King Oscar, who exchanged congratulatory messages upon the new means of intercourse established between the two countries.

Cheap Telephones.—A telephone for 36kr., or £2 per year, can, says *Industries and Iron*, now be had all over Stockholm, the Stockholm General Telephone Company having decided to meet the great demand for cheap telephones. Hitherto only one district of the town has been supplied at this low rate by the Telephone Company.

Local Authorities and Electric Lighting.—Mr. H. Scholey, of 22, Paternoster-row, has, we are informed, undertaken the organisation of a system of lectures to be delivered in towns where the local authorities are contemplating the adoption of electric lighting. The primary object of these lectures will be to furnish general information of the most recent character.

Cable Interruptions:

	Date of Interruption.
Cayenne-Paramaribo	October 25th.
Cayenne-Vizeu	November 25th.
Jamaica-Colon	November 25th.
Bissao-Bolama	November 24th.
Kotonou-Accra	December 4th.
Lagos-Brass	December 4th.

The Feeder Patent in the United States.—The General Electric Company, says our New York correspondent, have instituted an action against the Westinghouse and Western Electric Companies for infringement of their feeder and main patent. It s understood that the suit was deferred by an arrangement with the Chicago Exhibition authorities until the close of the Exhibition.

Carbons for Arc Lamps.—A recent number of the *Electro Techniker* describes an improvement in arc-light carbons, as used by the firm of Krupp, in Essen, which consists in saturating the carbon, or mixing the carbon paste from which they are made, with tungstic acid, or tungstates; this is said to increase the number of hours during which the carbon will last in the ratio of 18 to 21.

Personal.—Mr. H. J. S. Heather will sail shortly for South Africa, in charge of the electrical plant supplied by Messrs. Goolden and Co. to Moodie's Gold Mines and Exploration Company. The plant will comprise two 1,500 volt continuous-current generators, driven by Pelton wheels. The current will be transformed down after transmission, and distributed to the motors driving the stamps.

Tests of Gas Burners.—The footnote on p. 113 of our last issue on the omission of the cost of mantles and glasses of Welsbach burners, implied no inadvertence on the part of the observers, for it was obvious that their research did not deal with prolonged tests. The statement that the efficiency

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was only 10 c.p. per cubic foot per hour could not, however, be allowed to pass without comment.

The Legal Aspect of Motor "Bucking."—Liability for, damage caused by a "bucking motor" has become a matter of lgal importance in the United States. The Supreme Court of Minnesota holds that "failure to properly test a motor, which was known to have bucked, before sending it out in service, together with use of a low dash on driver's platform combine to make the company liable for damages for death of motorman who was killed by being thrown over the dash when the motor bucked." It is practically the same interpretation of the law which has long prevailed as regards the use of animals in car service known to be ferocious and dangerous.

The Unit of Illumination.—At the meeting of the American Institute of Electrical Engineers on November 15th, Prof. Houston announced the following Committee to take up certain lines of work left unfinished by the Electrical Congress of Chicago, more especially the determination of a practical Unit of Illumination:—Prof. E. L. Nichols (Cornell University), Prof. Ch. R. Cross (Mass. Institute of Technology), Mr. Thomas A. Edison, Dr. Louis Duncan (Johns Hopkins University), Prof. F. B. Crocker (Columbia College), Prof. R. A. Fessenden (Western University of Pennsylvania).

Royal Institution.—The following are some of the lecture arrangements before Easter: Prof. Dewar, six lectures (adapted to a juvenile auditory) "On Air: Gaseous and Liquid"; The Right Hon. Lord Rayleigh, six lectures on "Light," with special reference to the optical discoveries of Newton. The Friday evening meetings will begin on January 19th, when a discourse will be given by Prof. Dewar on "Scientific Uses of Liquid Nitrogen and Air"; succeeding discourses will probably be given, amongst others, by Prof. Silvanus P. Thompson and The Right Hon. Lord Rayleigh.

Proposed Association of Technical Institutions.—At a meeting of the Principals and Directors of technical schools and colleges, held at the Manchester Technical School, last month, it was unanimously agreed "that it is desirable that an association of technical institutions be formed." A second meeting has been convened, and is to be held on January 26th next at 2.30 p.m., at the meeting room of the Society of Arts, Adelphi, W.C., at which it is expected that this association will be formally constituted. Efforts are being made to render this meeting as widely representative as possible.

The Trolley in Chicago.—Last week's mail brought us American papers jubilant with the triumph of the trolley in Chicago, which was, we were told, about to be adopted by every one of the Chicago tramway companies, even by those which had at first raised deadly opposition to the trolley. This week the note is changed, and we listen to the wail of the electrical Press over the "defeat of the trolley in Chicago." It seems that the newspapers have been leading a fight against the overhead wire, with the result that public sentiment against this street excrescence was strongly excited, and the efforts to introduce it failed.

Lighthouse Communication.—In reply to a question in the House of Commons last week, the Postmaster-General said that the number of lighthouses on the coasts of the United Kingdom which had been provided with electrical communication was 22. This number included Lundy Island, Fair Isle, and the Gunfleet Pile Lighthouse. The Royal Commission on Electrical Communication with Lighthouses had recommended that communication be also extended to Caldy Island, the Tuskar, and the Fastnet. With regard to floating lightships, the President of the Board of Trade said that the work of connecting with the shore by electric cable the North Goodwin and the Kentish Knock light vessels was being proceeded with as rapidly as practicable.

Electric-Light Carbon Making.—At a recent meeting of the Academy of Medicine, M. Lancereaux exhibited the lungs of a polisher of electric-light carbon terminals, the said organ being transformed into veritable blocks of carbon. The deceased was, up to the age of thirty-six years, a vigorous stonemason. He was then transferred to a workshop eight metres long by seven broad, where, with eight other men, he was engaged in polishing on stone mills carbons for electric-lighting purposes. The shop was so badly ventilated that sometimes the men could not distinguish each other through the charcoal and stone dust filling the atmosphere. Better ventilation and the use of a respirator would have probably rendered M. Lancereaux's pathological exhibit less interesting.

Inverted Arc Lighting.—Messrs. C. A. Parsons and Co., of Newcastle, have just completed a rather interesting electric-light installation for the L. and T. Waterproof Garment Company, Cornbrook, Manchester. For the most part arc lamps are used for lighting the workrooms. These lamps are suspended from the ceiling and are inverted. The light cannot be seen, as it is within a large reflector which shows the rays of the light upon the white-washed ceiling, which acts as a very large reflector and distributes the light in a soft daylight manner. Messrs. Parsons are at present engaged in supplying and erecting over 60 inverted arc lamps for workshop lighting in various parts of the district. The work at Cornbrook was carried out by Mr. J. Moore, of Bolton, Messrs. Parsons and Co.'s local agent.

French Cable Projects.—A Commission has been instituted by the French Posts and Telegraphs Department to study the question of the International telegraphic communications of France. This Commission, which comprises several Senators and Deputies, Delegates from the Ministries of Foreign Affairs, War, and Marine, and Commerce and Industry, as well as superior functionaries of the Colonial Department and of the Posts and Telegraphs Administration, met on Friday last for the first time. The work of the Commission consists in drawing up the programme of all the telegraphic communications the establishment of which is deemed necessary in the interest of France, the estimation of the cost of the various lines, and the order in which the works should be carried out. After an exchange of views, in the course of which it was declared that it is now more imperiously necessary than ever to organise a system of French submarine telegraph cables, the Commission charged a Sub-Commission to elaborate a comprehensive plan, and to prepare certain projects, the carrying out of which was regarded as particularly urgent.

Coventry.—At the meeting of the Town Council on Tuesday last, the Electric Lighting Committee presented their report, in which it was stated that Mr. A. H. Preece had been called upon to advise the Committee on the selection of a tender for the electric lighting of the town. Mr. Preece had recommended the acceptance of Messrs. Hammond and Fowler's tender, subject to certain small modifications, which had been agreed to. The Committee had received an offer from Mr. Hammond (who is associated with Messrs. Fowler and Co. in this matter) to retire from the contract in order to act as consulting engineer to the Corporation for the execution of the works at a commission of 5 per cent., the contract being placed with Messrs. Fowler and Co. at 5 per cent. less than the figure named in the tender. The Committee recommended that this suggestion be adopted, and that the tender of Messrs. Fowler and Co. be accepted on condition that that firm guaranteed the efficiency of the generating plant to be not less than 75 per cent. at full load, and subject further to the sanction of the Local Government Board for the necessary loan. The tender, including the trenching of the streets, amounts to nearly £10,000. The Committee further recommended that the amount for which borrowing powers be asked from the Local Government Board should be altered to £20,000, instead of the original sum of £15,000. The report was adopted.

The Northern Society of Electrical Engineers.—Within the last few weeks a new Society, with the above name, has been founded, with its head-quarters in Manchester, "to hold meetings for the promotion of electrical science, and its commercial and other applications, and for social intercourse between members." It has for some time past been felt that little or no opportunity has been afforded the members of the electrical profession and trades—now very numerous—in the Midland and northern counties of meeting outside London, for the purpose of scientific discussion and social intercourse. A move-

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ment was recently set on foot by two or three gentlemen in order to bring some local members of the profession together to discuss the matter. The result has been that several meetings have been held, and the new Society founded. It is pointed out that the Society is not founded with any view of rivalry or opposition to the existing Institution of Electrical Engineers, but simply to enable members of the profession, who are unable to attend meetings in London, to do so in the provinces, and at the same time to become better acquainted with each other. A considerable number of gentlemen have already joined the Society, and invitations have been posted to members of the profession within range of Manchester inviting their co-operation. At present it has been decided to hold the meetings in Manchester, but it is expected that at an early date meetings will be arranged for at other important provincial towns. The hon. secretary is Mr. John Darney, 102, Portland-street, Manchester.

Battery Cars in New York.—Official figures have been published of the performance of the Waddell-Entz storage batteries on the Second-avenue line in New York. This road was started on June 1, last, and has been in operation since, between Ninety-fourth and One Hundred and Twenty-ninth streets. Ten cars were run, but lately the number has been increased to eighteen. The battery depreciation has been 1.54 cents a car mile. The total cost of operation is given as 9.32 cents, which it is claimed can be reduced to 5.29 cents, with the eighteen cars now running. The Waddell-Entz batteries are known as the zinc-copper alkaline type. A short description of this cell was given in *The Electrician*, Vol. XXVII., p. 84. The positive plates are of woven copper wire, insulated with cotton. The negative plates are the steel partitions of the iron case, which case serves the double purpose of being one electrode and holding the solution. The copper positive plates are slipped in between the steel partitions in the case, the cotton insulation preventing a short circuit. The solution is zinc dissolved in potash. In charging, the copper is oxidised and zinc deposited on the iron sides and partitions of the cell, this action being reversed, of course, in the discharge. In practice it has been found that the main weak point in the cell and the one which causes the chief expense of battery maintenance, is the cotton insulation on the positive mat. The electromotive force of these cells is less than half that of a lead cell, being from 0·82 to 0·89 volt, as against 1·8 to 2·2 volts. The amperage, is, however, sufficiently large to make up the difference.

The City Lighting.—At the meeting of the Commissioners of Sewers on Tuesday last, Mr. Burmester moved "That the gas standards be removed from the streets now lighted by electricity, and that it be referred to the Streets Committee to carry this out." He said this was the legitimate outcome of the report of the engineer on electric lighting. The total number of hours during which the lamps were burning was 783,343, while the total number of lamp hours failure was only 374. The percentage of failure in lamp hours was thus 0·047, or what was equivalent to one hour's failure in every 1,230 hours. He thought that justice ought to be done to the Company by giving them credit for the way in which they had lighted the streets. The total amount of gas consumed on account of the failure of the electric light during the six months had cost the Commission 1s. 2d., whereas the engineer reported that the Commission were paying for maintenance of the gas lamps at the rate of £1,182 per annum. Mr. Turner said the six months just past was the best part of the year. They were coming to the worst period, and it was absolutely inadvisable to remove the lamps. If the light failed the City would be in a dreadful state. The standards should be allowed to remain to the end of March, and he moved as an amendment that they should not be removed till March 31st. The amendment was negatived and the motion agreed to. The Chairman said that he had sent a letter he had received from one of his constituents on the subject of the delay in connecting up intending consumers to the Electric Light Company, and he had received a reply, which ought to be made public. In this letter the secretary of the Company said that the Company was doing all it possibly could to get the work through, but that with regard to the distribution plant the contractors had not kept faith, and transformer equipment ordered over a year ago was not yet delivered; the contractors alleged all sorts of excuses for this—strikes, non-delivery of proper raw material, and so on. The Company had now, however, made such arrangements as would overcome the transformer difficulty. It was only comparatively recently that they obtained sites for the 22 transformer stations. As far as the secretary could see, all (except the outlying areas like the St. James's-square, Redcross-street, and Fetter-lane ones) would be completed at different dates within, say, two months. Some little delay also arose in joining the cables as good jointers were scarce; and it would not be safe to employ other than fully-skilled workmen. It must not be forgotten that the Company was already supplying over 60,000 lamps, and had completed services ready to join up nearly 15,000 more.

Electrical Canal Boat Propulsion on the Erie Canal.—The first practical test of electricity for the propulsion of boats on the canals is, says the *Electrical Engineer* of New York, now history. By an act of the last Legislature, the sum of $10,000, or as much of that sum as should be necessary, was appropriated to carry into effect Governor Flower's recommendations regarding the investigation of electricity as a motive power on the canals. Parties interested were invited to make experiments, under the supervision of the superintendent of public works. A number signified their intention to participate, but only one plan, that jointly of the Westinghouse Company of Pittsburgh and the Niagara Power Company of Niagara Falls, materialised, and the Westinghouse method was tested on Saturday, Nov. 18th. On Monday, November 13th, a party of *employés* of the Rochester Electric Railway Company began stringing a trolley wire in position, for a distance of about one mile, east of the village of Brighton. All was ready for work in five days, and the current from the power house of the Rochester Electric Railway was turned on. In the meantime, a full-sized steam canal boat had been fitted and put in order for the test of the weighlock at Rochester, and was towed to Brighton, ready for the experiment. It moved off readily on the first trial, and made the private run without incident. The overhead construction consists of two parallel lines of No. 0 copper trolley wire, strung 5ft. apart, about one-third of the distance across the canal from the bank or heel path. The positive wire was connected with the feeder wire on the Rochester Electric Railway, and the negative with the rail of the Park avenue street railway track, on which there is no supplementary ground wire. In fact, the overhead construction was essentially the same as that for a double track street railway, where double trolley lines are used. In this experiment dependence was placed on the railway track for the return, and but one trolley was used. For the official test the next day ordinary street railway trolleys were used, but of course this form is not an ultimate type, and it will be superseded in practical work by an especially designed overrunning trolley, so constructed as to permit the boat to move in any part of the canal, while the trolley will follow the wire constantly. The boat used was an ordinary steam canal boat, with a propeller of the antiquated dish-pan type, not one-third of the surface of which, apparently, is active in propelling the boat. In preparing for the test, the engineers removed the boiler and engine and replaced them with two 25-H.P. Westinghouse street railway motors, of standard type. The motors were connected directly to the propeller shaft. The connection was made by simply taking out the bolts of the coupling which held the engine shaft, and making the coupling to the motor shaft instead of to the engine shaft. For the official test the Rochester Electric Railway undertook to supply 500 volts, and the apparatus was designed to do its work under these conditions. The actual voltage during the official test was from 300 to 250, with a current of 60 amperes, making about 20 E.H.P. During the official test the shaft made about 60 revolutions per minute, and the speed of the boat approximated four miles an hour against the current and the wind. The extremely difficult curves, the lock and the bridges, furnished typical conditions in canal work, and were taken without difficulty, and the test, in all respects, was very satisfactory to the canal officials and the electricians.

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MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 112.)

Effort and Resistance.—In every engine there are two sets of forces which determine the motion and the work done. These are: the effort, or driving forces; and the resistance, or opposing forces. In the foregoing considerations about the interchange of energy between bodies it has been assumed that the acting force is exerted directly along the line of motion, and that the resisting force has been exerted directly backwards along the line of motion. In engines the driving and resisting forces are often inclined to the direction of motion. In such cases we take the sum of the components of the acting forces measured along the line of motion, and call this total component the *effort*; and we take the sum of the components of all the resisting forces at the same place, measured along the same line, and call this total component the *resistance*. The total effort requires that every acting force shall be taken into calculation; and the total resistance requires that every opposing reaction or force shall be considered also. When we have followed this process strictly we shall always find that the total effort at any point in the engine is exactly and always equal to the total resistance at this same point. This is the application of Newton's third law to engines. What we have previously said about the relation between acting or opposing forces and energy, work and power is now to be taken as strictly applying to engines where the effort and the resistance assume the place of the acting and opposing forces. The energy exerted is equal to the product of the effort into the distance through which it acts, and the energy absorbed is equal to the product of the resistance into the distance through which it is overcome, while the power is determined by the product of either effort or resistance into the velocity of the moving point on which they are acting. In every engine, however, there are numerous opposing forces which contribute to the total resistance, and these may all be classed under two heads—useful resistances and wasteful resistances. In other words, a fraction of the total resistance is useful and the remainder is prejudicial.

Useful and Prejudicial Resistances.—The useful part of the resistance arises from the reaction of the mechanism upon which useful work is being done, as from the magnetic torque of the dynamo armature which opposes the motion which produces the current. Or, the useful part of the resistance may wholly or partly arise from another cause, namely, from the inertia reaction of the flywheel in which energy is being usefully *stored* for future use. The useful resistance may therefore be divided into: (1) The reaction of the directly useful work, and (2) the inertia reaction of the storage of energy. Prejudicial resistances arise from the unavoidable or improperly removed forces between the relatively moving parts of the engine or gearing, as from the friction of sliding or rolling parts, or the imperfect elasticity of parts which are in vibration or in collision with one another.

It is impossible to completely remove either of these two sources of prejudicial resistance; for no two surfaces are there, but their relative sliding or rolling will develop friction; and there are no materials which will withstand vibration and shock, or collision, without internal forces which will cause a prejudicial resistance. The resistance of friction between two solid surfaces in sliding motion is equal to the product of their total normal pressure against one another into the coefficient of friction of their surfaces. This coefficient is not independent of the intensity of pressure between the surfaces, especially if there is a layer of oil interposed between the surfaces, and is found to increase with an increase of pressure in most cases. Neither is it strictly independent of the velocity of relative motion, being greatest when the surfaces are relatively at rest—when it is called *statical* friction—and diminishing at very high speeds; but for the usual range of relative velocities in machinery it may be assumed that the coefficient of friction is, with solid surfaces, practically independent of velocity. Rolling friction is chiefly due to the slip of the surfaces which are rolling on one another, and is directly proportional to the percentage of slipping which occurs. The friction between surfaces which are not solid, as in water or wind engines, will be considered in the sections devoted to these engines, as it follows quite different laws.

Inertia and Moment of Inertia.—Inertia resistance arises in machinery when any portion of the moving parts is accelerated; and since the acceleration of a body may either tend to increase or to decrease the velocity of the body, this resistance may be either positive or negative. When it is negative it is virtually a portion of the total effort, and may be treated as such. The force which is required, in order to accelerate any body which is not acted on by any external opposing force, is equal to the product of the mass of the body into the linear acceleration which is to be produced. This force is numerically equal to the resistance of the body to change of motion, and it is usual to call this resistance the *inertia reaction*. There are two principal cases of inertia reaction which arise in machinery: the one occurs in simple harmonic motion, and the other occurs in any change of speed of circular motion. We will deal with these separately.

Simple harmonic motion (S.H.M.) is very commonly called reciprocating motion, and practically occurs in the piston of a steam engine. Let a point, P (Fig. 1), travel round a circle

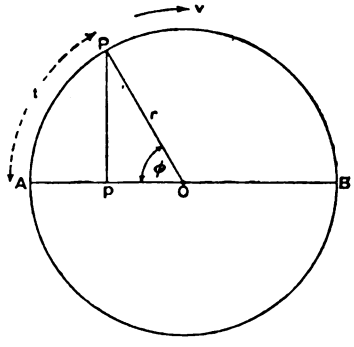

Fig. 1.

of radius, r, with a uniform velocity, v, or speed, N, revolutions per minute; and let another point, p, travel to and fro on the horizontal diameter A B in such a manner that it is always in a vertical line with the point P. Then the reciprocating motion which p will describe in A B is called a simple harmonic motion. Let V be the velocity of the reciprocating point at any time when the radius to the point, P, makes the angle, ϕ, with the horizontal radius, O A. Then

$$V = v . \sin \phi, \quad \ldots \ldots \quad (6)$$

and

$$\phi = \frac{2 \pi t}{T}, \quad \ldots \ldots \quad (7)$$

where t is the time taken to move through the angle ϕ, and T is the periodic time or time of one complete revolution of P.

Whence,

$$V = v . \sin \frac{2 \pi t}{T}, \quad \ldots \ldots \quad (8)$$

and the acceleration of p, which has this velocity, is

$$a = \frac{dV}{dt} = \frac{2 \pi}{T} . v . \cos \frac{2 \pi t}{T} . \quad \ldots \ldots \quad (9)$$

The acceleration multiplied by the mass accelerated gives the force exerted in causing the acceleration, and is equal to the inertia resistance of the mass f_i;

$$f_i = M a = \frac{W a}{g} = \frac{2 \pi W v . \cos \frac{2 \pi t}{T}}{g T} . \quad (10)$$

This gives the inertia resistance in pounds when all the other quantities are also in gravitation engineering units. The maximum value of this force is

$$f_i \,(\max) = \frac{2 \pi W v}{g T}, \quad \ldots \ldots \quad (11)$$

and occurs when the angle ϕ is zero or 180deg., *i.e.*, at the beginning and end of the to-and-fro motion. In the first case

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Table I.—*Moments of Inertia* (I) *of Homogeneous Rigid Bodies.*

Name of figure.	Dimensions in feet.	Axis of rotation.	Values of I. In terms of W = weight in pounds.	Values of I. In terms of Δ = density in pounds per cubic foot.
Solid circular cylinder ...	Length = L. Diameter = D.	Through centre of D, parallel to L.	$\frac{W}{g}\left(\frac{D^2}{8}\right)$	$\frac{\Delta}{g}\left(\frac{\pi D^4 L}{32}\right)$
Ditto..............................	Ditto.	Through centre of L, parallel to D.	$\frac{W}{g}\left(\frac{D^2}{16}+\frac{L^2}{12}\right)$	$\frac{\pi\Delta}{g}\left(\frac{D^4 L}{64}+\frac{D^2 L^3}{48}\right)$
Ditto..............................	Ditto.	Through end of L, parallel to D.	$\frac{W}{g}\left(\frac{D^2}{16}+\frac{L^2}{3}\right)$	$\frac{\pi\Delta}{g}\left(\frac{D^4 L}{64}+\frac{D^2 L^3}{12}\right)$
Hollow circular cylinder..	Length = L. Outer diameter = D. Inner diameter = d.	Through centre of D, parallel to L.	$\frac{W}{g}\left(\frac{D^2+d^2}{8}\right)$	$\frac{\Delta}{g}\left(\frac{\pi L (D^4-d^4)}{32}\right)$
Ditto..............................	Ditto.	Through centre of L, parallel to D.	$\frac{W}{g}\left(\frac{D^2+d^2}{16}+\frac{L^2}{12}\right)$	$\frac{\pi\Delta}{g}\left(\frac{(D^4-d^4)L}{64}+\frac{(D^2-d^2)L^3}{48}\right)$
Ditto..............................	Ditto.	Through end of L, parallel to D.	$\frac{W}{g}\left(\frac{D^2+d^2}{16}+\frac{L^2}{3}\right)$	$\frac{\pi\Delta}{g}\left(\frac{(D^4-d^4)L}{64}+\frac{(D^2-d^2)L^3}{12}\right)$

it is a positive maximum, in the second case it is a negative maximum. In intermediate positions, let the distance of the reciprocating point p from the centre, O, of its amplitude, stroke or travel, A B, be D feet; and let the total stroke, A B, be L feet. Then

$$D=\frac{L}{2}\cdot\cos\frac{2\pi t}{T}. \quad . \quad . \quad . \quad . \quad . \quad (12)$$

The ratio of a to D at any point is

$$\frac{a}{D}=\frac{4\pi v}{LT}=\text{a constant.} \quad . \quad . \quad . \quad (13)$$

It is a simple property of S.H.M. that the acceleration is directly proportional to the displacement from the middle part of the stroke. From (13) we get

$$a=\frac{4\pi v D}{LT}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (14)$$

and, by (10),

$$f_i=\frac{4\pi v D W}{LTg}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

This force may conveniently be expressed in terms of N, the revolutions per minute of the point P by eliminating v and T,

$$f_i\,(\text{max})=\frac{2WL}{g}\cdot\left(\frac{\pi N}{60}\right)^2. \quad . \quad . \quad . \quad (16)$$

It is notable that, other things being equal, this inertia resistance varies as the square of the speed of reciprocation or revolution.

Turning next to the inertia of a rotating body, let us consider a particle of mass, m, at the end of a rigid radius, r. If this is at rest it will require a force to give it N revolutions a minute, or a velocity of v feet per second in any given time, t. This force, f, will be equal to

$$f=\frac{m v}{t}=\frac{2\pi r N m}{60\,t}. \quad . \quad . \quad . \quad . \quad . \quad (17)$$

Multiply both sides of this equation by r, and we have

$$\tau=f r=\frac{2\pi N}{60\,t}\cdot(m r^2). \quad . \quad . \quad . \quad . \quad (18)$$

This gives the torque required to produce any given acceleration in the revolving mass, the acceleration being angular. The expression within the brackets is called the *moment of inertia* of the mass about the centre of rotation, and stands in respect to torque and angular acceleration in the same relation that mass stands to force and linear acceleration. Or,

$$\text{Linear acceleration}=\frac{\text{Force}}{\text{Mass}},$$

$$\text{Angular acceleration}=\frac{\text{Torque}}{\text{Moment of inertia}}.$$

Where, as is always the case, the mass is not concentrated at the same radius, we have to take the resultant inertia resistance of all the mass particles, or

$$\Sigma\, m r^2=\text{Moment of Inertia}=\text{I}.$$

Since the angular velocity, ω, acquired in any time, t, after starting from rest, is equal to the product of the acceleration by the time the number of revolutions per minute produced by an average torque τ upon a moment of inertia, I, which is free to move, will be

$$N=\frac{60\,\tau\,t}{2\pi I}. \quad . \quad . \quad . \quad . \quad . \quad (19)$$

Or this speed will be added to or subtracted from any initial speed, according as the torque is assisting or opposing motion. Assuming the rotating body to start from rest, it will perform a certain number of complete revolutions, R, in getting up the speed N, equal to

$$R=\tfrac{1}{2}N\,t. \quad . \quad . \quad . \quad . \quad . \quad (20)$$

Stored Energy.—Therefore the work done by the force, f, which, acting at the radius, r, turns the resisting mass, is equal to

$$W=f\times 2\pi r\times(\tfrac{1}{2}N\,t)=\pi N\tau t. \quad . \quad . \quad (21)$$

And, from (19) we get the value of τ, which inserted in (21) gives

$$W=\tfrac{1}{2}I\left(\frac{2\pi N}{60}\right)^2=\tfrac{1}{2}I\,\omega^2. \quad . \quad . \quad . \quad . \quad (22)$$

Here the work is represented as a condition depending only upon the motion of the body, or is, as we say, kinetic energy stored in the rotating mass. Hence

$$\text{Energy of rotation stored in mass}=\tfrac{1}{2}I\left(\frac{2\pi N}{60}\right)^2.$$

The power being expended at any instant in storing this energy can be obtained from the torque and angular velocity at that instant. For since power P is the product of force into velocity, we have

$$P=f\times v=\tau\left(\frac{v}{r}\right)=\tau\left(\frac{\pi N'}{30}\right), \quad . \quad . \quad (23)$$

where N′ is any speed during the acceleration. Expressed in horse-power this is

$$\text{H.P. (stored)}=\frac{2\pi N'\tau}{33{,}000}, \quad . \quad . \quad . \quad (24)$$

where τ if the torsional resistance of inertia; so that, expressing τ in terms of I, we get

$$\text{H.P. (stored)}=\left(\frac{2\pi}{60}\right)^2\frac{I N'}{550}\cdot\frac{dN'}{dt}. \quad . \quad . \quad (25)$$

The foregoing considerations of the opposing force, absorption of power, and storage of energy due to a rotating mass, is applicable to flywheels, in whole or in part, by means of Table I., which gives the moments of inertia for the most common shapes of portions of, or of complete, flywheels.

(To be continued.)

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COMMUTATION IN MOTORS AND DYNAMOS.

BY J. A. KINGDON.

A motor is usually regarded as merely a reversible dynamo, having the current in the armature reversed, and the brushes displaced from the neutral position in a backward direction, instead of, as in the case of a dynamo, in a forward direction, so as to obtain sparkless commutation. There is, however, a real difference, which appears to have been overlooked, between a motor and a dynamo. This difference is in the process of commutation of the current in the armature conductors, and in the effect of the reversal of current in the coils under the brushes, upon the magnetic field. In order to understand this difference it will be supposed that the brushes are in the neutral position, without lead or trail, midway between the poles, and that the commutator bars are comparatively few in number, so as to make the effects of the reversals more marked. It will also be supposed that the reversal of the current takes place instantaneously in the coils under the brushes, and that between two consecutive reversals there is a short period during which the current in the armature conductors is unaltered in direction or strength, although the armature is rotating during that period. Small circles containing dots represent in section conductors carrying positive currents, and the circles containing crosses represent conductors with negative currents. The relations between these and magnetic flux are shown in Fig. 1, which represents a bar magnet, and the relative positions of the positive and negative currents of its exciting coil and the direction of the magnetic flux.*

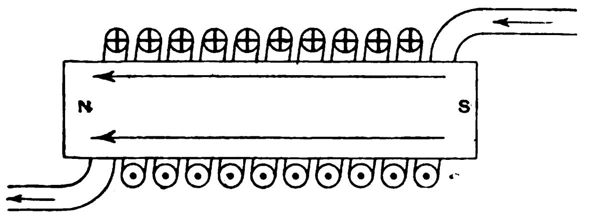

Fig. 1.

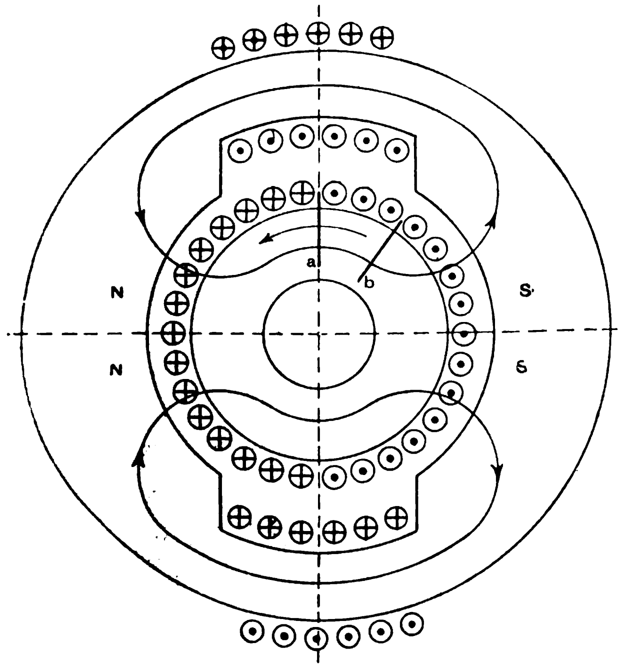

Fig. 2.—Motor.

Fig. 2 is a diagram of the magnetic circuits and the current directions of a motor whose armature is rotating in the direction of the arrow. The lines *a* and *b* represent connectors from commutator bars to the armature conductors. The current is supposed to be flowing from a commutator bar up the connector *a*, and then to divide and pass in both directions round the armature, in the positive direction in the conductors behind *a*, and in the negative direction in the conductors in front of *a*. The exciting coils are indicated by sectional conductors, and the magnetic circuits by lines threading the coils and traversing the iron armature core. The magnetomotive forces acting on these circuits is, as is well known, the aggregate of the magnetomotive forces of the field coils and of the armature coils. In the majority of dynamos and motors, the magnetomotive force due to the armature currents reduces the aggregate magnetomotive force acting on the circuit. Figs. 3 and 4 are similar diagrams for different positions of the armature of the motor. Figs. 5, 6, and 7 are corresponding diagrams for a dynamo. The lower parts of the figures, which are cut away, are similar to the lower part of Fig. 2.

* The dots in circles may be considered to represent the points of arrows shooting upwards; and the crosses, the tails of arrows shooting downwards.

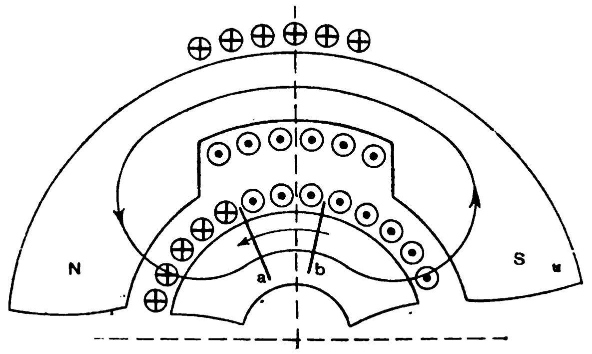

Fig. 3.—Motor.

In Fig. 2 it will be seen that the number of positive armature conductors within the magnetic loop is the same as the number of negative armature conductors, so that their aggregate magnetomotive force acting round the circuit is *nil*. The magnetomotive forces acting on the circuits in Fig. 2 are those due to the exciting coils alone. In Fig. 3 there are seven positive armature conductors within the loop, but only three negative armature conductors. Hence the magnetomotive force acting round the circuit in Fig. 3 has been increased by that due to the excess of the positive over the negative conductors. In Fig. 6 there are seven negative conductors and three positive conductors. Hence there is a reduction of magnetomotive force acting round the circuit in Fig. 6.

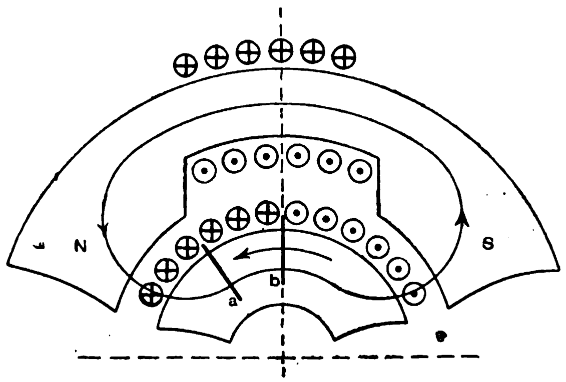

Fig. 4.—Motor.

In Fig. 3 the armature of the motor is supposed to have rotated through an angle, so as to bring the connector *b* nearly vertical, but no reversal has taken place of the current in the conductors between *a* and *b*, and the current in these conductors is still positive, as in Fig. 2. It will be seen that the aggregate magnetomotive force acting round the circuit is that due to four armature conductors, in addition to the magnetomotive force of the six conductors of the exciting coil. The rotation of the armature of the motor has consequently increased the magnetomotive force acting round the circuit, and there is a corresponding increase in the magnetic flux.

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In Fig. 4 the armature of the motor has rotated so as to bring the connector *b* vertical, and the reversal of the current in the conductors between *a* and *b* is supposed to have taken place. In fact, the current has been commutated, and flows up the connector *b* instead of up the connector *a*, as in Figs. 2 and 3. The result of the commutation is that the conductors between *a* and *b* have negative instead of positive currents, and the aggregate magnetomotive force acting round the circuit has now the same value that it originally had in Fig. 2. The effect of the commutation has therefore been to reduce the aggregate magnetomotive force. It is thus clear that in the case of a motor, supposing that there is first a period of rotation of the armature without commutation, and then an

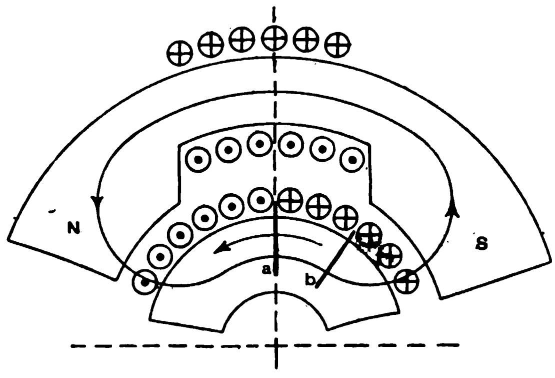

FIG. 5.—Dynamo.

instantaneous reversal or commutation of the current in the conductors under the brush, the effect of the rotation of the armature is to tend to strengthen the magnetic flux, and the effect of commutation is to tend to reduce the magnetic flux.

If the process of commutation in the case of a dynamo is analysed in a similar manner a difference will at once be evident. In Figs. 5, 6, and 7, which are diagrams for a dynamo, the direction of rotation of the armature, and the directions of the exciting current and magnetic flux, are the same as in Figs. 2, 3, and 4, but the direction of the armature current is reversed.

In Fig. 5 the current generated by the dynamo flows from the armature conductors down the connector *a* to the commutator and brush. The aggregate magnetomotive force is that due to the field coils alone, as the number of positive

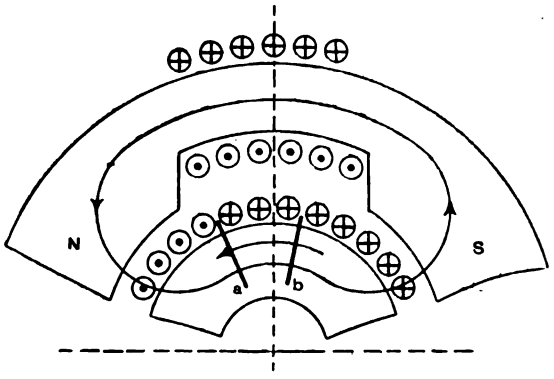

FIG. 6.—Dynamo.

armature conductors within the magnetic loop is equal to the number of negative conductors. In Fig. 6 the armature of the dynamo is supposed to have rotated so as to bring the connector *b* nearly vertical, but no commutation has taken place, and the current in the conductors between *a* and *b* is still negative. The result is that there are more negative conductors within the loop in Fig. 6 than there were in Fig. 5. The additional negative armature conductors in Fig. 6. tend to counteract the positive conductors of the field coils. Hence, in the case of a dynamo, the rotation of the armature tends to reduce the magnetic flux.

In Fig. 7 commutation is supposed to have taken place, and the current flows down the connector *b*. It will be evident that the aggregate magnetomotive force has been increased, and has now the same value that it originally had in Fig. 5.

Thus, in a dynamo, the effect of the armature rotation is to reduce the magnetomotive force acting round the circuit, and to tend to weaken the magnetic field, and the effect of commutation is to increase the magnetomotive force and to tend to strengthen the field.

It is, perhaps, unnecessary to point out that in a well-designed dynamo, with its brushes properly adjusted, the two processes go on simultaneously, so that there is practically no variation of the magnetic flux, and the commutation consequently takes place without sparking.

The conclusions arrived at may be summed up as follows :—

(1) In a *motor* the armature rotation tends to increase the aggregate magnetomotive force of the field and armature coils, and to strengthen the magnetic field.

(2) In a *dynamo* the armature rotation tends to reduce the aggregate magnetomotive force and to weaken the field.

(3) In a *motor* the effect of commutation is to tend to reduce the aggregate magnetomotive force and to weaken the field.

(4) In a *dynamo* the effect of commutation is to tend to increase the aggregate magnetomotive force and strengthen the field.

Now it is well known that iron is very sensitive to slight increases of a magnetomotive force acting on it; and, on the other hand, that it is comparatively insensible to considerable reductions of magnetomotive force. Some tests made by Prof. Ewing* on a length of annealed iron wire showed that

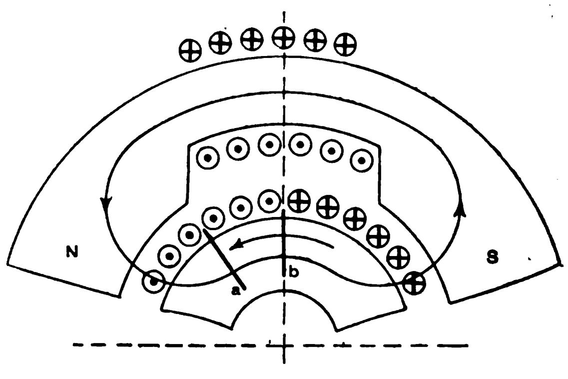

FIG. 7.—Dynamo.

when the induction in the iron was 6,800, a decrease of 30 per cent. in the magnetomotive force caused a decrease in the induction of less than 2 per cent., while an increase of 30 per cent. in the magnetomotive force produced an increase in the induction of over 60 per cent. The average magnetomotive force of one armature coil of a dynamo may be taken to be about 2 per cent. of the magnetomotive force of the field coils, and there is, consequently, a variation of the aggregate magnetomotive force of 2 per cent. when the current in the coil is suddenly reversed.

In the case of a motor it has been shown that commutation tends to reduce the magnetic flux, but owing to the hysteresis of the iron the reduction of flux is inconsiderable, and there is little sparking even if the brushes have no trail. This fact enables motors to be run in either direction without movement of the brushes, which are fixed in the neutral position.

In the case of a dynamo, on the other hand, supposing the brushes to have no lead, the effect of commutation is to increase the aggregate magnetomotive force of the field and armature coils. An increase in the aggregate magnetomotive force will produce a comparable increase in the magnetic flux. Variation in the flux produces sparking. Hence, in the case of dynamos, special arrangements are necessary for the commutation of the current, *e.g.*, the brushes have a lead so as to bring the commutated coils within the magnetic fringe of the leading horns of the magnets, or special reversing connections are provided, as in the Sayers dynamo, to effect the commutation.

* *Phil. Trans.*, Vol. 176, p. 523.

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ARC LAMP DESIGN.*

BY WM. A. TURBAYNE.

Although the arc lamp is to-day one of the most important pieces of electrical mechanism, yet it undoubtedly receives less attention from an engineering standpoint than any other like device of equal commercial value; this can hardly be accounted for, as the arc lamp field is certainly a very interesting one.

Although numerous experimenters have devoted their attention to the physical properties of the arc, such, for instance, as its counter-E.M.F. and temperature, but few have dealt with the more practical side of the problem, viz., the best method of feeding the carbons, and general design, including guiding statistics of faults to be eliminated, and such other things as would be a help to the electrical engineering profession.

Probably this partially accounts for the small number of arc lamp manufacturers as compared with manufacturers of motors, dynamos, &c., as, in the latter case well-seasoned rules and formulæ are laid down as a foundation; whereas, in the former case one has but to notice faults, if any, in present forms of apparatus, and experiment until improved modifications are a result. It is thus evident that any such improvements are almost universally due to the labours of each individual manufacturer.

As before stated, in dynamo and motor design, we have infallible rules and mathematical formulæ to assist, so that we know beforehand what to expect from the finished machine; but not so in arc lamp design, as each individual make of lamp requires a special controlling arrangement. There are no special rules to follow as regards the resistance or number of ampere turns required for this regulating magnet; these must be suited and proportioned to the other features of the mechanism; neither are there any definite ratios of series to shunt coils as regards their respective resistances or strengths.

It also depends upon conditions whether solenoids or electromagnets with stationary iron cores be used to the best advantage; the former are generally preferable on account of their wider range of steady movement, although in using the latter good results in this direction may be obtained by using properly shaped pole-faces and armatures. A greater strength of field would result for an equal expenditure of energy, although this would seem to be a matter of little importance in an arc lamp, as but a small fraction of the total current is utilised for regulation, and by the use of a leverage this may be still further reduced as the distance from fulcrum to magnet increases.

In the matter of efficiency or preference of design between a differential and non-differential feed, the latter is undoubtedly the better on account of its ability to operate steadily, irrespective of the current strength, the main current having nothing whatever to do with the regulation, and in this respect doing away with short hissing arcs, or "pumping," due to weak or strong currents.

For constant-current working, however, the form of lamp should contain a device to allow carbons to come together after burning, or to place a low-resistance shunt around the same, for, were the carbons all raised and nothing but the high-resistance shunts in circuit, the dynamo would fail to produce current, being a series-wound machine. For constant potential working this is of lesser importance, as the initial E.M.F. is greater than that ordinarily required by the shunts during operation; although a cut-out should be provided to open the shunt circuit and prevent overheating should the carbons be consumed or fail to feed.

No distinction is made in this article between rack or clutch-feed lamps, or lamps wherein the carbons are fed by the unwinding of a metallic band or chain, as these are all but subdivisions of one general principle, and the electrical features of all are identical and subject to the same rules. They all, undoubtedly, have their points of excellence, but any of the above-mentioned forms may be constructed so as to burn very steadily indeed.

A lamp should be designed so as to burn with a practically uniform length of arc, from time of lighting until extinguishing, and afford as constant a light as possible during operation. The writer has noticed arc lamps which, when started, would burn with a short arc, but if left for a length of time would be found to have a long flaming arc; on investigation the shunt coils were found to be exceedingly hot, and according to the well-known law, the resistance increased with the heating, which in turn diminished their attractive power, by lessening the current, and allowed the difference of potential at the carbon points to equal that at the shunt-coil terminals. This, of course, results in a very unsatisfactory light, and should be religiously guarded against.

Another instance of similar nature was that of an arc lamp originally trimmed with heavy carbons and adjusted at the time to burn an arc of normal length, but when the carbons were greatly reduced the arc was of considerable length.

These defects in design are more noticeable in series arc working where the machine allows for increase of voltage, but in constant potential working, as on incandescent or railway circuits, they are of lesser moment, if the lamps are of the differential type, as the weakening of the current, due to the increasing lengths of arc, would reinforce the shunt coils partially by decreasing the action of the series magnets, thus compensating in a measure for the faults mentioned.

In a properly-designed arc lamp, however, faults like the above should not appear, as the resistance of the shunt coils should be high enough to prevent undue heating, and the mode of suspension of the carbons and the internal arrangements should be such as would be affected but little by the gradual decrease in weight due to the consumption of the carbon. For this same reason a lamp should be adjusted for length of arc when about to feed, as then the whole weight of carbon and rod is about to be released from its support.

To sum up, the best foundation design for an arc lamp for direct-current working would undoubtedly be that of the non-differential variety, with proper cut-out and mechanical details, and in which faults, as before mentioned, would be totally left behind.

For alternating-current working the conditions are different. In this case the arc should be formed as slowly as is practical between carbons of equal length or their equivalent, all magnet cores should be carefully laminated, and any closed secondaries which would be likely to be used, as, for instance, metal magnet spools, should be broken up to prevent heating and other efficiency-reducing losses.

In conclusion, it is to be hoped that more work of investigation may be done in this line by persons having time and means at their disposal, and their labours recorded, in order that all interested in this important branch shall be benefited.

* From the *Electrical Engineer*, of New York.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, December 8th.

PHYSICAL SOCIETY.

5 p.m. Ordinary Meeting. The following Papers will be read: (1) "A Potentiometer for Alternating Currents," by J. Swinburne. (2) "The Specific Resistance of Sea Water," by W. H. Preece, F.R.S. (3) "The Calculation of the Coefficient of Self-induction of a Circular Current of a given Cross Section and Aperture." (4) "The Magnetic Field of a Cylindrical Coil," by Prof. G. M. Minchin, M.A.

TUESDAY, December 12th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. "Cask-making Machinery," by Mr. Lewis H. Ransome.

WEDNESDAY, December 13th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. "Carriage-way Pavements for Large Cities," by Lewis H. Isaacs.

THURSDAY, December 14th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Annual General Meeting. Reception of the Annual Report of the Council, and the election of Council and Officers for year 1894. Continuation of discussion on "The Electrical Transmission of Power from the Niagara Falls," by Prof. Geo. Forbes, F.R.S.

FRIDAY, December 15th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting. "The Brightness of Light: its Nature and Measurement," by Messrs. T. M. Barr and C. E. S. Phillips.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

Alternate-Current Electrolysis.—The conclusions to which Dr. J. Hopkinson and Messrs. Wilson and Lydall are led, by their researches into alternate-current electrolysis, are summed up in their recent Paper before the Royal Society in the following terms:—"A general conclusion of the experiments is that about one-tenth of a coulomb suffices to fully polarise 150 sq. cm. of platinum. This will liberate 0·00001 of a gramme of hydrogen; hence 0·000,000,07 gramme of hydrogen serves to polarise 1 sq. cm. of platinum. 0·000,000,07 cm. is probably a magnitude comparable with the distance between molecules of hydrogen when this body is compressed to a density comparable with the density of liquids."

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SCIENTIFIC SOCIETY EVOLUTION.

All establishments, it has been said, die of dignity, being too proud to think themselves ill and to take a little physic like ordinary mortals. In these days it is rather to be feared that our institutions will kill themselves with physic. The spirit of compromise, that is to say, the spirit which seeks to patch up, paint over, and make nice is, apparently, infectious. The *doyen* of our scientific societies having been solemnly warned in the columns of *The Times* that unless it moves with the age, and that smartly, we shall see what we shall see, immediately proceeds to indulge in a little introspective investigation, the outcome of which is a determination to make its meetings "not only interesting, but, if possible, amusing," and to provide to that end better lantern apparatus. We cannot help thinking that competition in this matter with its near neighbour (the Royal Institution) is to be deprecated. If the anonymous correspondent of *The Times* must be mollified by a little painting up and patching over it is, on his own showing, evidently not this particular kind which will attain that much-to-be-desired end. But, in truth, is it necessary that any Papers at all should be read before the Royal Society, or that it should condescend to compete for them? If the functions of the Royal Society were confined to making a graceful and world-valued recognition of the work of labourers in the field of science, to aiding by the funds at its disposal the work of deserving experimenters, and to publishing in the best possible manner, and at a reasonable price, valuable scientific researches which would otherwise never see the light of day, or would remain scattered amongst the volumes of half-a-dozen different societies; if the Royal Society, we say, were to do this, and nothing more, it would deserve well of the commonwealth of science, and its

prestige, so dear to all Englishmen, would suffer no abatement. The President, Council, and Fellows are, however, no doubt, alive to the necessities of the situation, and our fear is not that they will allow the Royal Society to die of dignity, but that in their desire to be all things to all men, they will discover disease where none exists, and try to amuse where they had better not try.

But the cry for innovation is not confined to the Royal Society nor to England, and in the case of the lesser lights of the scientific firmament the alterations called for are as often as not very easily effected, and meet a decided want. Thus, in his last letter, our New York correspondent was able to announce that the American Institute of Electrical Engineers had finally adopted a long-contemplated scheme providing for local meetings. Upon the application of twenty members residing in any locality the Council may authorise the holding of local meetings, at which Papers accepted by the Institute, and only such Papers, may be read and discussed simultaneously with, or subsequent to, a meeting for the same purpose in New York, no publication of Papers or discussions being, as a rule, permitted, except in the *Transactions* of the Institute. This scheme is the logical outcome of living in a country as big as a continent. With us eight or ten hours in the train suffice to bring a member eager to participate in dinner or discussion from the uttermost parts of our diminutive land. But in America, where no city dare lay claim to an independent existence unless it be at least a thousand miles from everywhere, and where trains hasten slowly, an Institute located in the extreme east is beyond the reach of electrical engineers residing in the west, south or centre. Even in England, members living in London get more value for their annual subscription to the Institution of Electrical Engineers than those whose duties keep them further afield; in the States the magnificent distances render a system of local meetings like that described by our New York correspondent absolutely essential, unless the American Institute of Electrical Engineers is to be such only in name.

In England, therefore, the need for planting local shoots from our engineering and kindred institutions is not, from the point of view of mere distance, particularly pressing. The idea, nevertheless, possesses one signal advantage which would render its adoption at home advisable. It would tend to check the multiplication of local societies, with their appalling multiplicity of *Proceedings* and *Transactions*. Any scheme which promises to keep down the flood of printed matter, and to concentrate its flow into a single channel, deserves consideration. The idea of local meetings is not, of course, new, nor confined to America. The Society of Chemical Industry has its Liverpool, Manchester, Newcastle, and Nottingham sections, which hold their own meetings with as much ceremony and effect as the London section in Burlington House. The Institution of Mechanical Engineers also meet regularly in the provinces. The majority of our societies, scientific, engineering, and other, are, however, content to cover all England in title only, and to remain, in fact, almost purely metropolitan bodies. This narrowing of their spheres of influence is probably largely responsible for the unnecessary calling into existence of many a local society, with its office bearers, secretary, and obscure journal. Only within the last few weeks, for instance, a Northern Society of Electrical Engineers has blossomed forth, its *raison d'être* being to afford electrical engineers resident in and about Manchester opportunities for discussing matters of professional interest. Much can without doubt be said in favour of local societies, and it is only their undue multiplication that we deprecate. Indeed the number, variety, and individualism of local societies in this country inclines one to the belief that there must have been at work some scientific analogue of the Abbé Sieyès, who, we are told, had whole nests of pigeon-holes full of constitutions, ready made, ticketed, sorted, and numbered; some with councils of elders and councils of youngsters, some without any councils at all; so that no one should go unsuited from his shop. We do not, of course, suggest the local-meeting idea as a panacea for all the ills the constitution of a scientific or engineering body is heir to; but a well-considered scheme of local meetings would, we think, if vigorously pushed, widen the scope and freshen the life of many a society; and, above all, would have a marked tendency to convert a single publication into a recognised receptacle, not for rubbish, but for the best work relating to that particular branch of learning or engineering with which the society is connected.

OBITUARY.

PROFESSOR TYNDALL.

It is a sad moment when one is called upon to take up one's pen to write an obituary notice of a master at whose feet one has sat, and from whose work and words one has received instruction, counsel, and inspiration in one's life work. John Tyndall was one of those men to whom it was given, not so much to be himself pioneer as to diffuse into others the spirit of pioneering, not so much to investigate as to make known the investigations of others in a spirit of sympathetic enthusiasm that warmed and infected his hearers. Possessed of a fluent and impressive delivery, rising at times into real oratorical power, his lectures attained a charm of style unique and inimitable. Ease and skill in experimentation before an audience—an art only to be acquired as the result of skill practised in the laboratory—he probably learned more from Faraday than from any other, except, perhaps, Bunsen. Even in his less-convincing discourse, when he left the exposition of science for the speculations of the philosopher, his peculiar gifts of manner carried his hearers irresistibly along. So great was this charm of animated personality that his own immediate generation ranked him, in consequence, more highly than his undoubtedly great achievements in research will seem to the generation following to have warranted. Twenty years ago his name was continually linked, in the public voice, with that of Darwin as of coequals in science. Few would to-day claim for Tyndall so high a pedestal of fame.

Born near Carlow, in 1820, the son of a member of the Irish constabulary, he had few advantages in the way of early training beyond a sound knowledge of geometry, and a schooling that lasted until he was nearly nineteen. He once remarked to the writer that he would not have missed the training in exact thought afforded by the propositions of Euclid, for all the more directly mathematical training in the world. He entered the Ordnance survey as a civil assistant in 1839, and was occupied in this work until 1843. Then, for three years, he was employed in railway surveying in various parts of England, only to find that his passion for science would not let him settle to the life of surveyor. So he accepted a post as assistant teacher at Queenwood College in Hampshire, and was by that fortunate circumstance brought into fellowship with the then rising young chemist, Edward Frankland. In 1848, these two young men repaired to the Marburg to study under Bunsen, Tyndall going on later to Berlin to work under Magnus at physics. He translated Clausius's thesis on the moving force of heat, and subsequently that of Helmholtz on the conservation of force, which was pointed out to him by his friend Du Bois Reymond. Whilst in Germany he began those investigations into diamagnetism and the relations of magnetism to crystallography which will ever be associated with his name. It was his work on these two kindred

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topics that brought him first into notice. He was, on his return to England, invited to lecture at the Royal Institution, where Faraday had for twenty years been actively at work. The lecture was given in February, 1853, and in May of the same year the post of Professor of Natural Philosophy was created for him. He devoted much time during the succeeding years to research, and from magnetism passed on to the subject of the radiation of heat, upon which subject he published—mainly in the *Philosophical Transactions* of the Royal Society—a number of memoirs. The substance of these was afterwards reprinted in a separate volume. His more popular work, "Heat a Mode of Motion," was published in 1863, and was followed by the volumes of lectures "On Sound" and "On Light." This latter was the substance of his famous lectures delivered in America in 1872. On electrical subjects, beyond the diamagnetic researches, he published little, his "Notes on Electricity" being mainly historical. His other topics of research were: the motion and structure of glaciers, the spread of dust and germs in the atmosphere, and the effect of mist and fog on sound.

No account of Tyndall would be faithful which did not contain some reference to the numerous controversies which he entered into with various scientific men. He was an uncompromising, and, at times, even bitter, adversary, and even on the most purely scientific topics could scarcely argue without personal tone. His dispute with J. D. Forbes on the origin of glacial motion, and that with Prof. Tait as to the merits of Robert Mayer as the founder, rather than Joule, of the dynamical theory of heat, witness to this personal trait. His controversy with Prof. W. Thomson (now Lord Kelvin) on the subject of diamagnetic polarity was a curious episode, since the opinion that seems to have been held at the time that Tyndall had answered his critic's strictures would not now be sustained by any competent authority. Tyndall took the view that the apparent repulsion of a bar of bismuth from the pole of a magnet was due to the induction of some new polarity, the opposite of that which would have been the case if the bar had been of iron. The north pole of a magnet induces, he maintained, a north pole in the end of the bismuth bar that is presented to it, and therefore repels it. Thomson on the other hand, maintained that the polarity induced in the bismuth was identical in direction with that in any other substance, but that the amount of the induction differed with the relative permeability of the substance and of the surrounding medium. As a consequence there was a tendency for the bismuth to move from the denser regions of the magnetic field into the less dense. The phenomenon was just as truly in accordance with the law of magnetic attraction as the apparent repulsion of a balloon from the earth is in accordance with the law of gravitation.

Tyndall's attitude towards the exponents of orthodox Christianity, and his utterances on the subjects of miracles and of the efficacy of prayer, raised, twenty years ago, a storm of theological opposition which had scarcely died away before his retirement into private life in 1887. For several years previously it was evident that his powers were waning. The repose of his last years in the solitudes of Hindhead, or of Bel Alp was only broken by his excursions into political warfare. His sternly independent spirit broke out impetuously in diatribes that caused his friends no little regret. Unfortunately, he was not the only man of science who, on one side or other of the Home Rule quarrel, showed how party strife may upset the balance of judgment.

In his youth the disciple, and in his middle age the intimate friend, of Carlyle, he also owed much to the influence of Emerson and to that of Goethe. His lectures contain frequent references to these his masters in literature; but his style was not modelled on that of any of them. His biography of Faraday was a thoroughly sympathetic work, though he differed widely from Faraday in religious views. The vehemence with which at times he spoke and wrote was indeed but one result of the passionate sincerity of soul and of the restless energy that burned within him. He made the whole world his debtor by his masterly expositions of modern science, and the whole world may well forgive the exuberances of his ardent nature. S. P. T.

COMPARATIVE COST OF LIGHTING BY GAS AND BY ELECTRIC LIGHT.

On April 8, 1892, Prof. Ayrton gave a discourse at the Royal Institution on meters, motors, and money matters. He exhibited on that occasion several curves, showing the cost of lighting by different gas burners. These curves, which have not before been published, are combined in a single diagram in Fig. 1. The cost is based upon one candle-power for a year, at four hours a day, and gas at 2s. 6d. per thousand cubic feet. This comes to 1,460 hours, and is equivalent to lighting from dusk until 10 p.m.

The costs have been derived from the figures in the Report by Messrs. Haycraft, Weightman and Gawthorp upon Test of Gas Burners, an abstract of which has appeared in our last two issues.

In attempting to draw a comparison between the cost of gas lighting and of electric lighting we are met with two difficulties. The candle-power per cubic foot of gas per hour, called the efficiency, in the Report to which we have alluded, depends largely on the size of the burner. Small gas burners give a very poor result. No such difference exists with glow lamps. It is true that the 8-c.p. 100-volt lamp of the Edison and Swan United Company took about 5 watts per candle, and that we are now hoping to find 2½ watt lamps, or at all events lamps taking a mean of about 3 watts per candle throughout their lives; but speaking generally, the efficiency of a glow lamp has little to do with its candle-power, as with gas burners. On the other hand, a good gas burner supplied with decent gas and not exposed to dirt and weather, has a long life, and the candle-power remains practically unaltered. It is true that gas burners often become choked with dirt and rust, greatly reducing the light, but this cannot be fairly attributed to any defect in the burner. A glow lamp suffers from such a defect. Its life is short and uncertain; more figures must be based upon its average performance, and the cost of renewals must be added to the cost of electrical supply.

While for purposes of strict comparison we ought to consider the mean performance it must be admitted that in a large majority of cases the consumption of current per lamp is of more importance to the consumer than the watts per candle-power. We could at one time get no 100-volt lamp that took less than an average of 30 to 40 watts throughout its life, and now we can buy lamps starting at 20 watts. As we recently observed, a 4-c.p. 100-volt lamp, taking, say, 12 watts to start with, would be a great boon to consumers, and would not, we believe, entail a loss of revenue to supply companies. A small gas burner, however, is a distinctly wasteful affair, as is clear from curve 7, Fig. 3, and curves 7 and 8 in Fig. 5, on page 96 of our issue of November 24th. And it must be remembered that the Welsbach burner has a short life, a quickly falling candle-power, and that the mantle is extremely fragile.

After these preliminary remarks we may proceed to Prof. Ayrton's curves. Four different burners were selected, and the chief feature of the diagram, Fig. 1, is the quality of the regulation. The Bray's street burner regulates perfectly between 0·6in. and 3in. pressure. This is very interesting; but it must be remembered that gas companies, with all their failings, do not force their gas through the consumers' pipes at 3in. pressure. For practical purposes, pressures from 0·6in. to 1·5in. only need be considered. We have no hesitation in disregarding at once the Argand burner; it is as outside the present comparison as an arc lamp. We assume 1s. 10d. as the average cost. We do not, however, take this figure from the curves in Fig. 1.

The last tables of the Report on Tests of Gas Burners consisted of the cost of one candle-hour at the maximum observed candle-power, with different burners, gas being taken at 2s. 6d. per 1,000ft., and the cost of one candle-hour under the conditions of maximum efficiency. Omitting the last six burners, which are of large candle-power and high efficiency, the average of the remaining 22 is 0·0187 for the maximum candle-power, and 0·0156 for the maximum efficiency. The maximum candle-power necessitated in most cases a high pressure of gas. We therefore take the mean candle-power at the maximum

efficiency at whatever pressure that efficiency may be obtained. A cost of 0·0156 an hour for 1,460 hours (Prof. Ayrton's unit) comes to 22·8d., or, say, 1s. 11d.

Before proceeding further, it may be remarked that the cost of electrical supply for glow lamps at 2½ watts per candle, and at 6d. per supply unit is exactly the same as this average, viz., 1s. 10d. for 1,460 candle-hours. To this lamp renewals must be added.

Lamp renewals at 1s. 6d. per lamp, and a life of 400 hours, comes to about 5s. 6d. for 1,460 hours, or 7s. 4d. for a life of 300 hours. In the absence of any definite information, we will assume a life entailing a cost of 6s. for renewals during the year. But as 8-c.p. lamps cost no less than 16-c.p. lamps, and may be assumed to have the same life, the lamp renewals for the 8-c.p. lamps is twice that of 16-c.p. lamps per candle-hour or candle-year. The cost for 1,460 candle-hours would be as follows:—

	2·5 watts per c.p.	3 watts per c.p.	4 watts per c.p.
1c.p. without renewals	21·9d.	26·28d.	35.04d.
8 c.p. with renewals	30·9	35·28	44·04
16 c.p. with renewals	26·4	30·78	39·54

From these examples we must for the present discard the 2·5 watts per candle. It is true that we have promises, and indeed offers, of such lamps, and a guarantee of one, at 2s.; but we have no experience as to their life. We take, then, 3s. as a fair average, and against this we put the 1s. 10d., the average cost of gas lighting. The cost of electric light by glow lamps at 6d. per unit is, then, to the cost of gas lighting at 2s. 6d. per thousand as 100 is to 61. The two costs would be almost identical if the price of gas were 4s. per thousand. The old rule used to be to multiply the price per unit of electrical supply by 10 to obtain the equivalent price of gas per thousand cubic feet. It appears that at 3 watts per candle and lamp renewals, at the rate we have assumed, the factor 8 instead of 10 may be used.

We have assumed that the cost of renewals will be 6s. for 1,460 hours, irrespective of the watts per candle at which the lamps are run. The renewals will of course be much lighter for lamps at 4 watts per candle than 2½ watts, say 3½ to 4 times less, but we have no data to go upon at present. This will tend to equalise the costs of electric lighting; but as we have taken such short lives as from 300 to 400 hours, the result will be to reduce the costs of the lighting at 4 watts per candle, and probably not to increase even the lighting at 2½

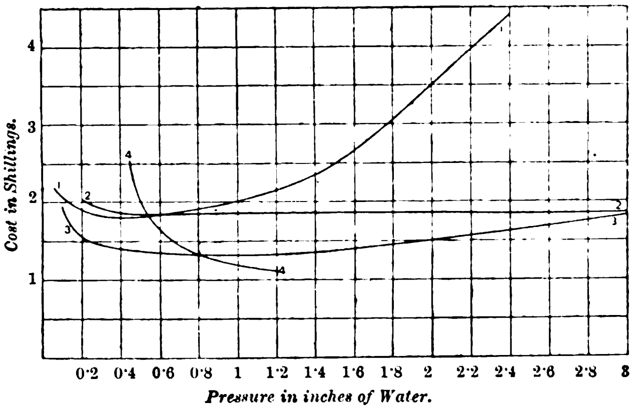


FIG. 1.—Pressure, and Cost in Shillings per Candle per Year, burning four hours per day, at 2s. 6d. per 1,000 cubic feet.

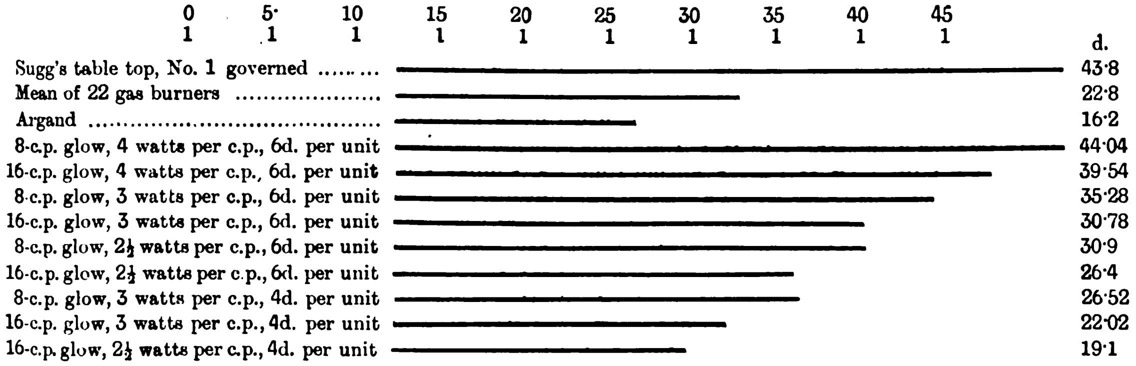
1. Bray's Enamel Regulator, No. 5, Union Jet.
2. Bray's Burner for Street Lamps, with Governor.
3. Sugg's No. 5, Table Top, Governed.
4. London Argand (Sugg's No. 1).

watts to any appreciable extent. It appears that in order to compete with the average gas burner with gas at 2s. 6d. a 16-c.p. lamp must be run at nearly 2½ watts per candle and at the rate of 5d. per unit for electrical supply.

The following table shows at a glance the comparative magnitudes of the foregoing costs. We are indebted to Messrs. R. J. Wood and H. C. Leake, of the Central Institution, for confirming our numerical calculations.

Comparison of Costs of Lighting.

Scale:—One centimetre equals 5d. per candle per year, four hours per day.



It should be noted that the difference between the costs of 16-c.p. and of 8-c.p. lamps, other things being equal, is the cost of renewals of a 16 c.p. lamp.

ON THE ELONGATION PRODUCED IN SOFT IRON BY MAGNETISM.*

BY SIDNEY J. LOCHNER.

Had it not been for recent experiments by M. Alfonse Berget,† which apparently contradicted those of Mr. Shelford Bidwell,‡ I should have deemed it a waste of energy to have attempted to contribute anything further to our knowledge of the subject. My original purpose was to confirm the experiments of either one or the other, not expecting in any way to reconcile the two. But I am led to believe that I have in general verified the experimental results of both.

The instrument which I employed for this investigation is in its essential features a Michelson interferential refractometer. With this instrument I found it an easy matter to measure to a tenth of a fringe, which means about $\frac{1}{1000000}$ of an inch. In making these observations, the only difficulty which I found at all troublesome were certain effects due to hysteresis.

Mr. Shelford Bidwell, in mentioning the difficulties which he encountered, states that he found it absolutely necessary to centre the bar in the coil. He finally adopted the method of suspending the coil on one end of his bar, so that it moved with the bar. In this way the effect was entirely obviated.

Early in the experiment I found that for a given magnetic field I could produce different amounts of expansion, depending upon the manner in which the current had been applied—for instance, whether the full amount of the current had been turned on suddenly or, on the other hand, had been applied

* Abstract from the *Phil. Mag.*, Vol. XXXVI, No. 223.
† *Comptes Rendus*, November 7, 1892.
‡ *Proc. Roy. Soc.*, Vol. XL.

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gradually; then, again, whether the current had been gradually *increased* from zero, or had been *decreased* from a higher point.

If the current be gradually increased from zero up, at a certain point we reach a maximum amount of expansion: now a further increase in current will produce a decrease from that maximum; but if, on the other hand, we gradually decrease the current, we are able to obtain a still greater expansion. This increase in the case of soft iron is from 0·05 to 0·20 of the total amount of expansion otherwise obtained. Mr. Bidwell has noted a peculiarity in the behaviour of a steel bar which will come under this head. At lower points in the expansion this peculiarity does not seem to exist.

I have adopted, as the method which gives the most uniform and certain results, that of quickly but gradually *increasing* my currents (not using the first contact), counting my fringes from the zero point for my lighter currents and from the turning, or maximum, point for my heavier currents. For attaining this end I constructed a resistance out of fine platinum wire placed in water to prevent fusing, with a sliding metallic contact. By using this resistance directly, and as a shunt for the smaller currents, I have been able to have the current perfectly under control.

In order to determine the effect of the thickness of his bar upon the amount of expansion, Mr. Bidwell selects for the purpose three rods of 100mm. length and 2·65, 3·65, and 6·25mm. in diameter. He assumes that the iron in the three bars may be regarded as similar, and that the differences in the expression are due only to their diameters. He finds that the expansion "varies inversely as the square root of the diameter" (the length remaining the same). I regret to say that my results do not in any way confirm his conclusions. Instead of finding that larger bars give less expansion than smaller bars, I find just the opposite. At first I thought that the best way

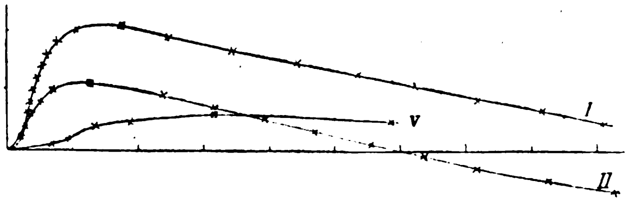

Fig. 1.

to make this test would be to take my largest bar and turn it down to successively smaller diameters. In fact, I did this. The resultant bar showed a falling off of the expansion from 10·3 fringes to 7·2 fringes. I found it a very difficult matter to turn so long a bar perfectly true in the lathe which I had at my disposal; and at the same time I was not certain about the effect of the strains due to the turning. Further, there was no certainty that the inside of my bar would behave in the same manner as the outside.

Although I have quoted M. Alfonse Berget's single experiment, because the ratio in this case was exceedingly large, yet, as the length of his bar was so short, and as he tells us nothing as to whether he has given us the elongation from the first or second contact, one must feel compelled to give it little weight except for showing the main point in the discussion. It must also be borne in mind that the iron used by different observers could of itself produce variations of as much as 25 per cent., due to a difference of permeability.

It may be stated briefly that my observations furnish the following evidence in regard to the expansion which takes place in soft-iron bars:—

1st. They confirm the general form of Mr. Shelford Bidwell's curves.

2nd. They indicate that the expansion is a function of the ratio between the diameter and length, and that the elongation varies *directly* as possibly the square root of this ratio.

3rd. They further indicate that the expansion varies directly as the permeability.

4th. That the amount of current required to produce the maximum expansion, and also the point of no expansion, likewise depends upon the ratio between the diameter and length.

5th. That there are two maxima: one produced by increasing the current, another by decreasing the current from that point which produced the first maximum.

6th. They confirm Prof. A. M. Mayer's observations, that the first contact gives more expansion than the second and following contacts, and, further, even these seem to disagree slightly among themselves, the expansion falling off with subsequent contacts.

In Fig. 1 I have plotted the expansion curves of three of the bars which show the greatest differences.

Mr. Bidwell's curves are similar in form to those produced by Bars I. and II., while M. Alfonse Berget's curve, as would be expected, agrees more closely in form with that of Bar V.

The experiments were carried on in the physical laboratory of Clark University, under the direction of Prof. A. G. Webster, to whom acknowledgment should be made for frequent suggestions.

THE REFLECTION OF ELECTROMAGNETIC WAVES AT THE END OF A CONDUCTING WIRE.

In *The Electrician* for April 28, 1893, p. 734, we alluded to some theoretical work of MM. Birkeland and Sarasin, appearing in the *Comptes Rendus* a few days previously, and consisting of an important application of Poynting's energy theorem to the case of a Hertz oscillator. They considered the movement of energy in the field, and how its rate of subsidence was affected by the presence of neighbouring conductors; and succeeded in giving a plausible explanation of a curious experimental result, obtained by MM. Sarasin and De la Rive, viz., that the stationary waves, formed by reflection at the end of a wire, have their nodes differently situated according as the waves are electric or magnetic. In the *Comptes Rendus* for November 6th, MM. Birkeland and Sarasin publish a further communication on this subject. It consists of a description of some experiments made with the object of exploring the field in the neighbourhood of the end of the wire by means of little resonators varying in diameter from 10 to 25 centimetres. The experiments do not confirm in every respect the views previously advocated by the authors, but they certainly form an important experimental contribution to the remarkable energy theorem of Prof. Poynting.

The electric undulations were produced by a small Hertz plate oscillator, giving sparks about 3 mm. long, the sparks being produced in oil. Facing one of the primary plates was a similar secondary plate attached to a copper tube 1 cm. in diameter and nine metres long. The resonators were in all cases circular, and fixed vertically, with the spark gap at the top. They were capable of two kinds of motion: one a rotation about a vertical axis passing through the spark gap, the other a motion of translation parallel to the copper conductor.

By means of these resonators the authors explored the field in the neighbourhood of seven different parts of the wire, the plane of the resonator in all cases being normal to the wire. Each determination of a node involved at least ten measurements. The numerical results thus obtained for the 10-cm. resonator are given in the Table below. The distance of the resonator from the conductor is counted from the axis of the latter to the nearest point of the former.

Distance of resonator from conducting wire.	2cm.	10cm.	20cm.	30cm.	40cm.	50cm.	60cm.
1st node..................	16·0	15·4	9·5	7·7	1·8	...	..
2nd „	56·4	56·3	54·2	51·5	47·3	44·8	37·7
3rd „	96·5	95·7	95·2	93·5	90·5	88·9	87·5
4th „	135·0	135·8	135·1	134·6	130·8	129·7	130·5
1st internode...........	40·4	40·9	44·7	43·8	45·5	54·6	...
2nd „	40·1	39·4	41·0	42·0	43·2	44·1	49·8
3rd „	38·5	40·1	39·9	41·1	40·3	40·8	43·0

In Fig. 1 the crosses denote the positions of the centre of the 10cm. resonator for the nodes given in the above table. When the 25cm. resonator was used the corresponding positions are indicated by the small circles.

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These results seem to show that if the first impulse given to the resonator occurs from electro-magnetic motions parallel to the conducting wire, the second must arise by direct radiation from the neighbourhood of the end of the wire. In fact, all the nodes are situated as if the energy, from which is derived the second impulse received by the resonator, travelled quite close to the wire until arriving at the end of the conductor, and then radiated from this point as a centre.

In the second place, the experimenters tried to find how to turn the plane of the resonator about its vertical axis, so that the total effect of the two impulses was a maximum.

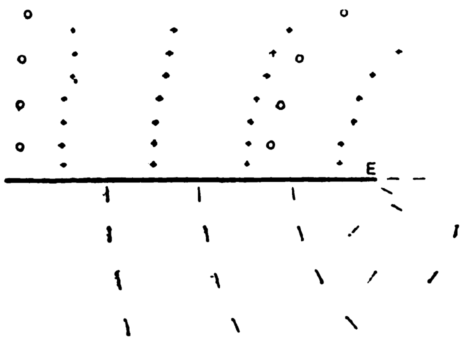

FIG. 1.

These directions are indicated in Fig. 1. They have been determined in most instances for places which are the internodes of the undulations. Two of the directions (indicated by the dotted lines) were, however, taken in positions where the nodes occur. The results strongly indicate radial action proceeding from the end of the wire.

The three series of observations made in the neighbourhood of the internodes shows that the normal to the plane of the resonator nearly bisects the angle between a line drawn parallel to the wire and the radius drawn from the end of it. The two observations made at the nodes show that for the maximum effect it is necessary to so turn the resonator that the electric waves arriving from the end of the wire strike its plane normally.

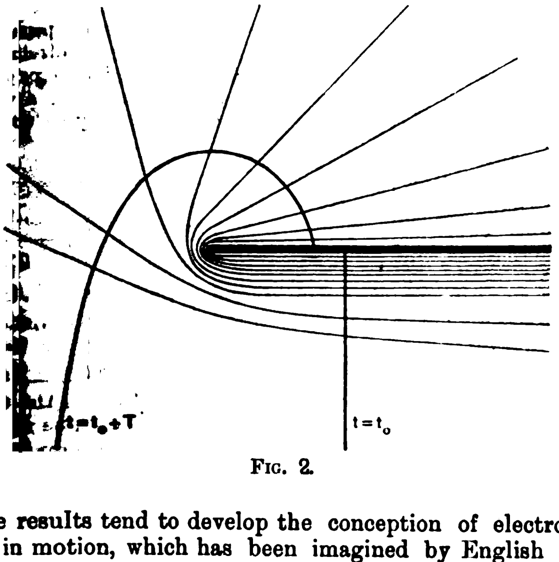

FIG. 2.

The results tend to develop the conception of electrostatic tubes in motion, which has been imagined by English physicists. Suppose that an electrostatic line (of the direct wave), each part of which moves normally to its direction at the moment considered, is rectilinear and perpendicular to the conducting wire. This will not be the case with the reflected wave.

Measurements previously made by one of the investigators show that at the surface of the conducting wire there is not any appreciable lag of the first node, and that in consequence the part of the electric tube in the immediate neighbourhood of the wire makes the complete turn round the end of this without any appreciable retardation. But the distant portions of the tube cannot traverse the same angular distance in such a short interval of time. The tube after reflection accordingly curves round the wire, the distant parts of the tube being shaped something like the tail of a comet (*see* Fig. 2).

Such is the origin of the characteristic radiation, proceeding from the end of the conductor, the existence of which the authors appear to have established. It follows as a matter of course that if, according to Poynting's theorem, the motion of the energy is always perpendicular to the instantaneous direction of the lines, energy must radiate from the end of the wire into surrounding space.

THE CONTINUOUS CURRENT ARC AS A STANDARD OF LIGHT.*

BY ANDRÉ BLONDEL.

(Continued from page 119.)

When it is a question of measuring a single arc lamp, the following method seems capable of yielding practical results.

(i.) The arc lamp is compared with the standard by means of a Foucault or Bunsen photometer, the eyes being blinked, as suggested by M. Allard, until the sensation of colour disappears. In this way one obtains the values of the *luminous* intensity always under identical conditions.

(ii.) The two sources of light are then compared from the point of view of reading by means of photometers based on the visual faculties, care being taken in every case to give the same absolute value to the illumination, and to expressly state it. The best value is such that the observer can only just read ordinary print. In this manner the value of the visual intensity is obtained.

By means of these two measurements,† both easily made, and without the intervention of coloured screens, we have measured the light under the two extreme conditions in which it is employed, that is to say, under those which it is of the most practical interest to know. It does not much matter whether we know the value of a light exactly when it is more abundant than necessary. The essential thing is to know what is the maximum useful light it can furnish. This once known, the effect of the Purkinje phenomenon no longer causes the same disadvantages as is the case with existing methods. Nevertheless, it seems decidedly better in the photometry of arc lights to replace existing standards by a secondary standard, also having the arc as origin, so that we may have two almost identical tints.‡ In that case it would only be necessary to ascertain once for all the properties of this standard to gain an accurate idea of the values of lamps measured against it. This standard§ is obtained, as I have said above, by isolating a small portion of the positive crater of carbon of sufficient purity.

I will not in this Paper describe the apparatus in its first shape.‖ I will only add two remarks to my original description, remarks which have been suggested to me by further experiments.

(i.) The little hole in the cold diaphragm placed close to the arc becomes filled at the end of a short time by carbon dust, due to the condensed vapour. It is, therefore, necessary to use fairly large holes, and to clean them out from time to time. Unless this is done errors will arise.¶

(ii.) The flame passing before the crater may, as Abney says,** apparently alter its intrinsic brilliancy. This defect, as well as those due to air currents, may be obviated by a new device which I now have, and which consists of an arc lamp with horizontal carbons, the arc of which is enclosed in a very small electric furnace, similar to those of MM. Violle and Moissan, but of simpler construction. This is shown in Fig. 3. The device will, I think, give more constant results than those obtained with the first type of apparatus. I will not insist further upon the necessity of having as high a current density as possible, so that the crater may be well "saturated."

* Paper read before the International Electrical Congress at Chicago, August, 1893.

† It would also be a good thing to make a measurement with a coloured screen absorbing the blue and violet rays, in order to get an idea of the value of the lamp in time of fog. It is well known that the electric light then loses many of its advantages.

‡ The tint of a lamp is always slightly less white than that of the standard, because the latter only uses the most incandescent part of the arc. But this difference, which is indeed scarcely perceptible, is no objection to this standard.

§ Constructed by Werlein, optician, Paris.

‖ Vide *The Electrician*, Vol. XXX., p. 658, April 7, 1893.

¶ From this point of view it may, perhaps, be better to use, instead of a hole, a lens of known surface, the coefficient (k) of which could be previously measured. The light produced on the photometer by the carbon image is, in fact, proportional to the surface (s) of the lens and to the intrinsic brilliancy i; $c = k\,s\,i$. The lens could be placed much further from the arc, and the water-jacket could be suppressed.

** "On Fixing a Standard of Light," Brit. Ass., 1882.

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Experiments.

I undertook a series of experiments with a view of comparing the intrinsic brilliancies of different carbons, either against each other or against an ordinary standard. In the first case I set two similar arc standards* up at either end of the photometer bench. In the second case, I merely compared an arc standard with a Carcel lamp, or I made a measurement with a Mascart photometer with petroleum standard.

This very simple method is the only one which can inspire complete confidence, since it enables one to investigate the phenomenon directly, and is more sensitive than any complex instrument; it enabled me to detect very important differences that were absolutely inappreciable on the pyrophotometer, which is not very sensitive under such conditions. Moreover, by setting two arcs against each other all the different errors resulting from difference of colour disappear.

The experiments were carried out at the Laboratoire Central d'Électricité (Paris), with the assistance of MM. Guilbert and Perrin. It was M. Perrin, Chef des Travaux Pratiques du Laboratoire, who was good enough to undertake the Bunsen photometer readings, which he accomplished with remarkable accuracy. Experi-

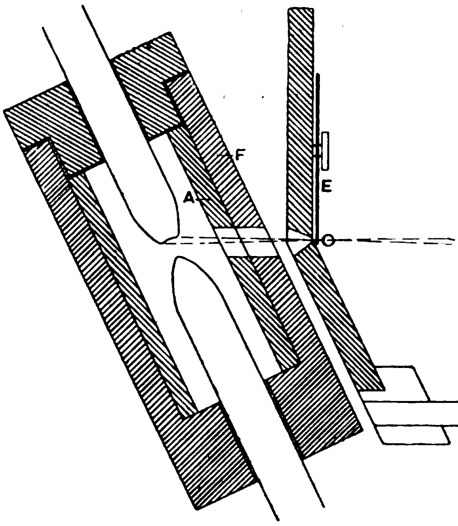

Fig. 3.

ments were carried out on three different makes of carbons, which I will denote by the letters B, C, L; some were homogeneous, others were soft, others again were hard, some had a more or less conducting core.

Constancy of the Brilliancy of a given Carbon under Constant Conditions.

When carbons of bad quality are employed, especially very hard uncored carbons, the brilliant part of the crater is continually moving, and it is difficult to make use of the arc as a standard. On the other hand, if suitable picked carbons are used, and the current densities indicated by me are employed, then it is possible to obtain great uniformity and fixity in the brilliancy of the crater. If the crater is examined on the hundred-fold projection afforded by the lens, it has the aspect of a boiling mass covered with little bubbles, which are generated and which burst without ceasing. But these bubbles are no longer seen when the lens is replaced by the pin-hole screen, and they are, moreover, much too small compared with the photometric surface of a Bunsen screen to in any way inconvenience the observer, or to compromise the accuracy of the measurements. In fact, with *good carbons*, the illumination of the photometric surface is remarkably constant, and all the comparisons showed this method of "diaphragmation" is quite correct enough for a standard.

As a sample I give below a series of measurements made without special precautions, the light of the crater of a 10mm. 20 ampere carbon being compared with the light of a carcel.

Table I.—*Total length of the photometer bar 3690mm. distance from the photometer screen to the standard carcel.*

Readings.	Average.	Differences.
790	794·5	4·5
804		−9·5
790		4·5
794		0·5

* I take this opportunity of expressing my thanks to MM. Sautter et Harlé, who, for the purpose of these experiments, lent me two of their excellent projectors.

This shows a relative error of 1 to 3 per cent. Generally speaking, therefore, one could with good carbons attain an accuracy of from 2 to 3 per cent., which is quite sufficient for arc measurements.

I may remark in passing that the boiling appearance of the crater seems to be a corroboration of the theory of the volatilisation of the carbon.

Constancy of the Brilliancy of a given Carbon under Varying Conditions.

M. Violle having showed that the brilliancy of a carbon is independent of the current and pressure, and Abney having arrived at a similar conclusion, I have not thought it necessary to take the question up again, but I will observe that the proof given by M. Violle only applies to the *maximum* brilliancy and to a permanent current and pressure. In fact it is easy to state the two following facts:—

(i.) The average brilliancy of the incandescent portions, taken as a whole, as measured for instance in lighthouse lights, increases with the current;* it increases also with the density of the current until the crater is well "saturated."

(ii.) If, by means of a rheostat, for instance, we suddenly vary the value of the current of a lamp, the intrinsic brilliancy undergoes a temporary and very appreciable variation, which may reach 10 per cent., and which diminishes gradually until the dimensions of the crater are so altered as to restore the surface of emission to the value which it ought to have having regard to the new value of the current.

This phenomenon is easily explained when we remember that the heating of the positive crater only takes place at the surface of passage, and that the temperature of volatiliation is therefore only reached by a very thin superficial film. This also explains why the points, blunted, or even shaped into little craters, such as one sees with alternate-current arcs of 25 amperes and more, have, according to measurements made by me with the pyrophotometer or with lighthouse apparatus, sensibly the same brilliancy as that of the continuous current arc.

For an appreciable portion of each period the arc is quite extinguished, but for the rest of the time the passage of surface presents a more brilliant aspect than normally, because it is somewhat too small for the current.

Influence of the Nature of the Carbons.

On this point I dare least to announce any definite conclusions, on account of the complexity of the effects which may intervene. Assuming that volatilisation of carbon really does go on in the arc at a fixed temperature, the following conditions are still necessary to ensure that the nature of the carbon should have no influence:—

(i.) The carbons must only contain a very small proportion of foreign substances. Formerly this was not the case, but to-day it is nearly so in practice, thanks to the methods of purification employed by all carbon makers. The majority of electric-light carbons do not contain more than 4 per cent. of foreign matter, 2 per cent. being mineral salts. Here, for instance, are some analyses made by M. Le Chatelier at his laboratory in the École des Mines:—

Table II.

—	1.	2.	3.
Carbon	93·0	95·1	95·5
Oxygen, Nitrogen	4·5	1·68	1·8
Hydrogen	0·5	0·22	0·3
Ash	2·0	3·0	2·4

The oxygen and the hydrogen are almost entirely in the form of hygrometric water. Moreover, many of these bodies, as M. Violle rightly remarked, are eliminated before the carbon comes to boiling point.

(ii.) The *molecular state* of the light-emitting body must always be the same. Now, at the temperature of boiling carbon, carbon only exists as graphite. The thin incandescent layer must, therefore, of necessity always have the same molecular constitution, in contradistinction to that which takes place in the case of incandescent lamp filaments, the temperature of which is much lower. I have verified the graphite theory by scraping the surface of the crater after the carbon has cooled, it was found that it was transformed into graphite to a small depth. From this direction it would seem, therefore, as if there existed no cause of variation.

The carbon at the surface of the crater being almost pure and almost black graphite, the emissivity at the same temperature should be the same for all carbons, according to Kirchoff's law. As a matter of fact, experiments have not rigorously verified this constancy. Differences have been detected between the different

* See my recent Paper on "Lighthouse Electric Lights," read before the International Maritime Congress, in London, July, 1893. See also abstract in *The Electrician*, Vol. XXXI., September 1st, p. 479.

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homogeneous carbons tested ;* soft carbons, in particular, appear to be less brilliant than hard carbons, as is shown by the results set forth in Table III.

Table III.

Total distance between the two screens 8,040 mm. surfaces :—Right hand screen 0·9038 sq. mm. Left hand screen 0·8135 sq. mm. Carbon employed in the right hand arc type L, with core ; average voltage.

Carbon used in the left-hand arc.	Distance of the Photometer in mm.		
	From left-hand arc.		From right-hand arc mean.
	Reading.	Mean.	
L (soft)...............	3,964 3,937 3,942 3,933 3,922	3,933	4,100
L (hard	3,853 3,820 3,907 3,852 3,878 3,840	3,858	4,182

Special carbons made out of shining retort graphite appeared to to be somewhat more brilliant than ordinary carbons. But tests were rendered very difficult by the continual displacement of the arc, which takes place with certain kinds of carbon, and the tests do not on that account merit absolute confidence. In all cases the differences detected were small compared to the differences which existed between the various carbons employed. These, according to the tests of M. le Chatelier, were comprised under two groups, A and B, which presented decidedly different molecular states, as will be seen by the following table :—

Type.	True specific gravity.	Calorific power.
A (soft)	1·60	7·94
B (hard)	2·00	7·76

We are, therefore, authorised to consider the brilliancy as independent of the specific gravity, and to set down the differences observed, above all to differences in the proportions of mineral salts present in the carbons.† These salts, usually rather refractory, only volatilise close to the crater, and may, therefore, play a part analagous to the core, about which I now propose to speak. If this explanation were not sufficient, it would be necessary to assume that a portion of the carbon of the arc escapes volatilisation, as in the case of the hissing arc.

(To be continued.)

* In Europe carbons are almost exclusively made out of graphite obtained from gas retort carbons ; this is sifted and mixed with different proportions of lamp-black, and agglomerated by means of oil tar. In America petroleum coke is also employed ; it contains much impurity, and results in inferior carbons.

† Perhaps also to a difference in emissive power.

LEGAL INTELLIGENCE.

The Medical Battery Company (Limited).

At Marlborough-street Police-court on Tuesday, C. B. Harness, managing director of the Medical Battery Company (Limited), J. M. M'Cully, C. B. Hollier, and Dudley Towers again surrendered to their bail before Mr. Hannay to answer the charges of having conspired together to defraud, and of having obtained by false pretences various sums of money.

Mr. FREDERICK THEOBALD BURBAGE, a provision dealer, of Liphook, Hants, was recalled and cross-examined by Mr. Gill.

Col. JEREMIAH BRASYER said he was a retired colonel of Her Majesty's Army, and lived at Margate. He was a C.B., and had served for thirty years in India and throughout the Mutiny. He was the prosecutor in the present case. About the middle of last year he was suffering from weakness in the loins. He saw many advertisements, and in consequence of reading them went to 52, Oxford-street. He could not fix the date of his first visit, but believed it was in June, 1892. When he went into the place he asked for Mr. Harness. Whoever the man that saw him was, he said, "We are Mr. Harness." Then he plainly and bluntly asked him about his means, saying, "What are your finances?" The Witness was vexed, and said he had not gone there to beg and could pay for what he required. Nothing was then said about his complaint. The man handed him a book (there were several persons standing about) and said, "Will you or can you sign that?" The book contained cheques. They filled up one and he signed it. After it had been signed the man said, "We will make a better man of you in a few days." A lad was then directed to take him upstairs. He went upstairs and got to a large saloon, where he was asked to sit down. He sat there until Dr. M'Cully came in and led him away to another room. M'Cully took him into his room and asked him to get on a chair which was on a raised platform. M'Cully then begun all sorts of antics, such as he had seen performed by fakirs in India. After he had sat down in the chair M'Cully walked round him swinging something. In the meantime a wheel was going round behind his back. That was all that took place on the first occasion. He went there three other times, when the same thing happened. On one occasion M'Cully put something stronger on, and he felt a pain at his shoulder which he could not bear. He called out to have it stopped as he could not bear it. Once another person operated upon him in place of M'Cully, and treated him in a gentler manner than M'Cully. After feeling the pain so badly he went home and felt that he had lost the use of his arm. He had not yet completely recovered. He had had nothing of the sort before he felt the pain. He got a belt at the establishment. He could not say where it was. He gave it to his solicitors. He could not say how long he wore it, but the discs caused blisters on his body. The blisters came out almost immediately, or, at any rate, after the second or third day. M'Cully told him there would be no extra charges. He received the letter produced, apparently signed by M'Cully, which enclosed an account for attendance at the Cannon-street Hotel, including cab fares, &c., amounting to £47. 15s. He remembered the cheque produced being drawn. He received no benefit from the treatment he received.

Cross-examined by Mr. AVORY : He was not treated at Oxford-street 17 times. He might have been there six times, but he could not be sure of anything on account of the confusion of mind they put him into.

Mr. AVORY : What did you give the cheque for 50 guineas for?—Because I suppose they asked me for it.

Continuing, the WITNESS said that he represented to Mr. Colyer what he had suffered, and left everything to him. For any information with reference to the action, he referred Mr. Avory to his solicitor and lawyer. When he went to Oxford-street he was suffering from an ache in his back. He went there to get relief, but only his pockets were relieved. He went to the place in the first instance to purchase a belt. At Folkestone, in June, 1892, he had no idea of getting married. He declined to say whether or not he contemplated marriage since that date.

Mr. HANNAY remanded the case at this stage until noon on Wednesday.

WEDNESDAY, DECEMBER 6TH.

On the hearing of the case being resumed on Wednesday, Col. BRASYER was recalled and cross-examined by Mr. A. R. Cluer on behalf of M'Cully. He said he went to the institution in Oxford-street to get a remedy for the pain he had in his back. He had read the advertisements concerning the place. M'Cully did not point out to him that treatment at his age was not likely to do him much good. He followed the advertisements, and seeing that so many had benefited by the treatment, according to the statements made in them, he thought that perhaps he would benefit by visiting Oxford-street. He could not remember how many times he visited the premises in Oxford-street. If it appeared in the books of the Company that he had been there 15 or 17 times he would not believe them. He did not believe in anything connected with the place. He could not tell the moment, but he had not been going there very long before he could tell that the treatment was doing him more harm than good. The people at the place said they would make a better man of him and set themselves above the Creator. He remembered telegraphing or sending a message from Cannon-street for Dr. M'Cully to go and see him. In answer to the message, M'Cully did go and see him. He might have told M'Cully that he was suffering from hernia. M'Cully did, upon that or another occasion, advise him to call in Mr. Stanley Boyd, of Harley-street, surgeon to the Charing Cross Hospital. Mr. Stanley Boyd attended him once at the Cannon-street Hotel, but whether more than once he could not say. Mr. Stanley Boyd and M'Cully agreed that he was ruptured, and afterwards M'Cully took him to Matthews, of New Oxford-street, and it might have been for the purpose of getting the description of truss which Mr. Stanley Boyd recommended.

Mr. PETER KEDDIE, an East India merchant, of The Terrace, Kennington-park, who gave evidence last week, was recalled and cross-examined by Mr. Gill. He said that he did not know who got the first belt for him. His mind was quite a blank as to how he got it. He wore the first belt about 2½ years, but not next to his skin. He pretty well used it up by wearing it. It was before he had the first belt that he was so ill that he had to go about on his hands and knees. While he was wearing the first belt he did not speak of the benefit it was doing him. His family knew of the benefit it was doing. He went and got a second one, but it was not because he thought the first one had done him good. He did not ask the people at Oxford-street about the cheque he signed for £105, because he was above doing such a thing. He went to his bank the day after he had given the cheque. He could not assign any reason why he did not ask his bankers to show him the cheque, but he felt he had been taken in and done for. He could not tell when the cheque came back to him, but he believed it did so in due course. He did not remember getting a receipt for the cheque from the people at Oxford-street. He would not swear that he had not been at Oxford-street 27 times, but he believed he had only visited the place 12 times. The only thing he had to complain of was the treatment when his back got ulcerated. He was told by the people at the institute to rest himself till it got well. When he saw the editor of the *Hawk* he was wearing the belt and said nothing to him about it. He was wearing one of the belts at the present moment. The receipt for the money he paid was not taken out of a book in his presence. Looking at the counterfoil produced, he saw that it bore his initials, and he had not the slightest doubt he had written them.

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He had no recollection of what took place after he had been told that he would have paralysis.

The cross-examination of Col. BRASYER by Mr. A. R. CLUER was here resumed: He did not know what M'Cully paid for a certain liniment—it might have been 6d. or £50. He did not remember M'Cully coming often to the Cannon-street Hotel and rubbing his shoulders with the liniment. It was agreed three guineas should be paid in any event, but that if the hernia were reduced £10. 10s. should be paid. It had not been reduced. M'Cully came to see him at Margate, with a Mr. Herbert. They bullied him for money, and behaved in a rude way. He sent down £10 to M'Cully by his servant in consequence of the blustering way he was behaving. The treatment he had received at his hands had injured his arm, which was now somewhat better.

Mr. HANNAY adjourned the further hearing of the case till next Wednesday, allowing the same bail as before.

The first meeting of the creditors in the matter of the winding up of the Medical Battery Company (Limited) is to be held at the Holborn Restaurant, Holborn, W.C., to-day (Friday) at 11 a.m.

Chelsea Electricity Supply Company (Limited) v. London Electric Supply Corporation (Limited).

This was an action in the Court of Appeal on Wednesday, in which the defendants appealed against a decision of Mr. Justice Wright, in August last, by which an injunction was granted restraining them from laying any distributing mains for the supply of the electric light within the area described in Schedule A of the Chelsea Electric Lighting Order, 1886, except as provided by an agreement between the parties, dated July 9, 1889. On the case being called, it was explained that the parties had come to an agreement, and the Court made an order on the terms so arranged.

Manville v. Gramshaw.

This was an action before Mr. Justice Lawrence and a jury in the Queen's Bench Division last week, brought by Mr. E. Manville, consulting electrical engineer, against Dr. F. Sidney Gramshaw, of The Villas, Tillingdon, Easingwold, Yorkshire. The claim was to recover the balance of £200, due as premium for taking the defendant's son as pupil. The defendant pleaded that his son was learning nothing, and therefore he took him away.

In opening the case, Mr. WALTER said the plaintiff was electrical engineer to the Corporations of Dublin, Salford, Portsmouth, Kilkenny, and various London vestries, and in 1889, in connection with the Electrical Engineering Corporation, was carrying out an electrical installation at a mansion in Yorkshire, and Dr. Gramshaw negotiated then for his son to be a pupil of the Corporation. By plaintiff's influence, the premium was reduced from 300gs. to £200, and young Gramshaw went to the Corporation's works at West Drayton. On January 6, 1891, a fire occurred at the plaintiff's works, which destroyed much property, and placed the Corporation in considerable difficulties. When the Company went into liquidation, the defendant's son was transferred as a pupil from the Company to the plaintiff, and the latter sent him over to Dublin, where a large central station was being erected. After being there some time young Gramshaw left, and took a situation at a small salary. Evidence was given by electricians that young Gramshaw would have gained valuable experience if he had stayed with plaintiff in Dublin.

For the defence, Dr. GRAMSHAW and his son gave evidence. The former said he never agreed to transfer his son as pupil from the Company to the plaintiff, and the latter's testimony was to the effect that the working of the apparatus was not properly explained to him, and he left because he learned nothing.

After hearing the evidence and the Judge's summing up, the jury found a verdict for the plaintiff for the full amount claimed.

Fry v. St. James's and Pall Mall Electric Supply Company (Limited).

This was an appeal, heard yesterday by Lords Justices Lindley, A. L. Smith, and Davey, from a judgment of Mr. Justice Kekewich, who had decided that the plaintiff, a holder of Founders' shares in the defendant Company, was entitled to one-half of two sums of £1,000 which had been set aside by the Directors, before payment of dividend, as a reserve or capital redemption fund. The Company carried on its operations under a Provisional Order, and was liable to be bought up by the Local Authority after a period of 42 years, and it was to provide against the gradual depreciation of the property that the Directors, with the entire concurrence of the Ordinary shareholders, set aside £1,000 annually, this having now been done for two years. The Company contended that the holders of Founders' shares were bound, to the same extent as were the Ordinary shareholders, to accept the statement of accounts of the Directors and the certificate of the auditor. There was no impeachment of the *bonâ fides* of the Directors; but the plaintiff did try to go behind their statement and suggest that the accounts had not been properly dealt with in conformity with the Articles of Association. There was a stipulation in the Articles of Association that the Founders' shares should carry half the net profits after a dividend of 7 per cent. had been paid upon the Ordinary shares, and the plaintiff relied upon a clause in the Articles which provided that only such profits as would otherwise be available for dividend on the Ordinary shares should be set aside as a reserve fund.

Their LORDSHIPS held that the judge below was right in the construction he had placed upon the clause in the Articles of Association, and that there was intended to be a distinction between the Founders' shares and the Ordinary shares when the question of reserve came into consideration.

The appeal was therefore dismissed.

Urch v. Greenhill.

This was an action in the Lord Mayors' Court, London, by Mr. F. Urch against Mr. M. Greenhill, electrical engineer, of Mansion House-chambers, E.C., to recover £23, balance of principal alleged to be due upon two bills of exchange for £25 and £14 respectively, and costs of a judgment paid by the plaintiff in respect of the said bills. The bills were drawn by the defendant and accepted by the plaintiff, and were discounted by a Mr. Talbot, who subsequently sued the plaintiff, and defendant on the bills and obtained a joint judgment against them which had been satisfied by the plaintiff. The plaintiff now sought to recover from the drawer his contribution of the total expense. The defendant declined to pay, firstly, because there had been no notice of dishonour, and, secondly, because the bills were drawn for the accommodation of the acceptor, who received the whole of the money less the charges for discounting.

The jury found for the plaintiff, for whom judgment was entered, subject to a reference of the figures to the Registrar.

CORRESPONDENCE.

SOME NEW EFFECTS WITH VACUUM TUBES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Some months ago you were good enough to insert a short communication from me on some new effects produced by means of vacuum tubes. After further pursuing this matter I have a few more words to say on the subject. My experiments are still very incomplete, and the nature of the subject is such that a long time must elapse to cover even a small portion of this field of investigation. The object I have in view in publishing a few notes from time to time on the subject is partly to prevent anticipation by others, and partly to assist those who are engaged on similar work.

There have been a large number of theories advanced to explain the "dissociation" observed in vacuum tubes. I have come to the conclusion that the whole phenomenon is simply a question of interference, and is comparable to, if not actually identical with, "Newton's rings." I am not aware that anyone else has advanced this theory, although I have been looking up the subject of late. I have had some special tubes made for illustrating this theory, which I hope to show in public later on. Tesla's experiments go a long way to confirm my view. His experiment of connecting two bars of metal to a high-frequency source of current, and then placing a lamp across these bars, is well known. If the connections of these lamps to the bars are shifted up and down, then the lamp at some places will glow, and at others remain unaffected, indicating nodal points. The behaviour of powders of various substances mixed together, under the action of an alternate current, also tends to show this circumstance. The great advantage, however, of working with vacuum tubes is that it is possible to actually see what is going on. I think that a great deal of future investigation will be accomplished by this method.—Yours, &c., DAVID SALOMONS.

Broomhill, Tunbridge Wells, Dec. 6, 1893.

AN ELECTROLYTIC "RIDDLE."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With respect to the "riddle" propounded on page 108 of your last issue, I would point out that the experiment was in effect made in the year 1880 (*Phil. Mag.*, November, 1880), when the late Dr. Guthrie and I made comparative measures of the conductivities of liquids, in which the currents were induced by a moving magnetic field, there being no electrodes. Of course there is no evolution of gas, and no effective decomposition.—Yours, &c., C. V. BOYS.

THE LATE A. RECKENZAUN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you allow me a space in the columns of your journal—which has amongst its readers so many of my late husband's friends—to thank them for sending me, in such numbers, letters of sympathy and condolence.

Their number is far too great for me to reply to them individually, and I hope you will give me this opportunity of expressing to them my warmest thanks, and the gratification it is to me to know how universally my husband was beloved and respected.—Yours, &c., E. RECKENZAUN.

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TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

The 1893 Edition of "'THE ELECTRICIAN' ELECTRICAL TRADES DIRECTORY AND HANDBOOK" contains over 1,000 pages, several new and handy features having been added. Price 7s. 6d., post free 8s. 3d.; abroad 8s. 10d. *Comparison with any similar electrical publication is specially invited.*

The 1894 Edition is in preparation, and will be published in January next. New names, alterations of addresses, &c., should be sent in at once. The Directory blanks and circulars are not sent out until late in the year, in order that the most recent, and consequently the *correct*, addresses *only* shall appear in the book. Full printed particulars can be obtained, post free, from "The Publisher," *Electrician* Office.

TENDERS INVITED.—The Swindon New Town Local Board invite tenders for the supply of gas, oil, or electric light for the public lighting, for one year, commencing January 1st next. Tenders must be sent in by the 11th inst.

——— The Derby Corporation invite tenders for the wiring, fittings, &c., for the various public buildings in their electric-lighting area. Tenders must be in by noon of the 16th inst.

——— The Walton-le-Dale Local Board invite tenders under various contracts for work in connection with their sewerage and sewage disposal works. Contract No. 5 (Sections A and B) is for steam engines, pumps, boilers, and fittings. Particulars can be obtained of Mr. J. S. Spencer, Haworth-buildings, Manchester, and tenders must be sent in by noon on Saturday, the 16th inst.

TENDERS ACCEPTED.—The Electric Lighting Committee of the Taunton Town Council have received a number of tenders for plant and apparatus required in the extension of the electric-lighting installation, and the following have been accepted:—Messrs. Laing, Wharton and Down, for small alternator and exciter, £284; for two 30-kilowatt transformers and switches, £261. 16s. Messrs. Easted and Chandler, for 50-H.P. high-speed engine, £243. British Insulated Wire Company (Limited), for armoured concentric cable (quarter mile), £81. 5s. Fowler-Waring Cables Company (Limited), for one mile of triple concentric cable, at 7s. 4½d. per yard. The last tender is accepted under certain conditions as to jointing, completing the work, making good and guaranteeing cable. The tender for the two 30-kilowatt transformers and switches was accepted on condition that Mr. Newton, of Taunton, could not satisfy Dr. Fleming on the subject of his tender for this apparatus. If Mr. Newton's tender proves satisfactory, then his tender was to be accepted in place of that of Messrs. Laing, Wharton and Down.

APPOINTMENTS VACANT.—The City of Londonderry require a chief engineer for the Londonderry electric lighting station; also an engine man and assistant, and a dynamo tender. Further particulars are given in our advertisement columns, and applications must be sent in not later than Tuesday, December 12th, to the Chairman of the Lighting Committee, Guildhall, Londonderry, Ireland.

LIQUIDATIONS.—Mr. Theophilus Coad has presented a petition for winding up the Aladdin Primary Electric Battery Company (Limited). The petition will be heard at the Courts of Justice, Strand, London, W.C., on the 19th inst. Mr. J. R. Pakeman, 20, Bucklersbury, is solicitor.

——— The following companies are to be voluntarily wound up:—The Corifact Syndicate (Limited); claims to be sent in to Mr. E. Hill, 69, Mark-lane, E.C., by the 22nd inst. Electrical Wonder Company (Limited); resolution passed November 27th; Mr. Howard Felgate, 115, Strand, W.C., liquidator. Fowler Insulator Syndicate (Limited), 5, Lime-street, E.C; Mr. R. R. Fastnedge, liquidator. J. R. Powditch and Co. (Limited); Mr. Edwin Hayes, 107, Cannon-street, E.C., liquidator.

BANKRUPTCY.—At Nottingham William Andrews, electrician, of 6, St. Ann's-valley, and 118, Hungerhill-road, Nottingham, was examined last week. The Official Receiver stated that the debtor had furnished certain information, but it was very far from accounting for the £900 which, at his examination, he admitted having received within a period of two years. The debtor had, however, kept no books, and as there seemed no probability of extracting any account more definite from him, there was no utility in keeping open the examination. Debtor was accordingly allowed to pass.

APPLICATION FOR DISCHARGE.—An application for discharge by Walter Rowbotham, electrical engineer, of Tintern Load, Moss Side, near Manchester, is to be heard at Salford County Court at 10 o'clock on January 9th.

ALLEGED FRAUD.—Henry Everard Hunt, electrical engineer, Manager of the Taunton Electric Light Works, has been remanded at the Taunton Police Court, charged with forging a promissory note for £233 with intent to defraud.

LIGHTNING CONDUCTORS.—Messrs. Morris and Gold send us some illustrated particulars of their system of lightning protection for church spires, chimney shafts, &c. The illustrations include several recent contracts.

MESSRS. GILBERT AND CO.—This firm inform us that they have opened a small central station at Cardiff for supplying current to the Philharmonic Restaurant, and other places close at hand. The plant at Messrs. Gilbert's installation of Messrs. Derry and Sons' premises, at Kensington, London, has recently been added to, and now more than 100 arc lamps have been provided, the majority of which are already working. Owing to increase of business the firm have had to extend their Hanway-street premises.

EXHIBITION.—The Mayors of the principal boroughs have received a circular stating that a committee of about 50 gentlemen, 25 of whom are members of Parliament, has been formed to promote a scheme for holding during 1896 or 1897, in London, a colossal International Exhibition.

PRICE OF GAS NORTH OF THE THAMES.—The St. Luke's Vestry is taking up the question of the difference of the price in gas north and south of the Thames. In the south the average price is 2s. 6d. per thousand, and in the north 3s. 1d.; and it is felt that some explanation is necessary why this difference should exist. The Gas Company pleads that more wages are paid, and that coal costs more, but the St. Luke's Vestry consider that the 12¼ per cent. received by the shareholders of the Gas Light and Coke Company chiefly accounts for the difference. The Islington Vestry have decided to support the action of St. Luke's in this matter, and no doubt other local authorities will follow. It is remarkable that an attempt has not previously been made by the local authorities to rectify this anomaly.

WOLFRAMINIUM.—Messrs. Van Wart, Leighton and Co. have on show at the National Cycle Show, now being held at the Crystal Palace, a new alloy of Roman metal, to which they have given the name of "Wolframinium." Cycle parts and also a complete cycle made in the metal are on show.

"THE ENGINEERING MAGAZINE."—The contents of the December number of this magazine are as varied and interesting as usual, and include "An English View of the World's Fair," by J. Stephen Jeans; "The Iron-Ore Region of Lake Superior," by Richard A. Parker; "History of Strikes in America," by Arthur A. Freeman; "Electric Power at the World's Fair," by Nelson W. Perry; "Relation of Chemistry to Engineering," by Joseph Torrey; "American and other Patent Systems," by Casper L. Redfield; and the usual Editorial Departments on Electricity, Architecture, Railways, Mining, and Metallurgy, and Machine-Shop Practice. The next number of the magazine is to be a souvenir edition, "The World's Fair in Retrospect," with over a hundred superb engravings, forming, with the specially-written letterpress, a splendid memorial of the great Chicago Exhibition. Orders for the European edition of this number should, in order to prevent disappointment, be sent in as early as possible to the publisher, Mr. George Tucker, Salisbury-court, Fleet-street, E.C.

THE HOOKHAM METER.—Messrs. Chamberlain and Hookham (Limited), of Birmingham, forward us a neatly-printed and illustrated descriptive pamphlet of the Hookham meter, including, amongst other particulars, the report on the meter by Mr. James Swinburne, and a reprint from the *Phil. Mag.* of the Paper by Mr. George Hookham, M.A., on "Permanent Magnetic Circuits." Instructions for using the meter, and prices, form part of the pamphlet.

THE "O.E." METER.—Mr. Joseph Edmondson sends us a useful hanging mounted sheet containing particulars of the "O.E." meter, and including a number of useful tables.

ELECTRICAL ADVERTISING SIGNS.—The Partington Advertising Company have entered into an agreement with the Electrical Advertising Syndicate (Limited), taking the sole agency in London for the sale of electrical letters (René Upward's patents).

SMITHFIELD CLUB SHOW.—This annual show has been held during the current week at the Agricultural Hall, London, N., and for the first time at these gatherings the electric light was in evidence. Messrs. Vaughan and Brown have installed a number of Luna arc lamps, and the light appears to have given satisfaction. Amongst the exhibitors were Messrs. Robey and Co., of Lincoln, who had on show a number of their well-known engines, several of which are specially designed for electric lighting work. Included in the exhibits was a high-speed vertical engine, for use in mills, factories, &c., where space is limited. All the wearing parts of this machine have large surfaces and are provided with means for self-lubrication. A Robey patent horizontal oil engine was a feature of the exhibit: the engine works on the Otto cycle, and contains a chamber capable of holding a week's supply of petroleum for working. All parts are easily accessible, and the

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combustion is perfect. The oil used in these engines can be the ordinary unrefined heavy petroleum of the cheapest kind. Messrs. Ransomes, Sims and Jeffries, of Ipswich, had as usual a fine display, including several of the latest patterns of both vertical and horizontal engines, and their new 6 and 8 H.P. portable engines, which have large steam-jacketed cylinders, wrought-iron crank shaft brackets, raised top fire boxes, and piston valve governors. The F vertical engine is connected with a new patent multitubular vertical boiler, so arranged as to present a maximum amount of heating surface in the smallest possible space, and giving ready access to every part of the boiler for cleaning, &c. Messrs. Marshall, Sons and Co. also had an excellent exhibit, including a 7 H.P. portable engine of the latest design, and a 10 H.P. compound engine, of which a large number are included in electric lighting plants throughout the country. A new 10in. fixed high-speed engine was also on show, fitted with the latest improvements in sight-feed lubricators, crank-shaft governors, &c. An engine specially designed for electric lighting purposes was a 6½in. vertical engine, fitted with Moore's crank-shaft governors. Messrs. Marshall and Sons have recently introduced a new 10in. engine fitted with Proell gear, sight-feed lubricators, Corins's exhaust pipes, chain gear, and all the latest improvements. This engine attracted considerable attention. Mr. E. S. Hindley, of Bourton, Dorset, had on show a number of small-power vertical engines for which the firm are well known, in addition to a 10 H.P. horizontal steam engine with disc crank and a 12 H.P. high-speed engine, of which a number have been supplied for electric lighting installations. These high-speed engines have been designed to work with steam up to 120lb. pressure, special provision being made for continuous lubrication and to prevent waste of oil. The governor is of special design, ensuring perfect regularity under sudden variations of work. Messrs. W. H. Willcox and Co. have their usual excellent exhibit of general engineers' stores in great variety. This is one of the handsomest stalls in the Smithfield Show, and it is doubtful whether any firm in the trade could make a more representative display of general stores. The Britannia Company exhibit Root's patent oil engines, of which a three-horse example was at work. Other exhibitors included Messrs R. Hornsby and Sons, the Campbell Gas Engine Company, and Messrs. John Fowler and Co. of Leeds.

Aberdeen.—The Gas Committee of the Aberdeen Town Council last week paid a visit to the new electric lighting station in Cotton-street. Mr. Murray, the city's electrical engineer, explained the various machinery and apparatus to the members of the Committee, and, in the course of a discussion which followed the visit, Mr. Johnston stated that it was unquestionably the best business the Corporation had undertaken for some time. That body had been handicapped seriously by having had to buy up the Gas Works from a company, and he believed that if they had not gone in for the electric light for themselves a company would have taken the matter up, which would ultimately have resulted in the Corporation having to buy them out. They might suffer a little loss at the start, but if they did as well as other towns were doing it would soon be a paying concern. He had no doubt whatever that as soon as the station was in condition to supply the light it would be very readily taken up by the townspeople generally. He was sorry to find that it was not anticipated the light would be ready before the middle of January, which was a disappointment to some of them, who would have liked to have seen the light in use at the beginning of the new year. Treasurer Bissett, at whose initiation the electric light work was undertaken, expressed the satisfaction he felt at the general success so far, and referred to the fact that it was only by the casting vote of the Chairman that it was agreed the Corporation should take the matter up. The Committee ultimately unanimously sanctioned the purchase of a quantity of necessary material, amounting in all to about £520.——Messrs. Drake and Gorham have recently completed an electric-lighting installation at Ardoe House, Aberdeen, for which water-power is obtained from the Burn of Ardoe. The plant includes a turbine supplied by Messrs. Gilbert Gilkes and Co., of Kendal, which is placed over a brick well 20ft. deep, from which the waste water is conducted, supplying a head of water of 63 feet.

Assessment of Electric Lighting Plant in the City of London.—At the meeting of the City Guardians on Tuesday, Mr. Klenck called attention to the electric lighting companies within the City area, with a view of having their plant, &c., assessed in the same way as other City undertakings and properties. Mr. Odell, Chairman of the Assessment Committee, stated that the matter was at present receiving the attention of the committee.

Bandon.—A recent meeting of the Town Commissioners discussed the question of opposing the application made by the Bandon Electric Lighting Company for a Provisional Order. After some discussion it was decided that the Board should oppose the scheme.

Blackburn.—Major-General Crozier held a Local Government inquiry last week on the application by the Corporation for powers for borrowing £200,000 for the purpose of the erection of new gasworks. The old gasworks will probably be devoted to electric-lighting purposes

Bray.—The liquidator of the estate of Messrs. J. E. H. Gordon and Co. has written to the Bray Township Commissioners, offering to dispose of his client's interest in the Bray Electricity Works to the Commissioners.

Bristol.—It is anticipated that the Electrical Committee of the Corporation will require to borrow about £20,000 for further extension of the electric lighting plant. The number of applications for the light have exceeded expectations, and an expenditure of £4,000 for additional plant is immediately necessary.

Burnley.—It has been decided to supply the electric light at Burnley at 4d. per unit. Applications for light equal to 3,434 lamps of 8-c.p. have been received.

Camberwell.—A meeting of the Vestry was held on Wednesday for sending a memorial to the Board of Trade for a Provisional Order under the Electric Lighting Acts. The standing orders of the Board of Trade require a statement as to the amount of capital proposed to be expended in the undertaking, and the Vestry, on the estimates of an expert, have quoted £50,000.

Castleford.—At the annual meeting of the Castleford Tradesmen's Association Mr. Little was elected President for the ensuing year, and, in the course of some remarks, suggested that instead of the Local Board disposing of the surplus plant at the disused waterworks it should be utilised for electric lighting purposes. The Board has already had expert evidence on the subject, and it appears likely that before next winter the town will be provided with the electric light.

Cathedral Lighting.—The Restoration Committee of St. Paul's Cathedral have discussed the question of installing the electric light in the cathedral, and have appointed a sub-committee to inquire what the expense would be. If it is ultimately decided to have the light, an appeal will be made for special funds.

Chelmsford.—The local authorities of Chelmsford are again discussing the question of the electric light, and at last week's meeting of the Town Council the Lighting Committee presented a report recommending the renewal of the contract for the public lighting of the town by electricity on the same terms as before; also the approval of the Provisional Order for which Messrs. Crompton and Company are applying to the Board of Trade; and further, the modification of an order by the Board of Trade that the electric-light wires in some of the principal streets should be placed underground. Messrs. Crompton's proposed Provisional Order was opposed by Aldermen Chancellor and Duffield, who complained that under its provisions Messrs. Crompton would obtain the whole of the private lighting for 42 years; but it was explained that the Provisional Order does not touch the question of public lighting, and there is nothing to prevent the Town Council from putting down its own plant for illuminating the streets. The matter is under discussion in committee of the whole Council.

Dover.—The Dover Electric Light Supply Company having been formed, and the official transfer of the powers under the Provisional Order from the Corporation to the Company having been legally executed, the Directors of the Brush Company called together last week a number of the principal townsmen, under the chairmanship of Sir W. H. Crundall, J.P., who is Mayor of Dover, and Chairman of the new company. The Chairman briefly referred to the somewhat lengthy negotiations which preceded the formation of the Company, and Mr. Sellon gave an interesting account of the prospects of electric lighting in the town. It was stated that arc lights of 3,000 c.p. are to be used for the public lighting.

Dudley.—Alderman Bagott (not Bigot), in moving the adoption of the Streets and Gas Committee's report, submitted a statement showing the number of towns that had obtained Orders for electric lighting, and pointed out that the Council, if they proceeded with the suggested scheme, after obtaining the Order, would have to get an electrical engineer at a salary of £400 or £500 per annum, then spend £20,000 or £30,000, and take all the risk. He further stated that out of 60 towns which had applied for Orders, only *four* had gone on with their schemes. He suggested that Dudley should join those local bodies who were watching to see if success attended those who had decided to proceed with the work.

Eccles.—The Tramways and Electric Lighting Committee of the Town Council will, at their next meeting, discuss the advisability of taking steps to light certain portions of the Borough with the electric light. The ratepayers will be consulted on the subject, we understand, shortly.

Edinburgh.—A considerable extension of the electric lighting area is under consideration by the Lord Provost's Committee.——A letter was received on Tuesday last by the Town Council from Messrs. Dick, Kerr and Co., asking to be allowed to sub-lease the

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Edinburgh tramway undertaking to the Edinburgh Tramway Company (Limited). After some discussion, a proposal that Messrs. Dick, Kerr and Co.'s letter remain on the table for one month was adopted.

FLEETWOOD.—The Electric Lighting Committee are still considering the tenders received for carrying out the electric-lighting scheme, and have adjourned the further consideration of the matter for a few days.

THE GENERAL POST OFFICE.—The new seven-storied building just completing for the use of the postal and telegraph authorities is being wired throughout for the electric light. The new building is one of the largest in London, and is known as the G.P.O. "North," to distinguish it from the older buildings known as "West" and "East." Nearly 200 H.P. will be necessary to supply current for about 2,000 16-c.p. lamps, which will ultimately be installed. The wiring work is being carried out by the department's own staff. A large increase in the generating machinery will be necessary, although it is intended to take a portion of the current from the "East" building. The machinery in this building, however, appears to already have its capacity severely taxed at times.

HACKNEY.—A special committee, appointed by the Board of Works, to consider the subject of electric lighting has sent in its report, and the matter is now under consideration. Under the powers recently obtained by the Board the parishes of Hackney and Stoke Newington are to be supplied with the electric light in due course.

HALIFAX.—An exhibition, interesting both to sanitarians and electricians, is now being held at Halifax for the purpose of demonstrating the feasibility of generating steam for electric lighting, &c., with ash-bin refuse as the only fuel. The installation (close to the Northern Engineering Company's premises in Parkinson-lane) consists of Livet's two-furnaced expanding flue steam generators, capable of giving off 300 H.P. when town's refuse is burnt. An electrical installation, consisting of a Parsons turbo-electric generator, is being put down, which will consist of a projector search-light of 25,000 c.p., and a full complement of arc lamps. These steam generators, instead of only destroying the refuse as "destructors" do, utilise it to the fullest advantage by turning it into steam.

HAMMERSMITH.—At the last meeting of the Hammersmith Vestry it was decided to instruct Messrs. Morgan Williams and King, of Westminster, to prepare a report for the carrying into effect the terms of the Provisional Order recently obtained, at a fee of 100gs.

HAMPSTEAD.—At the last meeting of the Hampstead Vestry a letter was received from the London County Council in reference to the application of the Vestry for a loan of £5,000, part of a sum of £25,000 for electric lighting purposes, and making inquiries as to the intention of the Vestry to make provision for a periodical replacement of machinery and plant by the establishment of a depreciation fund. The matter was referred to the Electric Lighting Committee, whose report on the subject of electric lighting generally is expected. The London County Council, on Tuesday, decided to lend the Vestry the sum of £25,000 for twenty-five years.

HULL.—Dr. Holder, the Chairman of the Electric Lighting Committee of the Hull Corporation, at the last meeting submitted a report from the Electric Construction Company (Limited), submitting their views upon the subject of electric traction. The Company stated their readiness to negotiate for the electrical equipment of a line of tramway, and for its subsequent working, at a figure much less than if worked by either horse, steam, or other mechanical power. After some discussion it was decided to refer the letter to the Tramways Sub-Committee, to be discussed by them in relation to the utilisation of heat from the destructors for the purposes of electric supply. Mr. G. F. Priestly has written to the Committee, calling attention to a new type of refuse destructor, with special reference to its being utilised in the town supply of electricity. Satisfaction was expressed by the Committee at the large number of customers already taking the light.

LANCASTER.—The price for electric current was fixed at 4½d. per unit at the last meeting of the Town Council. Amongst a quantity of plant and material authorised to be purchased were 50 Ferranti meters. An extension of the light is under consideration.

LEEDS.—The Highways Committee of the Leeds City Council recently discussed the subject of applying electricity to the Leeds tramways, which shortly come into the possession of the Corporation. Horse and steam power are at present used. A discussion took place upon various points raised in the consultation with Mr. R. Hammond, but no definite understanding was arrived at. The matter is to be further discussed.

LEIGH.—Amongst the buildings recently lighted, or which are being wired for the electric light, are the Athletic Clubs' Grounds and rooms and the Theatre Royal. A number of the principal shops are adopting the light, and Mr. W. Boydell, of Brown-street Ironworks, is working energetically to make it a success in the town.

LIVERPOOL.—The Church for the Blind in Hardman-street has been fitted with an electric organ by the Hope-Jones Electric Organ Company, of Birkenhead. The first trial of the organ proved highly satisfactory.

LLANDUDNO.—A public meeting was held last week to discuss the project of an electric railway up the Great Orme's Head, and a resolution approving of the proposal was carried by a large majority. The project, however, meets with considerable local opposition.

LYNTON.—At the last meeting of the Local Board the Clerk announced that the Electric Lighting Company were unable to supply more lights at present, as the entire capacity of their plant was already taken up.

MARGATE.—A Committee of the Town Council, specially appointed to consider electric lighting and tramway schemes, recommends that such schemes be not entertained, "as the time is too limited for a proper consideration of these matters." The committee's report has been adopted, so that nothing can be done in the matter until next year.

OMNIBUS LIGHTING.—The London General Omnibus Company were last week summoned for permitting a number of omnibuses to be in a public thoroughfare after sunset without a light. The Secretary of the Company explained that the vehicles were fitted with the electric light, which answered admirably in the summer, but were insufficiently supplied with battery power for winter lighting. He, however, was able to state that a new contract had been entered into by which all future liability of the kind would be obviated. After this explanation the magistrate imposed a nominal fine of 1s. and costs in each case.

OXFORD.—Messrs. Girdlestone, Tatham and Co. have been instructed to proceed with the work of installing the electric light at Oriel College. The work is to be carried out during the Christmas vacation.

PORT ELIZABETH (SOUTH AFRICA).—The Town Council of Port Elizabeth are anxiously discussing the question of lighting the port by electricity, and there seems every probability of an affirmative vote being obtained.

PORTHCAWL.—The local Electric Light Company have induced the Local Board to accept their offer for erecting and maintaining 23 electric lamps in the public streets.

RUSSIA.—It is reported that the Russian Minister of Finance has decided upon the issue of a decree exempting from Customs duties any foreign goods intended for Russian exhibitions.

ST. HELENS.—A sub-committee of the Town Council has been appointed to superintend the supply of electricity within the borough.

TAUNTON.—The Electric Lighting Committee of the Town Council have considered Dr. Fleming's proposal for the extension of the electric light. They will get rid of the small house transformers, and the town will in future be supplied from transformer sub-stations. Dr. Fleming considered it necessary to at once commence putting down underground mains, and work has been commenced in No. 1 district. Dr. Fleming has reported upon a number of tenders sent in to the Committee, and those accepted are detailed above.

TWICKENHAM.—The Local Board recently issued a circular asking support for their electric-lighting scheme. Of the circulars issued 133 were not returned, 134 returned in blank, 92 in favour of gas, and 274 in favour of electricity. The present annual cost of lighting houses where electricity is preferred is £3,006. 10s., and occupiers of these houses will be willing to pay £3,281. 14s. per annum for electricity, the number of lights required being 5,708. After some discussion it was decided to abandon the electric-lighting scheme for the present.

WALSALL.—The Town Council will have before them at their meeting on Monday next the proposal of the General Purposes Committee that the Council apply to the Board of Trade for their approval of the adoption of a scheme for electric lighting for the borough, and to the Local Government Board for sanction for a loan of £19,650, in addition to the estimated cost of the site for the works. It will be remembered that contracts have already been provisionally accepted from the Electric Construction Company (Limited), for £10,003; Messrs. Bumsted and Chandler, for £1,350; and Messrs. H. and T. Danks, for £805, for final acceptance as soon as the approval of the Board of Trade and the sanction of the Local Government Board is received.

WINCHESTER.—The Corporation have before them a scheme of electric lighting, which would, if carried out, involve an outlay of about £20,000, and would be adopted only for the more central parts of the city, leaving out the suburbs of St. Cross and other large ratepaying districts. It has been urged on the civic authorities that if there were a large participation in the scheme by private and public institutions, shops, &c., the cost would be greatly reduced, and to ascertain how many such will pledge themselves to

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adopt the light, a professional electric expert is to be employed to canvass the city, explaining the cost of fitting, the mode of lighting and other details. The result will not be known till February.

WORCESTER.—A rumour was current last week that a serious misfortune had happened to the works at Powick. It appears, however, that a landslip had occurred owing to the continued rains, but that no damage was done to the works now in progress——. The Water and Sewage Committee have decided that the surveyor shall consult with Mr. C. Hawksley, the Corporation's engineer, with a view of deciding the extent to which electricity can be utilised for pumping or purifying the sewage in connection with the new schemes which the Corporation have now under consideration.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

October 31, 1891.

20,557. E. REDANTZ. Liverpool. Improvements in electrical switches

20,584. A. J. MARQUAND and E. HANCOCK. London. Improvements in the manufacture of elements for electric or secondary batteries.

November 1, 1893.

20,625. H. T. BARNETT. London. Improvements in and connected with carbon electrode connections.

20,686. W. E. GRAY and W. A. PRICE. London. Improvements in electrical condensers.

20,698. G. G. M. HARDINGHAM. London. Improvements in, and in connection with, electric cables. (The firm of Felten and Guilleaume, Germany.)*

20,715. W. E. F. RUCKERT. London. An electrical heating apparatus.*

November 2, 1893.

20,723. W. T. GOOLDEN and S. EVERSHED. London. Improvements in electric measuring instruments.

20,732. W. ALDRED. Sheffield. An electrical or mechanical apparatus in connection with a ship's sounding lead, or for cognate purposes.

20,735. J. BALL. Manchester. Improvements in lightning conductors.*

20,788. C. DENN, J. COCKER, and C. DENN. London. Improvements in electric stop motions for warping machines.

20,793. A. MUIRHEAD. London. Improvements in recording instruments for electric telegraphs.

20,799. M. H. HARTOGH. London. Improvements in electric incandescent lamps.*

20,816. H. R. KEITHLEY. London. Improvements in connectors for electric conductors.

November 3, 1893.

20,837. W. E. AYRTON and T. MATHER. London. Improvements in electrostatic and other electrical measuring instruments.

20,840. A. E. SCHURR. Leigh-on-Sea. Electric firedamp indicator. (J. Cauderay, Switzerland.)

20,847. W. H. SCOTT. Norwich. Improvements in carbon brushes, blocks, or collectors, for electric generators and motors.

20,859. F. G. TREHAME. Cardiff. A process by which, by combined chemical and electrical action, he obtains motive power.

20,883. BULLERS (LIMITED) and E. J. CHAMBERS. London. Improvements in brackets or supports for insulators for telegraphic, telephonic, and other like purposes.

20,891. P. A. NEWTON. London. Improvements in phonographs and telephones. (A. Nobel, France.)

20,896. SIEMENS BROS. and Co. (LIMITED). London. Apparatus for working semaphore signals by means of electric currents. (Messrs. Siemens and Halske, Germany.)

November 4, 1893.

20,915. W. E. AYRTON and T. MATHER. London. Improvements in alternate-current synchronisers.

20,923. H. T. BARNETT. London. Improvements in the means of charging and discharging primary electric batteries.

20,966. J. PLUMMER. Midlothian. Improved incandescent electric lamp.

20,975. J. A. S. GREGG. London. Improvements in voltaic batteries.

21,004. K. RODLER. London. A method of, and apparatus for, electrically protecting trains.

November 6, 1893.

21,046. A. M. THOMPSON and W. G. WEBB. Crewe. Improvements in electric switches.

21,077. C. E. H. EDMAN and J. GREEN. London. Improvements in electrical arc lamps.

November 7, 1893.

21,094. H. F. LAUGHTON. London. A method of improving electric light switches, bell pushes, keyhole plates, door numbers, name plates, dials of clocks, house fittings, and the like, by the application of luminous paints thereto.

21,117. R. W. WEEKES. Manchester. Improvements in and relating to electrical dynamometric governors.

21,140. G. COHEN. Manchester. Improvements in medical electrical appliances.

21,192. G. S. RAM. London. Improvements in incandescent electric lamps.

November 8, 1893.

21,199. W. L. SPENCE. Pollokshields, N.B. Power transmission by alternate-current motors.

21,201. F. T. TROUTON. Dublin. A multiple circuit microphonic transmitter.

21,270. J. A. MURDOCH. London. Improvements in and in constructing pianoforte cases for lighting music desks by electricity.

November 9, 1893.

21,324. S. Z. DE FERRANTI. Liverpool. Improved electric cables and method of, and apparatus for, manufacturing the same.*

21,327. E. BERGMANN and C. ERBEN. Liverpool. Improvements in electric meters.

November 10, 1893.

21,370. W. H. TURCAN, and R. C. MORTON. Glasgow. Improvements in mouthpieces for telephone transmitters.

21,379. A. G. ADAMSON. Glasgow. Improvements in the application of electric light for photographic purposes and apparatus therefor.

21,418. A. CROSS and H. SIMON. London. Automatic burglar-proof shutter for inside of jewellers' window with electrical alarm.

21,430. C. J. P. ROBERTSON. London. Improvements relating to incandescent electric lamps.*

21,434. F. W. SCHINDLER. London. Improvements in electrically heated ovens.

21,435. F. W. SCHINDLER. London. Contact-device or circuit-connection for electric heating bodies, and analogous electrical appliances.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d. each.

1892.

19,919. DE SOLOMÉ. Electric conductors.

20,445. RAAB. Electric meters.

22,261. HILLS. Electric arc lamps.

23,101A. SCHROEDER, C. A., J. H., and H. E. R. Galvanic batteries.

24,009. CROMPTON and CHAMBERS. Pipes for electric cables, &c.

1893.

17,564. KOCH. Electric accumulators.

18,323. LEIGH (Chevallier). Electric batteries.

18,480. RAHNER. Dynamo-electric machines, &c.

18,524. BURNS, J. R. and W. F. Indicators for telephone stations, &c.

COMPANIES' MEETINGS.

Elmore's French Patent Copper Depositing Company (Limited).

Mr. C. J. Stewart (the Official Receiver) presided on Tuesday last at the Holborn Restaurant, London, W.C., at a meeting of the English creditors in the above Company.

The CHAIRMAN expressed a wish that Mr. Duncan should be appointed liquidator, and this was agreed to. He proceeded to say that he had been asked by the Directors to mention that of their fees, which appeared in the statement of deficiency as £3,600 (see last week's *Electrician*), part was receivable in cash and part in Preference shares.

The meeting was subsequently adjourned until the 20th inst.

At the meeting of shareholders, held in the afternoon, also under the presidency of Mr. Stewart, the CHAIRMAN attributed the failure of the Company to the fact that the works were undertaken on too large a scale in proportion to the capital. It was intended to raise more capital when the merits of the process had been proved; but this had not been done by the time the additional capital was required, and, consequently, the Preference shares were not subscribed for to the extent which had been hoped. The price paid by the Company for the patents was £183,375, of which £116,000 was paid in cash. To that had been added a large expenditure on works, bringing up the total cost of the patents and works to £311,138. That, however, did not include the amount of £17,000 spent in addition, in improving and experimenting on these patents. One grave difficulty which he had had to face in unravelling the affairs of the Company was the fact that the whole of its affairs seemed to have been mixed up with the firm of Messrs. Woodhouse and Rawson United (Limited). There was one office, one secretary, and the whole of the correspondence of the two Companies appeared to have been placed together. In justice to the Directors he would like to say that of the fees paid to them—£3,000 in all—part was paid in cash and part in Preference shares, while the Directors had lent the Company upwards of £1,400. In justice also to Mr. F. L. Rawson (who he had mentioned in his statement of affairs had exercised great influence in the management of the Company) he would like to add that it was in the financial management of the Company when it got into difficulties. Mr. Rawson had obtained large sums of money for the Company at reasonable rates of interest, and was not responsible for the high rates mentioned in his report. Nor was Mr. Rawson responsible for the management of the Company and the spending of these large sums. Mr. Rawson had given him the opportunity of looking into these matters.

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Mr. F. L. RAWSON stated that from the words of the Official Receiver it might be understood that the affairs of Woodhouse and Rawson and the Elmore Companies were mixed up, whereas the Official Receiver intended to convey that the affairs of the different Elmore Companies were mixed up. In order to save expense, all the Elmore Companies employed one secretary, and the correspondence was kept together, but all the necessary books were kept separate.

The OFFICIAL RECEIVER: Yes; Mr. Rawson is right, it is as he states.

Mr. RAWSON (continuing): He had sent a long letter to the Official Receiver, showing exactly his connection with the French Elmore Company, giving all the facts in such a way that the Official Receiver could check the statements made. In the early days of the Company he had assisted in connection with the patents, and from that day to this the Company had never had any difficulties with their patents. When M. Secretan insisted upon an expenditure of £80,000 upon the works if he took the post as manager, he attended a Board at which the English Elmore officials were present, who stated that the English Company would be turning out 20 tons per week in three months. He then told the French Elmore Board that if this were the case he could obtain any reasonable amount that the French Company required at a moderate rate of interest. Experience had since justified this statement. His next connection with the Company was in November, 1892, when the Board came to him and, as they were in financial difficulties, placed their money matters in his hands. Between that date and July, 1893, he obtained for them over £100,000, at an average rate of not more than 6 per cent. per annum. He then stated that if they could turn out 20 tons per week for twelve consecutive weeks he would obtain for them £100,000 at a reasonable rate of interest. The Directors required £30,000 to carry this out, and, with the assistance of his own personal guarantee, and with that of Lord Farrer, Mr. John Wood, Mr. Holland, and others of the large shareholders who came to his help, he obtained an offer of a loan of £30,000 for them for twelve months at 8 per cent. per annum from one of the Trust companies. The Directors refused this offer, as they were promised £50,000 at 6 per cent. Ultimately this arrangement fell through, and the Directors applied again to him (the speaker), having in the meantime had to borrow £20,000 at the high rates of interest mentioned in the Official Receiver's report. Mr. Rawson then obtained further loans, and negotiated the sale of the Company's business in France, which sale would have taken place, and the Company would not have gone into liquidation had it not been for the action of certain parties.

Mr. DUNCAN, as the official liquidator, also spoke, and, at the request of some of the shareholders, explained the present position of the Company. They had now sold the property for the sum of £8,600 in cash, £60,000 in debentures, and £5,000 in Founders' shares. These were very nearly the same terms as were offered before, because, although they were offered £20,000 in cash, yet they had to provide out of that certain heavy payments. They had gone a step further, and, with the consent of a large number of the creditors and debenture holders, they had been trying to work out a scheme by means of which something might still be saved for the shareholders; and there was a provision made by which the debenture holders would consent to be paid out in French paper for their credits against the Company, plus the interest at par. If this scheme were passed, the ordinary creditors would consent, also, to take paper in the shape of first mortgage debentures on what assets would then belong to the resuscitated Company, because the Company would continue, in a sense, as a Trust Company for receiving the results from Paris and distributing the same. They had also secured the consent of the Foreign and Colonial Company to postpone its claim on £50,000 of its holding in shares until the Ordinary shareholders should have received 5 per cent. Of course, such a prospect as 5 per cent. dividend on the Ordinary shares seemed a long way off; but it was not altogether impossible of realisation, judging from the appearance of things at present. In fact, he thought it was quite possible that they might still see something back on their shares. Altogether, the scheme was well worthy of their consideration; for it came to this—that if the process could have made profits in their hands, with the assistance of £80,000 more of cash put into it, then they would get more than half the same results; in fact, the scheme would be a bigger thing in reality, in the future, than it would have been in their hands.

After various questions had been answered by Mr. Duncan, Major Jones and Mr. Rawson, Mr. STRETTALL asked what the total amount of the commissions and fees were that Mr. Rawson had been paid for the work done by him.

Major JONES (late Chairman): Not a penny.

The OFFICIAL RECEIVER confirmed this, and Mr. Rawson stated that he would like to mention, to avoid misunderstandings in the future, that he had received a call of 10,000 Preference shares at par for certain services rendered. He has handed over the major portion of this call to parties who had, he considered, been badly dealt with by the Company, and had returned the balance of the call to the Company. He had not actually received his out-of-pocket expenses, with the exception twice of his ticket to the North of England.

At the request of Mr. Duncan his appointment as liquidator to carry out the scheme was adjourned till Wednesday, the 20th inst.

Hove Electric Lighting Company (Limited).

The following is the first report of the Directors of this Company, which is to be presented at the annual general meeting to be held at the Town Hall, Hove, Sussex, on Tuesday next, at three o'clock :—

The Directors congratulate the shareholders upon the success which has attended the operations of the Company to the present date. The balance-sheet accompanying the report is made up to September 30th last, and is only an interim statement, to be followed early next year by the accounts up to December 31st, prepared in the form required by the Board of Trade. The result of working up to September 30th, after debiting to revenue a proper proportion of the administration charges, from January 1st, when the lighting was practically commenced, is a debit balance of £264. 10s., a result which, in a new enterprise, must be considered satisfactory. Since about the middle of September the working account shows a steadily-increasing net profit each week, and the balance at the debit of the profit and loss account on September 30th has since been reduced considerably, and the Directors hope will soon disappear. The contract with Messrs. Crompton and Co. (Limited) was sealed on August 19, 1892, and by November 28th following a temporary station had been erected, with the necessary plant and machinery, a considerable length of permanent mains had been laid in culverts and casing, and the supply of electric current to the public was commenced, and has continued ever since without interruption. Since that date the mains have been extended in various directions to meet the public demand, until the total length now laid exceeds 6¼ miles. The erection of the permanent station by the contractors is rapidly approaching completion. The number of houses and buildings connected up to the Company's mains is 82, and, including arc lamps and sockets, the number of lamps attached to the system is equal to 6,169 of eight candle-power. Applications for the light are also steadily increasing, and it is confidently expected that the Company will soon be doing a large and remunerative business. From the station report of November 23rd, the net profits of the Company, after providing for all administration and other charges, amounted to £18. 15s. 0d. for the week. On September 30th last, the Company had issued 3,290 shares, and a few more have since been taken up, but the large amount due to contractors and others makes it a matter of urgent necessity that further capital should be obtained forthwith. The Directors have appointed Mr. Robert Payne (chartered accountant) to be Auditor.

CITY NOTES, &c.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns for the week ending December 3, 1893, were £902, as against £907 in the corresponding period of last year, being a decrease of £5. The total receipts for the half-year amount to £18,221, as against £18,043 for the corresponding period, 1892, being an increase of £178.

COMMERCIAL CABLE COMPANY.—A quarterly dividend of 1¾ per cent. on the outstanding stock of this Company is declared payable on January 2nd next to stockholders on the books on December 21st. The transfer books of the Company will be closed from December 21st to January 2nd, inclusive.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of November are £3,300, as compared with £3,262 in the corresponding month of last year.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for November amounted to £2,442, as compared with £2,137 in the corresponding period of last year.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of November amounted to £60,995, as against £60,491 in the corresponding period of last year, or an increase of £504.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of November amounted to £40,247, as against £40,851 in the corresponding period of 1892.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company for November amounted to £21,600, and from January 1st to November 30th to £248,400. In the corresponding periods of 1891 and 1892 the amounts were £260,200 and £245,600 respectively.

RICHARD HORNSBY AND SONS (LIMITED).—The ordinary general meeting of the shareholders of this Company was held at Cannon-street Hotel, E.C., on Monday last.—Mr. James Hornsby, in moving the adoption of the report, stated that severe competition, with lowered selling prices and other unfavourable circumstances, had had much to do with their unfavourable balance-sheet, but they were doing their best to meet all the changing requirements of the times. They had met the falling off in business caused by the general depression as well as they could, and had been greatly helped by the increased demand for their goods in South America. The item in the balance-sheet of sundry debtors, £136,037, was about £5,600 more than last year; but last year's amount was unusually low, being £9,000 less than the previous year, so that that amount was in no way excessive. Those debts were thoroughly good, and were being well collected, over £70,000 having already been received.—The report was adopted.

MORECAMBE ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—A special meeting of the shareholders, called to consider the necessity of increasing the subscribed capital of the Company, took place at Crescent-chambers, Morecambe, on Wednesday last week. After statements by the Directors and secretary as to the amount of outlay the Company was committed to for the extensions of plant made this year, and the position in other respects, nearly 1,000 shares were subscribed in the room. One of the Company's engineers, we understand, took more than 500.

NATIONAL TELEPHONE COMPANY (LIMITED).—Notice is given that the transfer books of this Company will be closed from the 9th to the 22nd inst., both inclusive, preparatory to the payment of an interim dividend, the warrants for which will be posted on the 22nd inst.

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NEW SHANGHAI ELECTRIC COMPANY (LIMITED).—An extraordinary meeting of the shareholders in this Company has been held, when the resolutions, previously passed, that the Company be wound up voluntarily, with the Directors as liquidators, were confirmed.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the week ending December 1st (after deducting 17 per cent. of the gross receipts, payable to the London Platino-Brazilian Telegraph Company, Limited), were £3,469.

COMPANIES' SHARE LIST.

Present Amount.	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Nov. 29.		Price Wednesday, Dec. 6.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Dec. 6. Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	12/6	Anglo-American	43	45	43	45	6 2 3	Jan., Apr., July, Oct.	44½	43¾
£2,932,680	Stock	25/0	Do. Preferred	82½	83½	82	83	6 12 6	" "	83½	82⅝
£2,932,680	Stock	5/0	Do. Deferred	7½	8	7½	8	..		7⅞	..
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	100	103	100	103	3 17 8	January and July ..	..	..
130,000	£10	4/0	Brazilian Submarine xd & bonus	11¾	12¼	11¾	12¼	5 6 1	Mar., June, Oct., Dec.	12	—
£18,700	£100	5%	Do. 5 per Cent. Bonds	100	103	100	103	4 17 1	January and July ..	..	—
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	..	—
10,000,000	$100	7%	Commercial Cable Capital Stock	140	150	140	150	4 13 4	Jan., Apr., July, Oct.	..	—
16,000	10	8/0	Cuba Submarine	11½	12½	11½	12½	6 8 0	February and August	12½	12
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	—
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October ..	..	—
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	..	—
60,710	20	3/6	Direct United States Cable, 1877	11½	11⅝	11½	11¾	6 1 9	Jan., Apr., July, Oct.	11½	11⅜
400,000	10	2/6	Eastern	14¾	15	14¾	15¼	4 5 11	" "	15⅛	14¾
70,000	10	6%	Do. 6 per Cent. Preference	15½	16½	15½	16½	3 12 9	" "	16⅛	15¾
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	115¼	114¾
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	108	111	108	111	4 10 1	February & August	..	..
250,000	10	2/6	Eastern Extension	15¼	15½	15⅜	15⅝	4 9 7	Jan., Apr., July, Oct.	15 9/16	15 5/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	114	117	114	117	3 8 5	February & August	116½	115¾
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	102	105	102	105	4 15 3	January and July ..	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	102	105	102	105	4 15 2	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	102	105	102	105	3 16 2	February & August	..	—
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	105%	108%	105%	108%	3 14 1	May and November	105½	..
180,227	10	1/6	Globe Telegraph and Trust	8⅜	8⅝	8¼	8¾	5 2 10	Jan., Apr., July, Oct.	8¾	8½
180,042	10	6%	Do. 6 per Cent. Preference	14⅞	15⅛	15⅛	15⅝	3 18 1	" "	15¼	15 3/16
150,000	10	5/0	Great Northern	20	20½	20	20½	4 3 0	Jan., April, and July	..	..
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	103	106	103	106	4 14 4	March & September	..	..
17,000	25	12/6	Indo-European	40	43	40	43	5 16 3	May and November	40½	—
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	3 6 8	" "	..	—
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	105	108	5 11 1	March & September	..	—
£100,000	£100	4%	Pacific European Telegh. 4% Guar. Debs. "Red" 1942	102	105	102	105	3 16 2	..	..	..
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October ..	5⅞	..
3,381	£100 Cert.	35/0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	" "	116½	116
15,609	10	5/0	West African Telegraph	5½	6½	5½	6½	7 13 10	January and July ..	..	..
£249,900	100	5%	Do. 5 per Cent. Debentures	98	101	98	101	4 19 0	March & September	..	..
30,000	10	2/0	West Coast of America	2	3	2	3	..	January and July ..	..	—
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	103	99	103	7 15 4	June and December	..	..
88,321	10	1/0	West India and Panama xd	1⅛	1⅜	1	1¼	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference xd	10	10½	9¾	10¼	5 17 1	May and November	10⅛	9¾
4,669	10	6%	Do. 6 per Cent. 2nd Pref. xd	9	10	8½	9½	6 6 4	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	108	111	108	111	4 10 1	June and December	..	..
64,242	15	4/6	Western and Brazilian	5½	6½	5½	6½	3 9 4	May and November	..	..
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5¼	5¾	5¼	5¾	..	..	5½	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1	1½	1	1½	..	..	1 7/16	1½
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	103	106	103	106	5 13 2	February & August	..	..
£222,700	100	6%	Do. 6 per Cent. Mort. Debs. Series "B" 1910	103	106	103	106	5 13 2	" "	..	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	105	102	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	..	..	—
22[illegible],000	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/8	3/8	1/8	3/8	..	May and November	..	—
220,000	£1	4·76d.	Oriental Telephone and Electric (11s. paid)	3/16	5/16	3/16	5/16	6 7 9	Yearly	..	..
484,597	5	2/6	National	4¾	5	4¾	5	5 0 0	June and December	4 13/16	4 11/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14	15	14	15	4 0 0	" "	14⅞	14½
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	13¼	14¼	13½	14½	4 2 9	" "	14	..
119,234	5	2/0	Do. 5% Non-Cumulative 3rd Pref.	5¼	5½	5¼	5¼	4 10 11	..	5 7/16	..
925,017	£100	4½%	Do. Deb. Stk. 4½%	113	115	113	115	3 18 3	January and July	..	..
5[illegible],000	5	1/0	United River Plate	2	2½	2	2½	..	January and July	..	—
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11½	11¾	11½	11¾	—	—	11⅝	11½
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	12¾	13¼	12¾	13¼	..	—	13⅛	12 15/16
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	—	..	—
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	—
8,322	£5	..	House to House Electric	..		..		—	—	..	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		..	..	—	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July ..	..	—
30,000	£5	1/9	Liverpool Electric Supply (£3 10s. paid)	4½	4¾	4½	4¾	..	—	—	—
15,000	£5	2/6	Do. (fully paid)	6½	6¾	6½	6¾	..	—	..	—
111,000	5	..	London Electric Supply	¾	1	¾	1	..	..	..	..
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	7¼	7¾	7¾	8¼	2 8 5	..	7⅞	7½
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40) .. xd	106	109	103	106	4 14 4	June and December	..	..
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	—	—	..	..
19,980	£5	9½%	St. James' and Pall Mall	6	6½	5¾	6¼	..	—	6 1/16	5 15/16
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	—	8 1/16	—
59,900	5	1/6	Westminster Electric Supply (fully paid)	5	5½	5	5½	3 3 8	—	5 7/16	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	2/1	Brush Electrical Engineering	2⅝	2⅞	2⅝	2⅞	6 5 8	—	2⅝	..
90,000	2	6%	Do. 6 per Cent. Preference Non-Cumulative.	2¼	2½	2⅛	2⅜	5 1 1	—	2⅜	2 3/16
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	106	108	105	107	4 4 1	March & September	107½	106
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	4¼	4¾	4	4½	..	January and July	4½	—
12,189	5	..	Edison and Swan United	—		—		—	—	—	—
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	—	..	—
49,900	10	12/0	Electric Construction	..		..		..	—	1 3/16	..
91,195	2	10/0	Elmore's Patent Copper Depositing	¼	½	⅛	⅜	—	—	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	—	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21½	22½	21½	22½	5 11 1	February & August	22	21⅞
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	..	—
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	..	—	—
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	—	—
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/0	4/0	3/0	4/0	..	—	—	—
78,949	5	1/9	Swan United (£3. 10s. paid)	2	2½	2	2½	..	May and November	—	..
37,350	12	12/0	Telegraph Construction and Maintenance	35	37	36	38	4 9 1	March and July	37	36
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	104	107	104	107	4 13 6	January and July	..	..
37,514	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		—	—	..	—
41,098	£5	..	Do. Preference (fully paid)	..		..		—	—	—	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	¾%	City and South London Railway	28	83	28	33	2 5 5	May and November	..	—
37,500	£10	..	Liverpool Overhead Railway	5¼	5½	5¼	5½	—	—	..	—

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THE ELECTRICIAN:

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NOTES.

THE supply of electrical energy from Deptford was last week once more impeded by a series of accidents. Unlike the recent difficulty at Bankside, where the failure of the field-circuit of one machine spread trouble through the remainder of the plant, the three mishaps at Deptford were practically independent. Unlike the Bankside accident, too, they did not arise from electrical causes, but were purely mechanical. And to push the contrast further, the Mordey alternators suffered from being banked together before suitable cut-outs had been fitted, the subdivision of units rendering no assistance, while the Ferranti plant failed to maintain the supply on account of the large size of the units, and the consequent fewness of machines.

THE chronicle of last week's misfortunes is as follows:—One of the two large dynamos, which used to be called 1,250 H.P., but which have proved to be nearer 1,750 H.P., was under repair; new armature coils for generating at 2,400 volts instead of 10,000 volts were being fitted. The spindle of one of the Corliss valves on the other set was damaged, and the engine had to be shut down. Another dynamo of 750 H.P. had been disabled during the week, something having fallen into the armature, wrecking the coils and bending the shaft. One of the 350-H.P. engines used for light-load work was at the time undergoing repairs to the governor. To add to the week's misfortunes, which were serious only because of their concurrence, the throttle valve of one of the large engines broke, and fouled the main valve. On Monday, Thursday, and Friday the supply was partially checked, and on Friday evening only two engines, one of 750 H.P. and the other of 350 H.P., were running until 9 p.m., when the full supply was restored.

IT will be remembered that the two 1,750-H.P. sets, with 12ft. 6in. armatures, occupy one quarter of the present engine house at Deptford, and about one-sixteenth of the whole space available for machinery. But thirty-two units of plant were never contemplated. One quarter of the present building was set apart for condensers for 120,000 H.P., and in the remaining half, four 10,000-H.P. alternators, with 45ft. armatures, were to be put down. The incomplete condition of the station does not, however, affect the number of divisions of the plant, for several sets that were at one time running at the Grosvenor Gallery are now in use at Deptford. It has been argued that far larger marine engines run continuously for weeks, under confined conditions of space. But the working conditions are altogether different, for the load at sea is comparatively constant, and the engine-room is not manned with the object of saving a decimal of a penny per horse-power hour, as in most electric supply stations. Had the load at Deptford been anything like that which might have been reasonably expected before the run of bad luck began, and had six or eight sets of 1,750-H.P. alternators been employed, such misfortunes as these could not have happened. The London Electric Supply Corporation has to do the best it can with its present plant, and our sympathies are with them and their engineering staff. But the accidents teach the danger of using large and few units of plant, and the importance, where alternators are used, of reserve machines, and of some efficient system of boxing in the armatures.

AT a recent meeting of the York Town Council the following rider was added, after a somewhat heated debate, to a report containing a reference to the electric lighting question:—"Whilst fully acquitting the Streets and Buildings Committee of any irregularity, this Council is of opinion that all expenses of its Committee on city business should be defrayed out of the rates of the city." The episode which gave rise to this categorical enunciation of an elementary municipal principle was the visit of an electric lighting sub-committee to a couple of central lighting stations at the expense of a couple of expectant contractors. After having been four years amassing information the sub-committee were still intent on getting more, and were not, as a member expressed it, "above being feasted with the not very distant object in view of those who feasted them obtaining some advantage." At the risk of being told, like the movers of the above mild censure, that we show "a supremely indifferent knowledge of what is carried on in the commercial world," we must congratulate the York Town Council on being the first to take action in regard to this growing practice of free trips and light lunches. Contractors, it is pretty obvious, cannot, in these days of keen competition, afford to neglect anything likely to lead to the securing of a contract, and if free trips and lunches contribute to that end, these will be provided, we may be sure. It is not for contractors to commence by taking up a puritan attitude: *que messieurs les conseillers commencent.*

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The commutation of alternate currents is a subject which appears every now and then to attract a large share of attention. We print in our correspondence columns this week a suggestion by Captain J. H. Thomson of a new method of rectifying these currents, so that they may be used for charging purposes. However ingenious this method is, there seems no prospect that it will be successful. It involves the use of a commutator revolving synchronously with the alternations of the current, and it also needs two condensers of large capacity capable of withstanding high potentials. These adjuncts are quite sufficient to condemn the method, but a more serious defect still arises from its inefficiency. It may be true that good condensers for high potentials can be easily procured at a moderate cost. But, however good they may be, they absorb energy due to the passage of the current through them. The present method suggested for charging cells would involve as much waste of energy in the condensers as is usefully taken up by the cells under charge. In order to charge a battery of 50 cells, it is apparently necessary to have a 2,000-volt circuit and two condensers, each taking the full charging current at 1,000 volts. Now, experiments which have been published on condensers have shown that the power they absorb is about one-fortieth part of the product of the voltage at the terminals into the current in amperes flowing through. The voltage on the condensers is so much greater than that on the cells that the power absorbed by the former is quite comparable with that given up to the latter. Under these circumstances the method is hardly efficient or economical.

Stepping into a train yesterday on the "underground" we observed that the long-promised penny-in-the-slot electric reading lamps were at length in position at the four corners of the compartment. Inserting the necessary penny and pressing the button (the larger one), we noticed nothing particular to happen, and certainly no light shone forth. Presently, however, we detected the lower limb of the circular coin projecting from the bottom of the apparatus; and taking this as an indication that there were no watts on supply, we transferred the penny to the opposite lamp. This time a radiance filled the corner of the carriage. We had heard that a light of 20 c.p. would be supplied. As it is a projected light, there may be special ideas as to the way it ought to be photometered. Certainly it did not look like a light of twenty candles. Still, there shone upon us a soft and steady light, bright enough to enable the smallest type of printing to be comfortably read, yet not dazzling. A light of twenty candles would, probably, be far too dazzling for the purpose. But is it not monstrous that the passenger should be mulct in pence for necessary light? As a daily contemporary some time ago observed, we shall some day be asked to "put a penny in the slot" in order to stop the squeaking of the railway carriage wheels by supplying them with a small quantity of a superior grease.

If dynamo makers still continue to use annealed wrought iron forgings for magnet bars and yokes it is not for lack of invitations to try special cast steels and peculiar iron castings. We have received from a well-known electrical engineer a set of lithographed curves which he has received from a firm of iron-makers, and which profess to set forth the advantages of a wonderful kind of cast iron. The B H curve of wrought iron is given, showing a positive induction of 16,000, with a positive magnetising force of 58, and a negative induction of 14,400 for a similar negative magnetising force. Singular as such a brand of wrought iron may be, it is a pity to use it for purposes of comparison; it should be kept in a museum. But the "special" magnet material is no less remarkable, for while the B H curve practically coincides with that of wrought iron for the positive magnetisation at 16,000, it runs up to about 16,700 for the same negative magnetising force. This æolotropic permeability might be useful for making so-called unipolar dynamos, and prepares us for the announcement of a queer kind of steel, which will gratify mathematicians by the realisation of a single free magnetic pole.

Aberdeen.—The scheme for experimental street electric lighting is to be proceeded with at once.

Bristol.—The electric light is now being supplied to all the streets comprised in the area agreed upon for the initial undertaking.

Obituary.—We regret to announce the death, on the 4th inst., of Mr. Bryan Donkin, at the age of 84. Mr. Donkin was well-known among engineers, especially in connection with his extensive researches in steam-engine practice and economy.

The Gauss-Weber Memorial.—The subscriptions received for the erection of a monument in honour of Gauss and Weber, at Göttingen, have reached a total of £1,110. This figure does not include sums promised but not yet paid, which will bring up the total to £1,250.

The Government and the National Telephone Company.—It is stated that there is no prospect of the agreement between the Post Office and the National Telephone Company being laid on the table of the House of Commons this session. Mr. Arnold Morley promised it some time in the autumn session, but it has not made its appearance, nor is it likely to do so before the House adjourns.

Use of the Telephone by the Police.—On November 5th, for the first time, the Hertfordshire constabulary brought into requisition telephonic communication between Hitchin, Baldock, and Royston, three of their principal stations. By order of the County Council the whole of the police-stations in the county are to be brought into direct communication with each other. The wires are fixed to the various telegraph posts, thus considerably curtailing the expense to local authorities.

Royal Society Medals.—We learn from a French contemporary that the Rumford Medal of the Royal Society has been awarded to Prof. D. E. Jones for his translation of Hertz's researches, and that "Lord George Gabriel Stokes" has received the Copley Medal. Never before, says our contemporary, has a translation been so highly recognised. Never before, we echo, has our contemporary's translator so thoroughly surpassed himself.

Novel Form of Electric Railway Car.—It is intended to introduce new passenger cars on the Brighton Electric Railway of a very novel shape. These cars will be built in the form of a yacht, with a "saloon" in the middle. It is thought by the projectors that this method of taking a marine trip will recommend itself to excursionists; but whether the remote chance of the cars taking to the water had anything to do with the choice of this shape, we are unable to say. The Brighton electric railway is shortly to be extended to Rottingdean.

Accident to a French Telegraph Line.—A somewhat curious accident occurred recently to the Tours-Châteauroux telegraph line. One of the poles was blown down and fell across the

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railway. A train coming along, the wires got entangled with the wheels, but the driver did not notice the fact until he had pulled down a long length of line. This may perhaps be taken as an illustration of the disadvantage of always running slow trains, the habit so grows upon the drivers that the braking effect of a few miles of telegraph wire coiled round the axles is scarcely sensible to them.

Cable Interruptions :

	Date of Interruption.
Cayenne-Paramaribo	October 25th.
Bissao-Bolama	November 24th.
Cayenne-Vizeu	November 25th.
Jamaica-Colon	November 25th.
Kotonou-Accra	December 4th.
Lagos-Brass	December 4th.
San Domingo-Martinique	December 10th.
Haiphong-Hongkong	December 11th.
Singapore-Saigon	December 11th.

The General Electric Company of America.—According to *Electricity*, of New York, the business of this Company "has sunk to almost nothing, its factories are almost as silent as a graveyard at midnight, and its *employés* have few duties except attendance upon committee meetings. There is no head to its affairs, no policy, and consequently no energy. It is like a ship at sea with a discredited captain and broken-down engines." In a subsequent issue the same journal states as the result of investigation at the Lynn and Schenectady works that the Company has 2,100 men at work on half time, against a high-water mark of 7,500 men at full time.

House-to-House Electric Light Supply Order, 1889.—In an order, dated the 6th inst., the Board of Trade give notice that they have revoked the House to House Electric Light Supply Order, 1889, in so far as it relates to the area of supply specified in paragraph (*b*) of the first schedule to the Order, as from December 1, 1893. The scheduled streets in area *b* were Ladbroke-grove, Ladbroke-grove-road (part of), Uxbridge-road, Royal-crescent, Lansdowne road, Lansdowne-crescent, Cornwall-road (part of), Lancaster-road (part of), Elgin-crescent, Elgin-road, Ladbroke gardens, Archer-street, Colville-square, Powis-square, Cambridge and Oxford-gardens, Bassett-road, St. Mark's-road (part of), and St. Charles' square.

A Telegraphic Reminiscence.—Inspector William Craig, has just sent in his resignation to the Directors of the Great Western Railway, after over half a century's inspection of traffic at Paddington Station; he was in 1845 one of three servants of the Company who took part in the first application of the electric telegraph to the detection of crime. The Company had not then adopted the telegraph, but there was an experimental wire to the Slough signal box, which was exhibited as a sort of shilling wonder. A message was received at Paddington to "watch Tawell," a man suspected of murder. Tawell duly reached Paddington, was apprehended, and in due time executed.

New Books.—Messrs. Macmillan and Co. are about to publish a revised and enlarged edition of "Elementary Lessons in Steam Machinery and the Marine Steam Engine," by Messrs. Langmaid and Gaisford, instructors on H.M.S. "Britannia." It will be followed by other works, constituting a Britannia Science Series. Among those already in hand may be mentioned "Physics for School Use," by Mr. F. R. Barrett, Mr. A. E. Gibson, Rev. J. C. P. Aldous, and others; a "Physics Notebook," by Messrs. Gibson and Aldous; "Trigonometry for Practical Men," by Mr. W. W. Lane; and "Geometrical Drawing, Perspective, and Mechanical Drawing," by Mr. J. H. Spanton.

Institute of Chemistry.—Prof. W. A. Tilden, F.R.S., opened the new laboratories of the Institute of Chemistry of Great Britain and Ireland, at 30, Bloomsbury-square, W.C., on Friday last. Much care has been expended on the construction of the new buildings, which appear to be admirably adapted for the purposes for which they are designed. Prof. Tilden, in declaring the laboratory open, explained that the Institute insisted upon a course of training extending over three years, at the end of which time a student could become an associate if he had satisfied the examiners in the various branches of study prescribed. Another three years' study was necessary before an associate could become a fellow of the Institute. There were now 731 fellows, 104 associates, and nearly 200 registered students.

Telephone Tubes in the City.—At the last meeting of the City Commissioners of Sewers a letter was submitted from the City of London Electric Lighting Company, asking the Commission to end the present deadlock as to the telephone tube question by giving their consent as required by the Telegraph Act, 1891. The Company first controvert the assertion that the tubes were laid simultaneously with the electric-lighting apparatus without the knowledge of the Commission. With reference to the conditions which the Commission sought to impose on the users of the tubes—to grant a telephone service within the City at £8 per annum—the Company were informed by the highest authorities that that was incompatible with an adequate return on the capital invested. The Company was erecting plant, &c., to supply 25,000 customers with electric light. If the revenue derived from telephone tubes be reduced to please 3,000 citizens, it could only be at the expense of 25,000. In the meantime, the tubes were lying idle, neither benefiting electric-light users nor telephone subscribers. The letter is under consideration.

Walsall.—At the Town Council meeting on Monday last a special report was presented with regard to electric lighting in the borough. The committee "being advised that a properly-constructed plant would be no danger to the consumers," recommended the adoption of the high-pressure system, and that the tender of the Electric Construction Company be accepted to erect the plant for £10,003. They also recommended that contracts be made with Messrs. Bumsted and Chandler for engines, and Messrs. H. and T. Danks for boilers, and that steps be taken to obtain the necessary sanction of the Board of Trade and the Local Government Board. The resolution was carried. The Streets Committee also submitted a special report from Mr. F. Brown, electrical engineer to the Corporation, stating that the electric tramcars had worked very satisfactorily. There had been difficulty with some of the lengths, but they had been remedied, and the line was in a good condition throughout. The number of passengers in the borough had increased from 1,871,816 in 1892 to 2,245,660 in 1893, and the public appeared thoroughly satisfied with the appearance of the trams as compared with the old steam traction engines.

Defective Flywheels.—An article by Mr. W. Stuart-Smith, in a recent number of the *Electrical World*, of New York, on the subject of defective flywheels, calls attention to a point of the greatest importance. In the discussion of flywheel accidents it is almost invariably assumed that the cause is due to tangential strain, which involves the further assumption of an increased speed of the engine, and a defective governor is held up as the initial cause. Mr. Stuart-Smith points out that a sufficient cause for such accidents is a want of symmetry in a wheel with respect to a plane perpendicular to the shaft. This may follow from the construction of the wheel itself, or from its being so mounted as not to run true. From the design of flywheels they are incapable of resisting any considerable lateral strain, and there is every reason to believe that many accidents, ascribed without sufficient evidence to defective governors, have been due to the cause referred to. One fatal mistake which is commonly made is to assume that a wheel which is in balance when at rest will also be balanced at a high speed. There are numerous deforming forces set up by the motion which may cause deformation sufficient to rupture the rim of the wheel.

Proposed Regulations for Accumulator Works.—The Departmental Committee appointed by Mr. Asquith to inquire into white lead and the allied industries have issued their report, which is signed by Messrs. Edward Gould (Chairman), A. Dupré, Thomas Oliver, H. J. Cameron, and H. J. Tennant. The Committee were directed by the Secretary of State to inquire (1) into the conditions under which lead smelting, the working of blue lead, and the production of white lead, red lead, yellow lead, and litharge are conducted, with the object of diminishing any proved ill effects on the health of the workpeople engaged therein; (2) as to whether the special rules which already exist with regard to the manufacture of white lead are sufficient; and (3) to suggest any precautions necessary to the industries specified for the protection of life

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or health. The inquiry was extended into England, Scotland, and Wales, and the Committee visited 46 works, and examined 184 witnesses. Its recommendations as regards electrical accumulator works are summarised as follows:—The adoption of respirators and overalls for mixers; the provision of gloves and aprons for rubbers; the provision of bath and lavatory accommodation, with a plentiful supply of hot and cold water, soap, nail-brushes, and towels.

Electric v. Steam Railways.—A lecture was delivered last Monday evening, before a crowded audience, in the Chemical Theatre of the Owens College, Manchester, by Dr. Edward Hopkinson, on the subject of electric railways. During the lecture some instructive details were given of the comparative cost of electric and steam power. The City and South London line had enabled experiments to be made on the efficiency of the railway system as a whole. The loss in the line was about 11 per cent. of the electrical power generated, and the efficiency of the locomotives as a whole was 70 per cent; thus the electrical efficiency of the entire system was 62 per cent. The cost of working, including all charges, during the last half-year, was 6½d. per train mile. It was perhaps hardly a fair comparison to compare the cost of working such a line as the South London line with the cost of steam traction on other lines, inasmuch as steam could not possibly be used in the tunnels, only 10ft. 6in. diameter, in which this line was constructed, but the comparison was not uninstructive. Taking the Mersey Railway, where the gradients and nature of the traffic were similar, according to the published returns of the Company the cost of locomotive power was 14d. per train mile, *i.e.*, more than double the cost on the South London line, but for a train weighing between four and five times as much, but capable of carrying only 3½ times the number of passengers; thus the cost of steam traction per ton mile of train was about half that per ton mile of train for electric traction. But it was not on the cost per ton mile that the success of a passenger line depended. The real basis of comparison was the cost per passenger mile, and here electric traction had great advantage over steam.

What is Electricity?—"To the metaphysical mind on the one hand and to the confident ignoramus on the other," says the *Electrical World*, of New York, "the mysterious nature of electricity offers a fruitful subject of speculation. To the latter, especially, it seems a reproach that the true nature of electricity has not long before been made manifest, and he is always prepared to dash off an explanation with much more confidence than Newton proposed his theory of gravitation. It seems inexplicable to the public at large that the mystery surrounding electricity is not dispelled. The successful business man, who prides himself upon always getting to the bottom of everything, cannot understand why this one problem, as he believes, remains unsolved, and, perhaps unconsciously thinks that if his work had been in this direction, his 'hustling' abilities would have produced a more favourable result than attained by scientific theorists. It does not seem to occur to those who are impatient to have the great question, What is Electricity? answered, that we are in just as dense ignorance as to the mechanism of other phenomena. Gravitation, light, heat and chemical action are in the same category of scientific mysteries and have had centuries more of thought bestowed on them than has been devoted to the new agent. While it now seems that we may be on the threshold of one of the greatest discoveries of the human mind, yet it is possible and even probable that the knowledge of man may never be permitted to extend to the entire solution of the problem, for it is the very problem of the universe itself. True, we may demonstrate the exact relation between electricity and magnetism, and may satisfactorily connect these with other phenomena, and even obtain a working hypothesis that will answer all scientific needs, but the ultimate solution may for ever evade the human mind. Whatever we do learn, however, will not be through the speculations of metaphysicians or the guesses of tyros, but through physical investigations."

Heliotropism produced by Electric Sparks and Arcs.—In a Paper read before the Royal Society last month, Prof. G. J. Romanes, F.R.S., describes his researches on the effects of intermittent light, such as that produced by an electric spa discharge, or by an arc light and instantaneous shutter, upo the growth of plants which exhibit heliotropism. Th phenomenon is very common in the more highly-develope organisms of the plant world; it may be defined as th bending or twisting action upon the growth of stalks an stems, such as the "staircase effect" in the convolvulus, upo their exposure to a source of light. The electric sparks wer made either with a Wimshurst machine, induction sparks, c by means of the following contrivance:—From the bindin screws of the condenser of a large induction coil copper wire were led to a cup of mercury, where, by means of an electr magnet suitably actuated by clockwork, a current was close and opened at any desired intervals; each break was, ther fore, accompanied by a brilliant spark. A thick plate of gla was interposed between the seedlings and the electric apparatus. In all the experiments here described the plan employed were mustard seedlings (*Sinapis Nigra*), previous grown in the dark until they had reached a height of betwe one and two inches. Comparative estimates were formed by usi the same pot of seedlings: during the first half of a compa tive experiment half of the seedlings were protected from t light by a cap of cardboard covering half the pot; during t second half of the experiment this cap was removed, and t pot turned round so as to expose the previously protect seedlings to the influence of the light. From the experime it would appear that the heliotropic influence of electric spa (or flashes) is greater than can be produced by any ot artificial or natural source of illumination. But, strange relate, this mode of lighting appears to be absolutely un companied by the production of chlorophyll—the green colo ing matter in the stems and leaves of plants.

The Field Electric Railway Patent.—One of the m important suits ever brought before the Federal Courts of t country, in its relations to the electric railway industry, says the *Electrical Engineer* of New York, just been arg before the Courts in New York. The case is that of Electric Railway Company of the United States *v.* the Jam and Brooklyn Road Company, for infringement of lett patent No. 407,188, granted July 16, 1889, to Stephen Dud Field, for "Improvement in Electric Railways." Only on the claims of the patent is involved in the suit, namely, first, which is as follows:—"The combination, substanti as hereinbefore set forth, of a stationary dynamo electric ge rator driven by a suitable motor, a circuit of conductors c posed in part of an insulated or detached section of the line rails of a railroad track, a wheeled vehicle movable upon along said insulated section of track, an electro-magnetic mo mounted upon said vehicle for propelling the same and incluc in said circuit of conductors, and a circuit-controlling dev placed upon said vehicle." On March 10, 1880, Mr. Field fi his application for letters patent. The application was sc brought into interference with subsequently filed applicatio of Ernst W. Siemens, Thomas A. Edison, George F. Gre and Thomas Hall, and the contest was conducted with a pe sistency seldom, if ever, equalled in the history of the Pate Office. In all of these interferences, Mr. Field was decided be the first and original inventor of the subject matter ther and particularly of the combination of elements in the fi claim of the patent in suit. In 1883, prior to the settling the claims of the various contestants, the Field interest a Edison interests decided to pool their patents. Subsequent however, the Edison interest purchased a controlling inter in the Sprague Electric Railway and Motor Company, a co petitor with complainant; and a suit at law was necessary compel the attendance of the Edison Directors at the meeti of the Company to which both parties had assigned th patents. The Edison Directors refused to advance more mo for the carrying on of complainant's business, though the Fi Directors offered to advance an equal amount; and to s complainant corporation from going into a receiver's hands was necessary for it to sell back to the Edison interests t patent rights originally received from them. It is furt claimed, and admitted by counsel, that the real defendant the case is the General Electric Company, the successor to t Edison Electric Light Company.

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MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 136.)

Waste Power.—The elastic forces of inertia, which under certain circumstances form a part of the total resistance, are modes rather of diverting than of wasting the energy which is expended against them, inasmuch as they are perfectly elastic and reversible. On an accession of speed they absorb energy and divert the power from its directly useful work, but on a return to the original speed they restore the energy which they formerly absorbed and expend power over and above that directly developed by the source of energy itself. Not so, however, with the other resistances which prevent the total power from going directly to its work, for these are prejudicial, and actually waste the energy which they absorb. It f_1 represents the total of these inelastic and prejudicial resistances, and v is the velocity with which their point of application is overcome, in feet per minute, then the horse-power wasted against them will be

$$\text{H.P. (wasted)} = \frac{f_1 \cdot v}{33{,}000}. \quad . \quad . \quad . \quad (26)$$

To minimise this waste of power is one element in engine design and construction; firstly, because this waste is a direct expenditure of energy from the source which must cost money: secondly, because the secondary actions arising from this waste are liable to cause injury to the engine details; thirdly, because the presence of waste involves the construction of a larger and more expensive engine in proportion to the amount of waste going on. Wasted power is dissipated in some one or other form of radiation—either as waves of sound, as vibration communicated to the foundations and immediate structure, or as heat generated in the places where the resistances occur. Sound and vibration are liable to become [illegible] nuisances in the eyes of the law; heat is liable to cause sufficient expansion of the bearings, &c., where it occurs, to break down the machinery. There are several ways of [illegible] these wastes:—

(1) By minimising the coefficient of friction of the moving parts where pressure occurs, as by lubricating those parts.

(2) By carefully adjusting the distribution of pressures on relatively moving parts, so as to avoid excessive concentration, want of balance, or suddenness of change in direction or magnitude of the pressures.

(3) By locating the pressures at such points that there is as small velocity as possible against them in the normal working of the parts where the pressures occur; as by selecting small diameters for journals for shafting, or by the use of ball or roller bearings.

Useful Power.—The action of the engine in overcoming the resistances of the machine upon which useful work is done, constitutes the useful power. This power is the difference between the total power and the sum of the stored and wasted power, and is equal to

$$\text{H.P. (useful)} = \frac{f_2 \cdot r}{33{,}000}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (27)$$

where f_2 is the useful resistance and r is the velocity with which it is overcome, in feet per minute. This power is not [illegible] less than the total power which is being developed by the engine, as will be seen from the equation:—

Total power = Waste power + Stored power + Useful power. (28)

In which the stored power may sometimes have such a large negative value as to make the useful power greater than the total power developed by the engine. For this to continue, however, would necessitate a large store of energy; and since no engine is provided with stored energy enough to enable it to do more than a few revolutions of full work, it follows that in the long run the stored power may be taken as having no value. In such a case, we may write

Total power = Waste power + Useful power. . (29)

Every term being positive in value at all times, it follows that the ratio of the useful power to the total power cannot (over a long average) be greater than unity. In point of actual fact, this ratio cannot be so large as unity; but the closer it approaches this ideal value the more perfectly may the engine be considered to utilise the energy which is supplied to it. This ratio is therefore called the *efficiency* of the engine. It is usual to express this quantity as a percentage, in which case its limiting value is 100. In this series we shall express its fractional value by the symbol η.

Load.—The term *load* has several meanings in engineering. It is applied to the action of external forces upon a structure, in the engineering of structures and materials, and it is applied to the power which is taken from an engine or motor or other source of power. Usually the load on an engine is the mechanical horse-power which is, at any moment, being taken from the engine-shaft or pulley, but the term *total load* is sometimes used, as distinguished from this *external load*, to express the total horse-power which the engine is called upon to develop. In this sense load is another term for power, or, to be more correct, it is the condition of things which calls upon the power to develop itself. In an electric-power station there

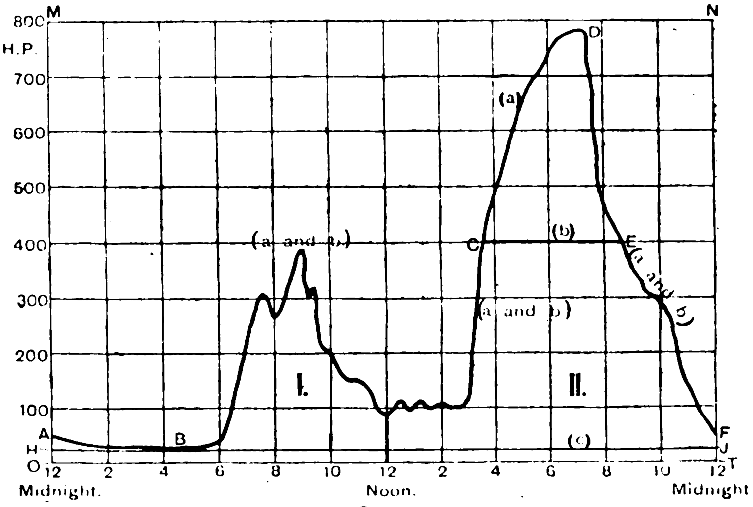

FIG. 2.

are many forms of load; there is, firstly, the external electrical load, or the electrical horse-power (E.H.P.) taken off by the mains; secondly, there is the sub-division of this into the several loads on the various generators and on the electrical storage plant, if any; thirdly, there is the load in mechanical horse-power which each of the generators imposes on its gearing, if any; and, lastly, there is the load, or series of loads on the engine and its accessory parts. Both the distribution of the loads at any moment of time, and their variation from time to time, have a very important bearing upon our study of motive power and gearing. It is convenient to construct a diagram or curve on rectangular axes of the variation of each load from time to time, and in some cases special recording instruments are arranged to automatically construct such curves.

Load Diagrams.—These curves are called *load diagrams:* and by means of them we may study the distribution of work and power in a generating station. They are commonly constructed on a horizontal axis of *time*, in hours or minutes or even days, and a vertical axis of *load*, output or power, as it is severally called. Fig. 2 gives a series of load diagrams (a), (b), (c), such as commonly occur at a power station. The curve (a) represents the variation of load on the whole station, throughout the day of 24 hours. If only one engine is run at a time, this curve will also be the load diagram of that engine in so far as it is running; but it may be divided up into

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successive portions, such as I. and II., if two or more engines run consecutively. If the total load is taken by more than one engine at a time, say by two equal engines, then we may take the curve (*b*), which is partly level and partly coincident with (*a*), as the variation of load on one engine; while the surplus will be the load on the other engine. Lastly, if there are a great number of engines capable of being run at the same time, the load diagram of any one engine may be represented by the straight line (*c*). It will be seen that we have either large engines working at a small fraction of full load, or else small engines which largely remain idle during the time the station is at work. In neither case does the station do as much work in the day as it is able, as will be seen if we take the total power as O M, and draw a straight curve M N, representing what would occur if the station worked at full load all day.

Load Factors.—It is convenient to represent the ratio of the actual work done in a day, or an hour, or a year, to the total work which might have been done at full rate as a coefficient. This coefficient is called the *load factor*. It will be convenient in these articles to consider the following load factors:—

(1) The station load factor, or the ratio of the total work done by the station in any given time to the total work which it might have done had it worked at full capacity all this time without intermission.

(2) The dynamo load factor, or the ratio of the work done by any one dynamo in any given time to the work which it might have done had it worked at full capacity during the time it was actually running. Working without intermission is not here required.

(3) The engine load factor, which is determined in the same manner as (2), but for an engine.

(4) The plant load factor, or the ratio of the work done by any unit of plant in any given time to the total work it could have done had it worked at full capacity during the time without intermission.

Time spent in a state of absolute non-working will affect the values of the load factors in (1) and (4), but will not affect the values in (2) and (3). The difference between the station or plant load factor and unity may very conveniently be called the *factor of idleness*. The difference between the dynamo or engine load factor and unity may very conveniently be called the *factor of underloading*. The object in distinguishing between these two kinds of load factors is made evident when we study the questions of *prime* and of *working costs*.

Prime and Working Costs.—The principles which should guide the engineer in the design of an engine, dynamo, or power station, or indeed any machine for power production and transmission, are based upon economic laws, and not merely upon the physical laws of energy, stress, and strain. It is not sufficient to construct any plant so that it will work: it must be built so that it will *pay*. We cannot here discuss fully the economic principles which underlie engineering; but it will be necessary to briefly notice them. The total amount of money invested in the purchase and erection of plant and works, or the capital expenditure, is called the *prime cost*. The annual expenses, apart from capital charges, are usually called the *working costs*. These latter include works costs—such as cost of fuel, oil, &c., wages and salaries, repairs and maintenance, &c., rent, rates and taxes, and management costs. Economically, a plant may be said to pay when the surplus of the revenue, after all working costs have been paid, is equal to or greater than the sum of the normal annual value of the interest on the capital and the annual value of the depreciation of the plant. It is popularly supposed that a plant pays if there is *any* surplus of revenue over working expenses; but this is an error, since such payment is made for a short time at the sacrifice of capital in the long run. Interest on capital may be taken at the normal current rate, and may be defined as the percentage yield of capital when invested in a safe commercial market. Depreciation is expressed as a rate er cent. of the capital expended in plant, and is an allowance for the steady decrease in value of plant on account of wear and tear in ordinary work, and on account of the prospect of competition by improved patterns of plant. It must be observed that both prime and working costs tend to militate against any plant paying, since an increase of either will reduce the surplus of revenue, unless indeed there is a corresponding decrease of the other. It will in general be found that in order to decrease either of these factors of expense, it will be necessary to increase the other; and the essential business of the engineer is to design and arrange the plant in such a manner that the net expense shall be as low as possible,

The Economic Law of Design.—We have already said that no plant, or portion of plant, works with perfect efficiency. Let us suppose that it is proposed to improve a portion or the whole of any given plant with a view to increasing its efficiency, and thus reducing its expense in waste of power. This may be done, for example, either by substituting a better class of plant, or by paying for more skilled labour in looking after the plant, or by minor alterations in the existing plant, such as working it with higher pressure steam or different quality steam or by raising or lowering the chimney of the boiler furnaces. Let HP be the power which will be saved from waste by this process of change, and let C be the total cost in pounds sterling which the change involves either directly or indirectly, any saving which is made in the prime cost on account of the fact that a smaller engine may be used being set off against this cost by subtraction from it. We may say, then, that C is the net prime cost of the alteration; and let A be the annual cost of an amount of power equal to that which it is proposed to save. If instead of affecting the alteration we invest C in some commercial market, we may get B pounds sterling in the shape of dividend, but we lose the A pounds on account of waste of power. Now if A is greater than the current average value of B, it will clearly be advantageous to effect the alteration; while if A should turn out to be less than B, it will be more profitable to abandon the proposed alteration, because it will not yield a profit equal to the market value. Again, if a small alteration will yield a greater saving, A, than the interest, B, on the capital, C, it may happen that a more extensive alteration may be carried out, so as to yield a still greater advantage. But it is also evident that the limit, beyond which it will not pay to carry out any alteration, is that point where the annual value of the saving in working costs is exactly equal to the sum of the annual depreciation and the annual interest of the capital which the alteration would require. Suppose, for example, that the annual interest on capital may be taken at 5 per cent., and that it is proposed to spend £200 on a condenser for a steam engine, the depreciation and extra repairs being taken at 5 per cent. also. Then, if we have the condenser, we must spend £10 per annum on repairs and on account of depreciation; but we may save £30 in the engine expenses. While if we do not have the condenser, we shall only get £10 interest on the money. Here, since the annual interest plus the depreciation £(10+10) is less than the saving in annual expenses, £30, there is an advantage of £10 in having the condenser. In most cases there are several indirect costs and savings to be taken into account as well as the direct sums here considered, in which cases it will be a good plan to draw up a balance-sheet, with amounts debited and credited to the proposed alteration. In many other cases it is quite impossible to determine the money value of any alteration in design or in the character of the plant; and experience alone can be relied on to guide towards the best practice. This question has been worked out in *The Electrician*, Vol. XXIX., p. 248 in an article by the author on "Thomson's Law of Economy," and it was there shown that *the most economical design in any case is that in which the annual interest on the cost of any small improvement in the efficiency of the plant is equal to the annual saving of expenses which would result from that improvement being adopted*. Where the money values are determinate every effort should be made to obtain them correctly and fully; where they are indeterminate, the choice must rest upon experience assisted, it may be, by a series of carefully conducted experiments.

(To be continued.)

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THE ALTERNATING CURRENT ARC.

To readers of our excellent contemporary, *La Lumière Electrique*, M. André Blondel is already well known for several valuable researches on the nature of the alternating-current arc. Some further researches by him have quite recently been published in the same journal, and the numerous curves which are given appear to completely describe the phenomena of the alternating arc under various conditions.

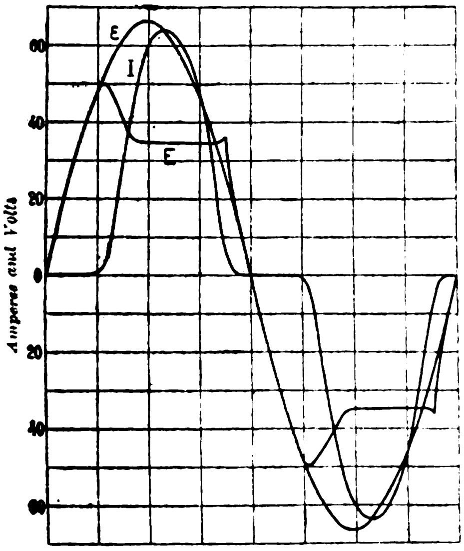

FIG. 1.—Solid carbons, non-inductive circuit. $l = 2$mm., $R = 0·10\ \omega$, $L = 0·0007\ h$, $\epsilon = 44·5\ v$, $E = 32·7\ v$, $I = 36·9\ a$, $\eta = 0·77$.

As in his previous work, M. Blondel employs a photographic method for recording the law of variation with time of the current through the arc, and of the voltage at the terminals of the carbons. His apparatus consists of a couple of d'Arsonval

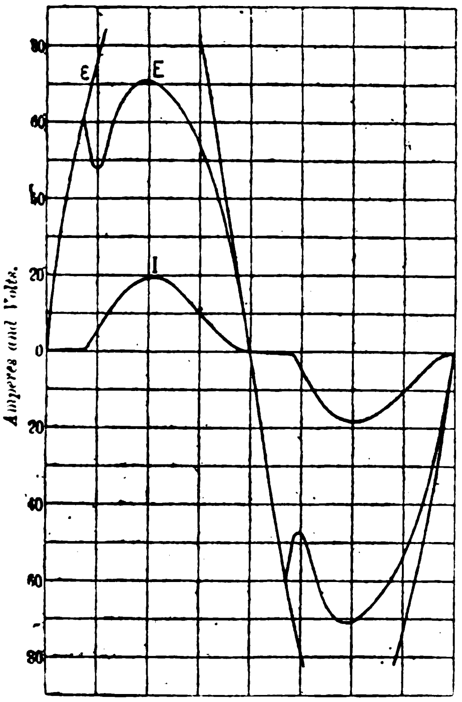

FIG. 2.—Jablochkoff candle (hissing arc), non-inductive circuit. $l = 5$mm., $L = 0·0007\ h$, $R = 2·70\ \omega$, $\epsilon = 72·5\ v$, $I = 11·1\ a$, $E = 53·3\ v$, $\eta = 0·91$.

galvanometers, one placed in the current circuit and the other in a potential circuit shunting the arc. Each of these circuits is periodically made and broken by means of a revolving contact maker attached to the shaft of the armature of the alternator. The mirror of each galvanometer reflects a ray of light on to the surface of a cylinder covered with photographic paper; and this cylinder is rigidly attached to the brush holder of the revolving contact maker, and turns with it.

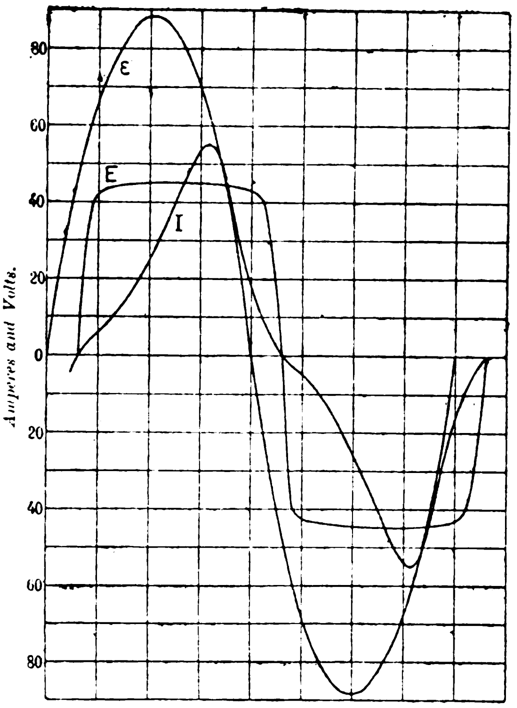

FIG. 3.—Solid carbons, inductive circuit. $l = 3$mm., $R = 0·10\ \omega$, $L = 0·0028\ h$, $\epsilon = 63\ v$, $E = 40·8\ v$, $I = 30\ a$, $\eta = 0·88$.

The result is that the photographic curves obtained on the cylinder show the way in which the current and potential vary with the time. After detailing a number of experiments which prove that his apparatus really acts as stated, M. Blondel proceeds to give a number of interesting curves showing how the shape of the current, or potential, curves is dependent on the character of the carbons, the inductive nature of the external circuit, and on other such circumstances. Of these curves we

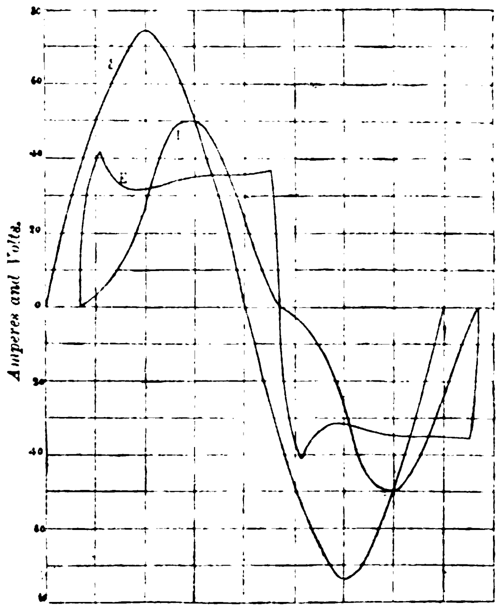

FIG. 4.—Solid carbons, inductive circuit (hissing arc). $R = 0·10\ \omega$, $L = 0·0038\ h$, $\epsilon = 51·5\ v$, $E = 31·8\ v$, $I = 29·8\ a$, $\eta = 0·86$.

have only space to reproduce a few of the more interesting. In all those given below the curve ϵ represents the electromotive force of the alternator, that marked E denotes the voltage between the carbons of the arc, while that marked I denotes the current through the arc. L is the self-induction of the

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external circuit in henries, and R is its resistance in ohms, l is the length of the arc in millimetres, and η is the *power factor* of the arc, that is the ratio between the real power in watts absorbed by the arc and the apparent power absorbed obtained by multiplying the voltage on the arc by the current in amperes. This power factor in some cases is as low as 0·70. For silent arcs the value lies between 0·88 and 0·95, but for hissing arcs lower values generally obtain. Some tests made by Prof.

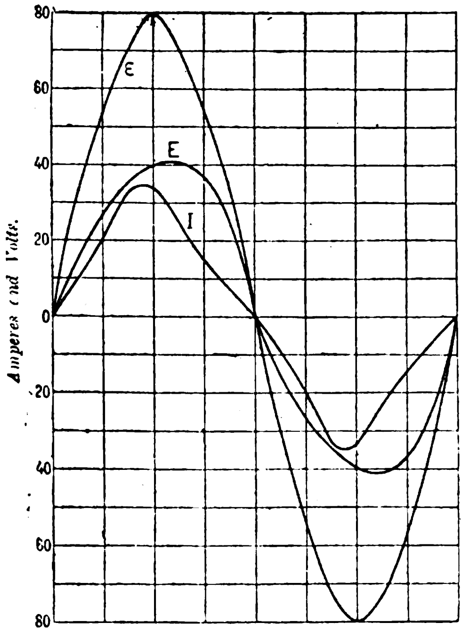

Fig. 5.—Cored carbons, low voltage, non-inductive circuit. l=2·5mm., R=0·40, ϵ=54·5v, L=0·0007h, E=27·9v, I=36·1a, η=0·93.

Ayrton and Dr. Sumpner, published in April, 1891, before the Royal Society seem to show that with a hissing arc the power factor may be as low as 0·50 for an alternating current whose frequency is 100 periods per second. M. Blondel was not able to obtain any case in which the power factor was as

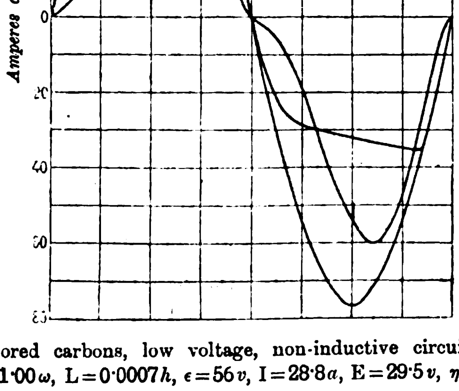

Fig. 6.—Cored carbons, low voltage, non-inductive circuit. l=4mm., R=1·00ω, L=0·0007h, ϵ=56v, I=28·8a, E=29·5v, η=0·95.

low as this, and attributes his failure to do so to the fact that the frequency of the current he used was different from that used by the English experimenters. It will be seen that the shape of these curves is dependent to an extraordinary extent on the character of the external circuit. We also notice that while the current curve is in general a simple zigzag in shape when the arc is silent, when the arc is hissing the current curve

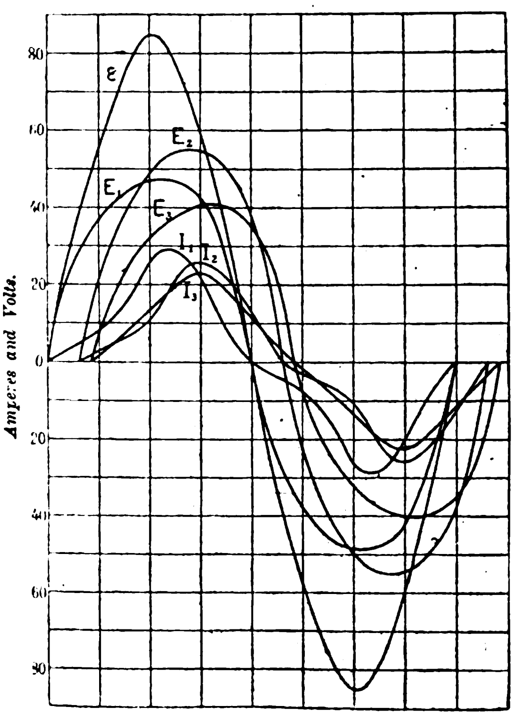

Fig. 7.—Cored carbons, low voltage. No. 1. Non-inductive circuit. l=9mm., R=1ω, L=0·0007h, ϵ=60·5v, E=35·8v, I=16·5a, η=0·95. No. 2. Inductive circuit. l=12mm., R=0·10ω, L=0·0046h, ϵ=60·5v, E=41·3v, I=15·5a, η=0·94. No. 3. Inductive circuit. l=5mm., R=0·10ω, L=0·0094h, ϵ=60·5v, E=31.1v, I=14a, η=1·00.

tends to become discontinuous, so that for certain portions of the period the current is either zero or very nearly so.

M. Blondel's conclusions from his experiments may be summarised as follows :—

1. The phenomenon of the alternating arc is more complex than is generally believed, and it cannot be described by reference to a single typical case. The differences in the effects produced by various dynamos can in most cases be explained by the values of the self-induction and resistance of the armature.

2. The shape of the periodic curves depends on the character of the external circuit, and on the nature of the carbons and

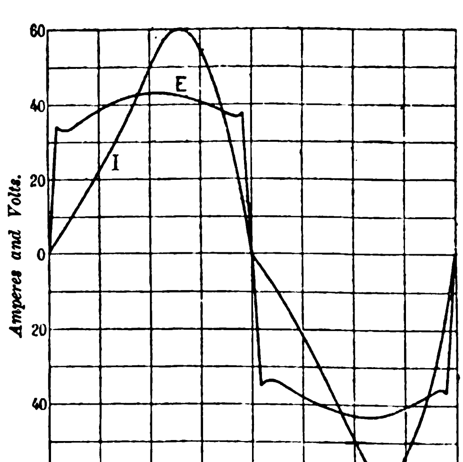

Fig. 8.—Cored carbons, high voltage, inductive circuit. l=4mm R=0·55ω, L=0·0066h, ϵ=94v, E=37v, I=37a, η=0·88.

of the cores. The extinction of the arc which takes place at each alternation is not always accompanied by a cessation of the current. This stoppage of the current becomes less marked as the circuit is made more inductive, and the core

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more conducting. It is most marked when the arc is hissing, and the external circuit is non-inductive.

3. To interpret the results, it is necessary not only to consider the vaporisation of the carbon, but also the effects of the molecular bombardment, and the conducting power of the hot gases. There does not seem to be in the arc any back electromotive force in the true sense of the word.

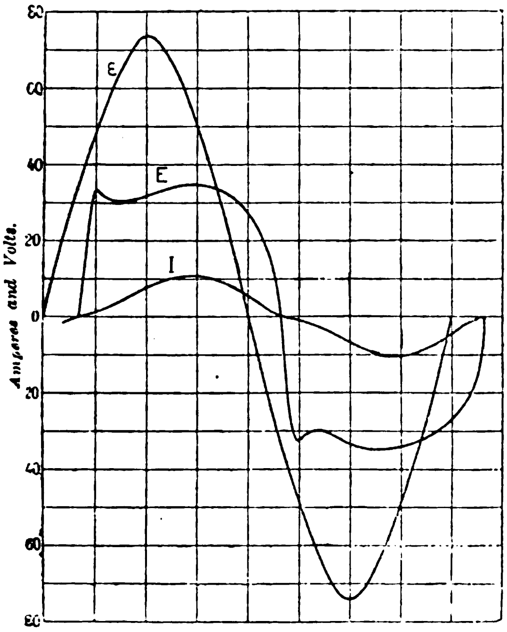

FIG. 9.—Cored carbons, moderate voltage, inductive circuit. $l=3$mm., $R=0{\cdot}10\,\omega$, $L=0{\cdot}016h$, $e=51{\cdot}5v$, $I=6{\cdot}8a$, $E=28{\cdot}8v$, $\eta=0.94$.

4. The power factor of the arc is very nearly unity for a silent arc and for soft carbons. With low-voltage arcs it may easily be 0·95, and the arc can then be treated as a non-inductive resistance. With uncored carbons, especially when the arc is noisy or hissing, the power factor can be as low as 0·70 when the frequency varies between 26 and 52 periods.

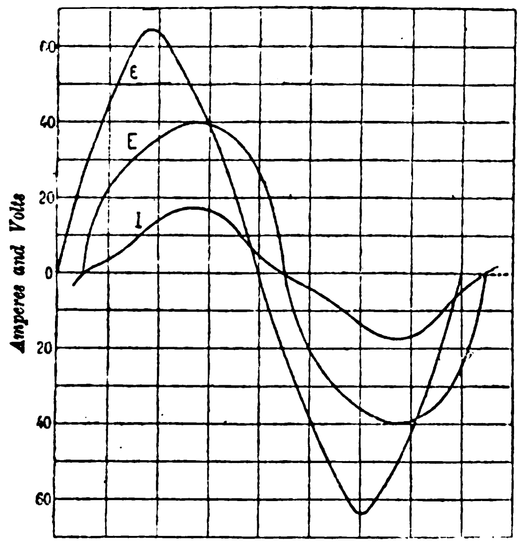

FIG. 10.—Cored carbons, moderate voltage, inductive circuit, $l=2{\cdot}5$mm., $R=0{\cdot}10\,\omega$, $L=0{\cdot}0048h$, $e=40{\cdot}5v$, $E=30{\cdot}6v$, $I=10{\cdot}9a$, $\eta=0{\cdot}97$.

5. The stability of the arc depends on the nature of the carbons, on the core, and on the electromotive force of the circuit (which must not be confused with the voltage on the carbons). It increases with the frequency, and is favoured by self-induction.

A Long Run.—The Westinghouse engine which drove some of the dynamos at Chicago ran 83 days 2 hours and 15 minutes without a break.

STANDARD SCREWS AND DRAW-PLATES.

The Société d'Encouragement pour l'Industrie Nationale has published a report by M. Gustave Richard on the question of the standardising of screws and draw-plates. This report, carefully examined and studied, will be found to possess great interest. The importance of the standardisation of wires has long been recognised by engineers and others, who have been struck by the inconvenience attending the diversity of our wire gauges. It has been proposed to adopt a uniform standard, in France by d'Armengaud, Denis Poulot, and others, in Germany by Rouleux, Delisle, and others. In England and the United States uniform systems have been adopted, which, in part, compensates for the absence of a decimal system. The systems adopted are those of Whitworth and of Sellers, and are constructed on the system of measurement of which the pound is the basis. In France the greatest disorder exists in this regard. The navy, the railway and maritime companies, the large manufacturing concerns, each and all have their special standard. The following are the chief characteristics of a unified system which has been drawn up by MM. Pierre, Redier, Bienaymé, and Sauvage:—(1) The shape of the gauge: an equilateral triangle, right truncated; this is a form easy of reproduction. (2) The sizes vary in half-millimetres. (3) A series of twenty numbered sizes forms a set, the gauges and diameters in which are determined by a formula of easy application. (4) Between the standard sizes thus determined all the useful intermediate diameters are intercalated.

The Société d'Encouragement pour l'Industrie Nationale proposes to convene a congress, at which this question shall be discussed by all who are interested in its issues, having for its object the final settlement of a definite system.

The British Association screw thread, which, according to the committee by whom it was introduced, was designed with special reference to Continental practice, seems to have been ignored. The only reason appears to be that it does not run in round numbers of millimetres. This is an absurd objection; for anyone who prefers to make his own taps and dies, and is really competent and equipped for the job, should be able to work to decimals of a millimetre as easily as to round numbers. But ninety-nine out of a hundred would not dream of "recovering" the gauge thus, and nine hundred and ninety-nine out of a thousand would buy working taps and dies, or at all events standards, from some reliable maker.

The British Association thread has taken firm hold in this country, and this is in no small measure due to the London Chamber of Commerce. We regret, however, that some very bad specimens of screws, said to be of the B.A. thread, have been turned out.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, December 15th.

ROYAL UNITED SERVICE INSTITUTION.

3 p.m. Lecture. "The Telephotos," by Col. G. E. Gouraud.

INSTITUTION OF CIVIL ENGINEERS.

7 30 p.m. Students' Meeting. The following Paper will be read: "Continuous Automatic Railway Brakes," by Mr. H. J. Orford.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting, at 28, Victoria-street. The following Paper will be read: "The Brightness of Light: its Nature and Measurement," by Messrs. T. M. Barr and C. E. S. Phillips.

TUESDAY, December 19th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper will be read: "Hydraulic Power Supply in London," by Mr. E. B. Ellington, M.Inst.C.E.

WEDNESDAY, December 20th.

ROYAL METEOROLOGICAL SOCIETY.

8 p.m. Ordinary Meeting. The following Papers will be read: (1) "The Great Storm of November 16–20, 1893," by Charles Harding, F.R.Met.Soc. (2) "Rainfall and Evaporation Observations at the Bombay Waterworks," by S. Tomlinson, M.Inst.C.E., F.R.Met. Soc. (3) "On Changes in the Character of Certain Months," by A. E. Watson, B.A., F.R.Met.Soc.

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THE ARC-STANDARD OF LIGHT.

The abstract of the Paper by M. ANDRÉ BLONDEL on "The Continuous-Current Arc as a Standard of Light," read before the Chicago Congress, is concluded in our present issue. The Paper was kindly abstracted for us by the author; the parts which have been omitted relate to matters which have been already published, and to suggestions presented to the Congress on the use of a secondary standard of light. To speak of a unit of light is to misuse the word unit as employed in physical science. Candle-power is the measure of the rate of emission of energy; not, however, of the total radiant energy of the source of light, but only of that part which can stimulate the human retina. Photographic electro-optical devices and radiometers may be employed, as Prof. ROSCOE and others have done, for certain physical researches; but the usefulness of the radiation as light must eventually be referred to the eye. The desideratum is a standard of light, and as the irregularities of atmospheric absorption put the light of the sun out of the question as a standard, we are driven to seek some artificial source of light. The Violle proposal and Siemens' modification of it exhibit a strong affection for, at all events, the C. of the C.G.S. system, in combination with the properties of a pure metal. Round numbers of centimetres are, however, of no use whatever in co-ordinating a standard candle power to any other physical quantities. The Hefner-Alteneck lamp can be constructed to the inventor's specification in millimetres, and used with the definite substance amyl-acetate; or the mean of a

large number of measurements of the British standard candle or of the French carcel lamp, or *bougie décimale*, under certain standard conditions may be taken. We need a convenient apparatus with which one of these standards can be readily reproduced, with the necessity, if possible, of but few corrections. The idea of screening an arc as METHVEN screened an Argand burner was very fascinating when it was first proposed, but the necessary apparatus for realising it turns out to be as complicated and expensive as that of the Violle platinum standard, and perhaps more difficult to manage. Another serious difficulty is the want of uniformity among carbons. The matter has been considerably advanced by M. BLONDEL, whose figures are now for the first time published; but, as he modestly admits, he has not yet produced a satisfactory standard of light.

Capt. ABNEY'S selection of the light from the positive carbon of an arc, as a qualitative standard of white light, is well known, but the screening or "diaphragmation," as M. BLONDEL calls it, seems to be a modern idea. Even if in M. BLONDEL'S hands the arc-standard had proved to be a thoroughly trustworthy standard, it is not likely that the priority or credit for discovery would have been seriously disputed. As our readers know, both Mr. SWINBURNE and Prof. S. P. THOMPSON had thrown out suggestions. Prof. S. P. THOMPSON has, we understand, made some experiments, and has published some calculations, while Mr. SWINBURNE, in collaboration with another investigator, had given some attention to the construction of a practical standard before M. BLONDEL'S first communication was published. Up to the present these investigations have not been thought ripe for publication, for, although they have proceeded on somewhat different lines to those of M. BLONDEL, they have approached no nearer to a satisfactory standard. While others have made suggestions, M. BLONDEL has not only carried out, but has published his work, and it is by publication, even of incomplete researches, that progress is made. The difficulty which has been experienced with the varying quality of carbons may prove less serious than M. BLONDEL thinks, but the expense of the apparatus, and other difficulties, such as the estimation of the area of the hole in the diaphragm, considerably impair the simplicity of the original idea. M. BLONDEL uses a hole of more than a millimetre diameter. Ordinary commercial photometry is now carried to within two per cent. error, and in the hands, or eyes, of some observers to one quarter or one-fifth per cent. A standard of light should therefore be accurately known, and reproduceable to within one-half per cent. This means that the diameter of the hole must be measured to within one quarter per cent., and that the hole should be truly circular. This is no easy matter. A way out of this difficulty may be to build up a square hole with straight edges and distance pieces, or as M. BLONDEL suggests, to use a lens of known absorption, as in the photometer of Dr. J. HOPKINSON, used in his lighthouse measurements in 1884.

The expense and trouble of an arc-standard, should it ultimately be improved and capable of three-figure accuracy, that is, involving an error of only a half per cent., need not prevent the establishment of such standards in national or other standardising laboratories, and by such standards secondary standards could be easily calibrated. For many purposes no better secondary standard can be employed than that to which Prof. AYRTON has given considerable care, in connection with the recent eclipse expedition, viz., a good glow lamp run at a low efficiency. The colour of the light is, at all events, not worse than that of an amyl-acetate flame, and, given a good ammeter, no corrections whatever are required. A secondary battery and a rheostat are needed, and to avoid the optical effect of irregularities of the glass bulb a diffusing screen must be employed.

M. BLONDEL'S Paper is a valuable contribution to photometric science, not only for the results of his work with the arc-standard and the modifications which experience has led him to introduce, but for the preliminary considerations on our present methods and standards. His assertion that "all methods of heterochromatic photometry are illusory" requires, perhaps, a little more explanation. The long and important work of Capt. ABNEY and Gen. FESTING can hardly be said to be illusory. They have established, with a completeness approached by no other investigators, the relations between different colour-sensations as perceived by the normal eye. It is only when candle-power is considered as a physical quantity that heterochromatic measurements become incommensurable. The object of electric lighting is not to cause a lamp to emit certain radiant undulations; but, as we have already suggested, to stimulate the optic nerves of the consumer who pays for it. He likes his wave-lengths in considerable variety and well mixed, but prefers them between 7×10^{-5}cm. and 4×10^{-5}cm., that is, light with as little heat as possible. One other statement in this Paper will not, perhaps, be accepted without further consideration, viz., "all measurements should be expressed in *bougie décimales*." The British standard candle is from 0·95 to 0·984 of a *bougie*, according to different observers. We have been informed that an attempt has been made during the last few years to reduce the value of the standard candle by altering the standard size of the Methven screen, but without success. The carcel lamp is, however, probably a much better standard than our candle; and as most scientific work is now referred to the amyl lamp, a change of 5 per cent. or so will affect nobody but gas companies, and a short Act of Parliament would soon settle them.

INSTITUTION OF ELECTRICAL ENGINEERS.

The following members constitute the Council of the Institution of Electrical Engineers for the year 1894. New members of Council or members occupying new offices on the Council have their names in italics:—

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Alexander Siemens, M. Inst. C.E.

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Prof. A. B. W. Kennedy, F.R.S., M. Inst. C.E.	*Robert Kaye Gray.*
	Augustus Stroh.

Associate Members of Council.

G. K. B. Elphinstone.	*The Earl Russell.*
Dr. W. E. Sumpner.	

It was announced in the course of the reading of the annual report that the Institution Premium had been awarded to Mr. W. B. Sayers for his Paper "On the Prevention and Control of Sparking; Continuous-Current Dynamos without Winding on the Field-Magnets, and Constant-Pressure Dynamos without Series Winding." The Paris Electrical Exhibition Premium and the Fahie Premium were not awarded, but a Students' Premium was granted to Mr. W. R. Cooper for his Paper on "Primary Batteries."

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MEMORIAL TO THE PRESIDENT AND COUNCIL OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

We have received a copy of the following memorial, addressed to the President and Council of the Institution of Electrical Engineers, which, we understand, is being largely and influentially signed :—

GENTLEMEN,—It will be within the recollection of the Council that in the year 1889 the composition of the Council, and their recommendations for the filling of the positions thereon then vacant, gave rise to so much dissatisfaction and complaint that a protest was addressed to the members of the Society and to the Council against the manner in which telegraph and telephone interests had come to be ignored in the composition of the Council. The discontent assumed such proportions that the Society stood in grave danger of a split, which, however, was happily averted by the frank manner in which the Council admitted the just claims of the telegraph and telephone professions to a fair amount of representation, and agreed to restore the balance at the first opportunity. Accordingly, at the next election, four representatives of these branches were recommended by the Council and duly elected. Year by year, however, as these particular representatives retired, the Council, instead of continuing the policy which they had admitted both directly and by their action to be just and reasonable, and proposing the election of other representatives from the same professions as the retiring members, did in no case follow that principle, but recommended the election of other gentlemen from professions already fully represented, until with the disappearance of the telephone representative in the present year the last trace of the successful agitation of 1889 has disappeared, and once more private and railway telegraphs and telephones are unrepresented except among the past and vice-presidents who, *ex officio*, are irremovable.

It is much to be regretted that the good understanding arrived at such a short time ago should have so quickly been upset, and that this question should once more have to be pressed on the attention of the Council by the private and railway telegraph and telephone members, who form so large a proportion of the institution. It is clear that the rules and regulations themselves are largely to blame for that lack of harmony and co-operation which are so essential to the well-being of any society. We, therefore, desire respectfully to lay before the Council and the members generally the following suggestions respecting the composition of the Council and the method of electing members thereof, begging that they may be considered merely as roughly indicating the lines upon which we consider alteration desirable.

(1st.) That the twelve ordinary members of Council should, as far as possible, consist of representatives of the following branches of the electrical profession, in something like the following proportions :—

3	members representing	Pure Science,
2	„ „	Electric Lighting,
2	„ „	Postal Telegraphs,
1	„ „	Railway Telegraphs,
1	„ „	Private Telegraphs,
1	„ „	Telephones,
2	„ „	Manufacturers.
12		

(2nd.) That when any of the representatives of any of the above branches retire the vacant seats shall be filled up by representatives from the same branches, so as to secure the permanent representation of the various branches in the fixed proportions agreed upon.

(3rd.) That it shall be competent for any twelve members, including proposer and seconder, to propose the election of a representative for the vacant seats, and on receipt of such nominations the names of the nominated person or persons shall be included in the balloting papers, such nomination papers to be in the hands of the Secretary not later than November 1st in each year.

We are of opinion that the adoption of the above suggestions will probably meet the difficulty, and give the members generally a more direct interest in the affairs of the Institution.

COMPENSATION FOR HYSTERESIS.

BY E. B. VIGNOLES.

The article by M. Abdank-Abakanowicz in the issue of *The Electrician* for Nov. 24th last is one which appears to call for some short comments from me, since a former note of mine on this subject has elicited from him the very interesting and lucid remarks in question. M. Abakanowicz begins his article by stating that he writes with the object of impressing the minds of the readers of *The Electrician* with some idea of the difference between his method and that of Mr. Evershed, to which I alluded; and I will therefore enter in further detail into the subject, in order to show that the difference is a superficial one, and depends merely on the point of view; in essence the methods are the same. M. Abdank-Abakanowicz has very kindly furnished us with a diagram, Fig. 1 (Fig. 4 of his Paper here reproduced), which will enable me to show clearly what I mean, aided by his accurate description of the principle of his instrument. In his "Results" 1, 2, 3, he states his principle of compensation to be this, that the force working his instrument is composed of two components, of which it is the algebraic sum; and these two components, if perfect compensation is attained, each go through, with rising and falling currents, a cycle, such that the difference of their ordinates remains constant for any particular value of current, whether rising or falling (and, we may add, whether positive or negative).

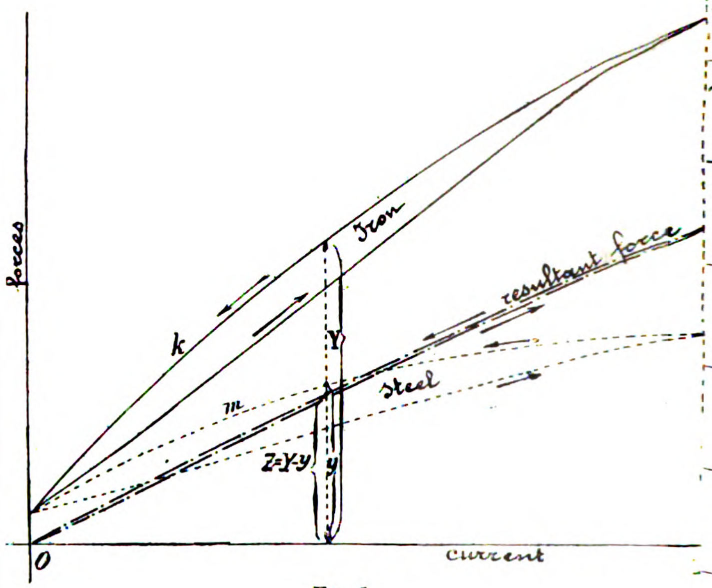

FIG. 1.

Now this is precisely what we did with the Evershed instrument in order to compensate it. The annexed Fig. 2 represents, in plan and elevation, the working parts of an Evershed movement. A A are the fixed blocks, B the attracted piece of soft iron, and C the compensating piece of steel. The force on the movement is the sum of two components, an *attraction* of the blocks A A on B, and a *repulsion* on B due to C, which forms a magnet of similar polarity. If these two forces go through the cycles "k" and "m" respectively (in M. Abakanowicz's Fig. 4), then perfect compensation will be attained. I think no further proof is required that the method of MM. Abakanowicz and Meylan is the same as ours; the only

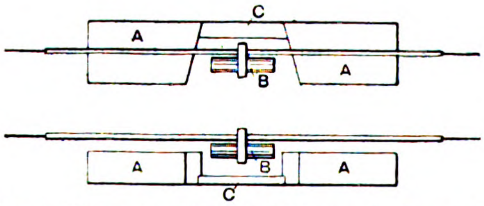

FIG. 2.—Plan and Elevation of Evershed Movements (Iron and Axle only shown).

difference lies in the application to a different class of instrument. It must be remembered that the object of our experiments was, as makers of commercial instruments (chiefly ammeters and voltmeters), to produce a type which while retaining the universally-used form of a moving system worked by alterations of magnetic resistance, should be devoid of hysteresis error, and I sincerely hope that if M. Abdank-Abakanowicz has hit on a method which produces this result as simply and more effectually than ours did, that he will communicate it, as promised, to the pages of *The Electrician*. It is easier to apply the method of compensation to the case of the wattmeter for

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this reason, that in the wattmeter case only the induction cycles of the iron and steel need have the form shown, whereas in the ammeter and voltmeters the curves are complicated by the variation in force due to the variations in distance apart of the iron and steel parts of the movement.

I annex here a figure showing the percentage difference of reading of an ammeter compensated in this way on reversal of the current at various parts of the scale, compared with one not so compensated. The improvement is very marked; but in order to obtain more perfect compensation than this, an amount of adjustment is necessary for each instrument, which would be quite out of the question in commercial work. I may mention that this curve was shown by Mr. Evershed at the Institution of Civil Engineers, and a description of the method given, on the occasion of the discussion of Mr. Swinburne's Paper on "Measuring Instruments," in May, 1892. It is not improbable,

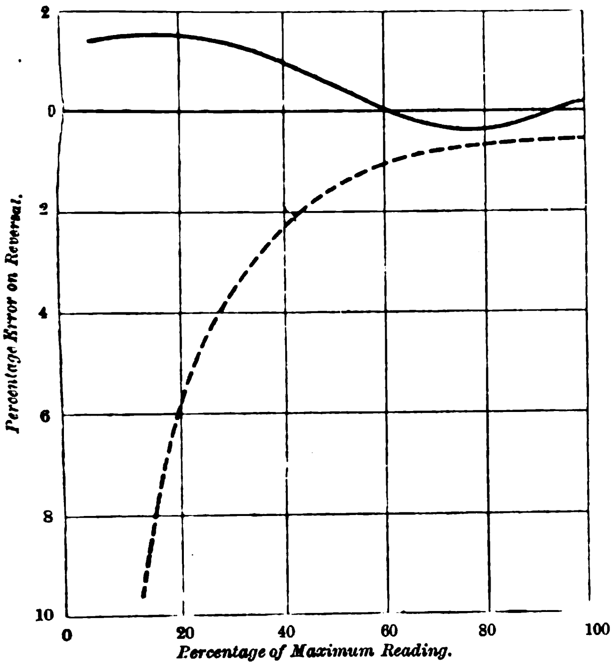


FIG. 3.—Full Line, Compensated. Dotted Line, Not Compensated.

since the subject has fallen into the hands of such able experimenters, that further progress has been made, and we shall look forward with great interest to the publication of MM. Abdank-Abakanowicz and Meylan's researches; but I think it must be acknowledged that to Mr. Evershed is due the credit of having been the pioneer in this field.

In conclusion, I may add that while I am sorry that the publication of this method in *La Lumière Electrique* and the *Elektrotechnische Zeitschrift* should have led me to discuss it prematurely, I regret it the less since my action has caused M. Abakanowicz to give us so interesting a summary of his work in connection with M. Meylan; and I rejoice that an investigation which the exigencies of trade prevented our pursuing should have fallen into such good hands.

THE HANSEN ARC LAMP.

The regulation of the arc in this lamp is effected by means of a pivoted electromagnet, which, on an increase in the resistance of the lamp circuit, is caused by a stationary armature to turn on its pivot to an extent corresponding to the increase of resistance, and thereby release the arresting mechanism which controls the movement of the carbons.

The chain-wheel around which the chain carrying the carbon-holders runs is mounted to oscillate with the electromagnet, but is so connected therewith that the point of its circumference where the chain carrying the upper carbon-holder runs off lies exactly in the axis of oscillation of the electromagnet, so that during the oscillatory regulating movement of the electromagnet with the chain-wheel the said point, and consequently the upper carbon suspended therefrom, will remain stationary, and only the opposite part of the chain carrying the lower carbon-holder will be moved according to requirement, so that the regulation of the arc will be effected by the movement of the lower carbon alone.

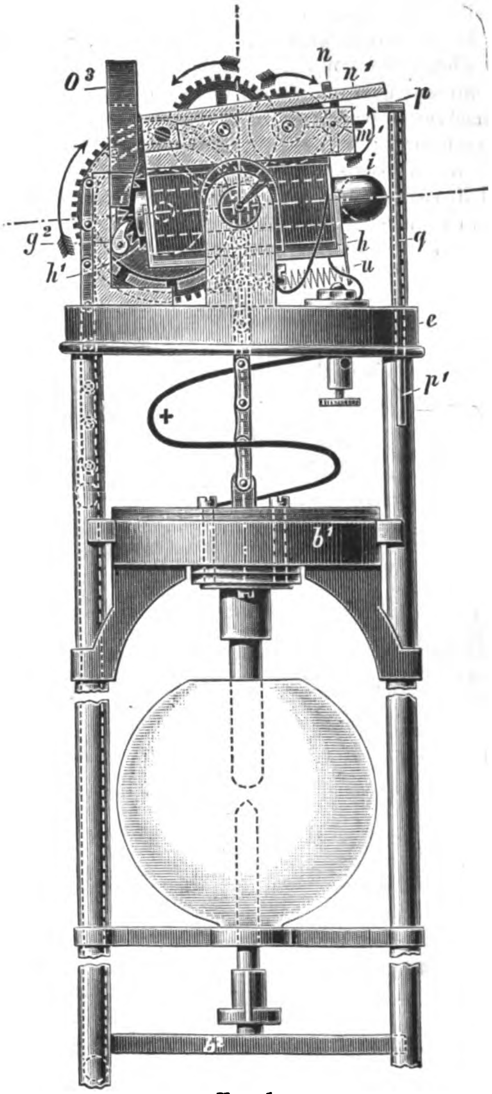


FIG. 1.

b^1 = top carbon-holder, b^2 = bottom carbon-holder, e = top plate, g^2 = detent, h = knife-edge, h^1 = knife-edge, i = pivoted electromagnet, m^1 = star wheel, n = pawl, n^1 = lever, o^3 = fixed armature, p = stop, q = rod, u = spring.

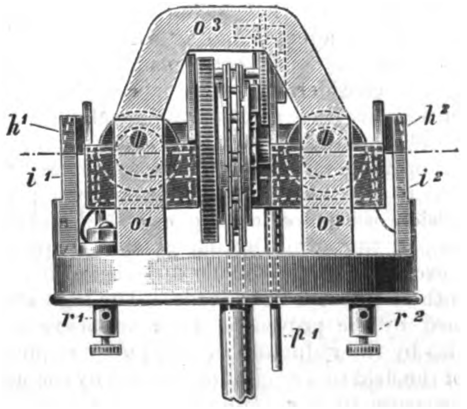


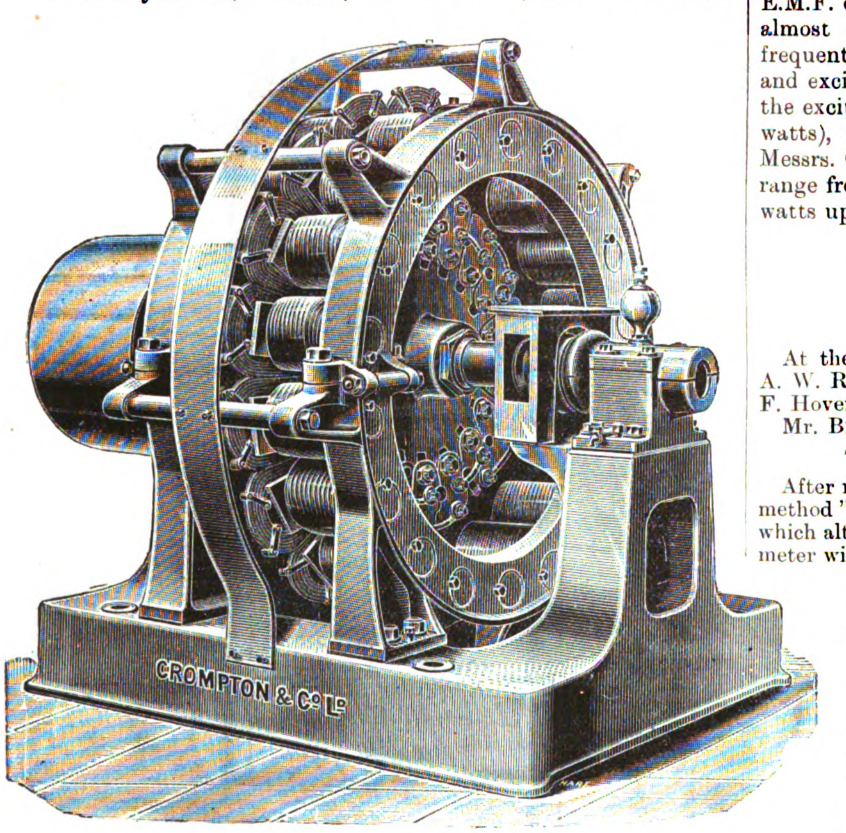
FIG. 2.

h^1 = knife edge, h^2 = knife edge, i^1 = lug, i^2 = lug, o^1 = supports, o^2 = supports, o^3 = fixed armature, r^1 = terminal, r^2 = terminal, p^1 = rod.

The regulating mechanism is mounted on the plate e, as shown in Fig. 2.

CROMPTON-BRUNTON ALTERNATOR.

Although Messrs. Crompton and Co.'s name has hitherto been chiefly known in connection with the supply of direct-current machinery, we understand that they have always had a full appreciation of the advantages of the high-pressure alternate-current system for all work where the distribution has to be carried out over widely-scattered districts where the lamp density is too low to pay for the larger amount of copper required for a direct system. They have, in carrying out contracts where the conditions warranted it, made use of the alternate-current system. They have, for some time past, occupied themselves in working out a complete system of alternate-current machinery; while, proceeding on well-tried lines, by a careful attention to proportions and mechanical details, they have succeeded in turning out designs which appear to be thoroughly reliable and extremely efficient. The most important item of such a system is, of course, the alternator, and we illustrate



above a 60 kilowatt machine. These alternators have revolving armatures and stationary field-magnets. The present is scarcely the place in which to detail at length the reasons which have led Messrs. Crompton and Co. to adopt this design in preference to that using a stationary armature and revolving field-magnets, and it will be sufficient to say that their choice has only been made after careful consideration and considerable experience with both types. Special attention has been paid in this machine to the following points:—(1) a ready access to the armature for inspection or repair by opening one or both upper halves of the field-magnets, which are hinged for that purpose; (2) facing; (3) the provision of a powerful magnetic field and small armature re-action, so that the alternators shall require but little variation of exciting current to suit variation of load; (4) high efficiency both at full and light loads. The high efficiency has been obtained by the provision of an armature without any iron core, also by the reduction of the power required for the excitation of the field to a minimum and also by the use of a light revolving armature giving a minimum of weight and loss of power at the bearings, and as a consequence, not the least important, a minimum of trouble. The armature is of the well-known disc pattern formed of sector-shaped coils fixed round a periphery of the hub. Probably the parent design of this type of armature is that described in Siemens' original specification of 1878; such an armature is, electrically, probably the best that could be devised, and it is only in the constructional details and proportions that improvements are to be looked for. The special features of the armature, as constructed by Messrs. Crompton and Co., are the methods adopted for attaching each armature coil to the centre disc, or hub, and the provision made for drawing it radially inwards toward the centre, so that the whole armature when mounted can be very securely tightened up, thus entirely preventing all detrimental vibration of the armature conductor, and making a very strong and rigid job. Moreover, a new armature coil can be quickly inserted at any time, and tightly drawn into place. The field-magnets, bearings, and other portions of the machine are of the usual type, and call for no description. The collector is entirely enclosed, to prevent all risk from accidental contact, and the brushes are in duplicate, so arranged that either may be removed for inspection when the machine is at work. The machine illustrated is designed to work at an E.M.F. of 2,000 volts at 600 revolutions, and it has been in almost daily use for the past eight months. It has been frequently run for experimental purposes (with increased speed and excitation) at over 3,500 volts. The power required for the excitation of the field at full load is only 1¼ per cent. (750 watts), and the commercial efficiency exceeds 91 per cent. Messrs. Crompton and Co.'s standard sizes of these alternators range from 15 kilowatts to 200 kilowatts, those from 65 kilowatts upwards being provided with three bearings.

PHYSICAL SOCIETY.

At the meeting of the Physical Society on Friday last, Prof. A. W. Rücker, President, in the chair, Messrs. J. H. Gillett and F. Hovenden were elected members of the Society.

Mr. Blakesley then read Mr. Swinburne's Paper on

"A Potentiometer for Alternating Currents."

After referring to the many advantages of the "potentiometer method" of measurement, the author describes an arrangement by which alternating pressures can be measured. A quadrant electrometer with a double fishtail-shaped needle suspended by a torsionless fibre is employed. The electrostatic attraction exerted by an alternating pressure between the needle and one pair of quadrants is balanced by the force due to a steady pressure between the needle and the other pair of quadrants. The magnitude of the steady pressure is determined by a potentiometer and standard cell, and the effective value of the alternating pressure thus deduced. For measuring alternating currents, a differential electro-dynamometer having two fixed coils and one moving coil, and no controlling spring, is used. A direct current, measured by the fall of potential over a small resistance, is passed through one of the fixed coils, the alternating current through the other fixed coil, and the moving coil is included in both alternating and direct current circuits. When the two forces balance the currents are taken as equal. Several small inaccuracies to which the method is subject are mentioned in the Paper.

DISCUSSION.

Prof. S. P. THOMPSON inquired if the fishtail-shaped needle of the electrometer was novel.

Mr. BLAKESLEY said the author had mentioned the needle previously. He (Mr. Blakesley) thought the name "Potentiometer" was not very suitable. In effect, the so-called measurement of *pressures* was a comparison of two *powers*.

The President announced that Mr. Preece's note on the "Specific Resistance of Sea Water" had been temporarily withdrawn, and Prof. G. M. Minchin made a communication on the

"Calculation of the Coefficient of Self-Induction of a Circular Current of Given Aperture and Cross Section."

Instead of assuming the cross-section of the wire small, and the current density constant over the section, as is usually done, the author takes into account the dimensions of the section and the non-uniform distribution of the current. Making use of the expressions for the vector potential (G) of the current given in his previous Papers (*Phil. Mag.*, April and August, 1893) the author calculates the total normal flux of force through a surface intersected once in the positive direction by every tube of force emanating from the given current. This flux divided by the current gives the coefficient of self-induction. The surface chosen is the circular aperture of the current, and the half of the anchor ring formed by the wire,

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When the current density is inversely proportional to the distance from the axis of the circular current, the value for the coefficient of self-induction is found to be

$$\pi\left\{4a(L-2)+2c\left(L-\frac{5}{4}\right)-\frac{c^2}{16a}(2L+19)\right\},$$

where a is the radius of the central filament of the current, c the radius of the cross section of the wire, and $L=\log_e\frac{8a}{c}$. Clerk-Maxwell's approximate expression agrees with this in the principal term. As an example of the closeness of the approximation, the case of a current in a wire two millimetres diameter bent to a circle of 2 centimetres mean diameter had been taken, the approximate and corrected coefficients being 58·866, and 59·207 absolute units respectively. When the current in the wire is superficial, as in case of alternating currents of high frequency, the coefficient is somewhat greater, being given by the expression $\pi\left\{4a(L-2)+2c\left(L+\frac{3}{2}\right)+\frac{c^2}{16a}(4L+11)\right\}$. Incidentally it was pointed out that the function $G.x$ where G is the vector potential at a point distance x from the axis of a circular current was the same as Stoke's *current function* in hydrodynamics.

Prof. MINCHIN then read another paper on the

"Magnetic Field of a Current running in a Cylindrical Coil."

The cylindrical coil is regarded as a series of equal circles lying close together and forming a cylindrical surface. Replacing each circular current by its equivalent magnetic shell the problem of finding the magnetic potential at a point resolves itself into calculating the gravitational potential due to the circular plates of attracting matter, one positive and the other negative, situated respectively at opposite ends of the cylinder. The magnetic potential due to one plate is then deduced in terms of elliptic integrals of the first, second and third kinds. The President had pointed out that the expressions given in the printed proof of the paper only applied when the perpendicular from the point to the plate fell within the circle; the author had therefore modified the formula so as to be true generally. From this formula the equipotential curves can be constructed. The same system of curves serve for the plate at the other end of the cylinder by changing the signs of the numerals representing the potentials and giving the curves a motion of translation equal to the length of the cylinder in the direction of its axis. The equipotential curves for the coil can then be deduced by drawing through the points of intersection of the two sets of curves whose numerical values have a constant sum. In determining the curves, the author had to calculate tables of elliptic integrals of the third kind, and these he hoped to complete before the Paper was published. In reply to a question on the first Paper which had been brought before him by Prof. Perry, the author said that as the diameter of the wire diminished indefinitely, both the self-induction and resistance became infinite, but the ratio L/R became zero. It was interesting to examine what relation between the aperture and cross-section gave minimum impedance. If the ordinary expression for L be taken the problem was impossible, but the corrected form admitted of a solution.

DISCUSSION.

Prof. PERRY hoped the work Prof. Minchin had done so well for circles and cylinders would be extended to cylindrical coils of rectangular cross-section. It was most important to be able to find the shape of the field produced by such coils.

Prof. S. P. THOMPSON inquired if there was any way of deducing the expression for the magnetic force at a point other than that given in the Paper on the "Magnetic Field of Circular Currents" (*Phil. Mag.*, April, 1893).

In reply, Prof. MINCHIN explained how the formula followed at once from the fundamental theorem that magnetic force is the curl of the vector potential. This was based on Laplace's expression for the force between a magnetic pole and an element of current, which had been proved experimentally.

THE CONTINUOUS CURRENT ARC AS A STANDARD OF LIGHT.*

BY ANDRÉ BLONDEL.

(Concluded from page 147.)

Influence of the Core.

Here no doubt exists. It has been clearly shown by all experiments that the core added to the positive carbons plays an important part from the point of view of the brilliancy. This core consists generally of a mixture of powdered carbon and mineral substances, such as silica, silicate, &c., which give an artificial conductivity to the arc so that a certain current may flow without volatilising so much carbon as it otherwise would. The result is :—(i.) A reduction of the area of the surface brought to the maximum degree of incandescence ;* (ii.) a lowering of this maximum, as shown by the following tables, which are a summary of comparisons made either directly between carbons or between carbons and the carcel standard, the lights being very slightly different so as to render a comparison legitimate. The figures in the last column were obtained by directly comparing the intrinsic brilliancy of one of the carbons with the carcel standard. These figures are, therefore, all infected with the probable error of this comparison with a heterochromatic light.

Table IV.

Total distance between the two diaphragms 5,474 mm. Area of the diaphragm hole, left hand, 0·8135 sq. mm. Area of the diaphragm hole, right hand, 0·9038 sq. mm. Carbon employed in the right hand arc: L cored; mean voltage very constant.

Carbons used in the left-hand arc.	Distance of the Photometer screen. From the left-hand. Readings.	Mean.	From the right hand (mean).	Intrinsic brilliancy or corresponding emissive power in *bougies décimales* per sq. mm.
L (hard homogeneous)...	276·6 278·1 283·9 276·4	279·6	267·8	163
C (cored) ...	263·6 262·6 267·0 266·2 261·4	264·2	283·2	131
L (cored high voltage) ...	275·4 274·9 278·0	276·1	271·1	154
L (cored low voltage) ...	265·0 262·5 258·6 260·4 267·4 267·2 263·9	263·6	283·8	132

Table V.

Total distance from the carcel standard to the arc standard, 5,340mm. Area of the diaphragm hole, 0·9038 sq. mm.

Carbons.	Distance of the Photometer screen. From the carcel standard. Readings.	Mean.	From the arc standard (mean).	Maximum emissive power in *bougies décimales* per sq. mm.
L, cored, low voltage ...	126 126 120 123	123·7	410·3	117·2
Homogeneous; mean of five makes...	...	110·06	423·94	158·4

It is the effect of the core which justifies the statement, frequently made by those who use the arc for projection work, that modern carbons have not as great an intrinsic brilliancy as those used in Foucault's days. The lowering of the intrinsic brilliancy is the greater the greater the conductivity of the core. The intrinsic brilliancy frequently goes down to 130 *bougies décimales* per square millimetre, and less in the case of low-voltage carbons, which require for an equal length of arc 35 volts in lieu of 45. Generally speaking the relative reduction of voltage caused by the use of the core gives a close approximation of the relative lowering of the intrinsic brilliancy.

Absolute Value of the Intrinsic Brilliancy.

None of the figures hitherto given by experimenters for the intrinsic brilliancy of the crater have been determined directly, and there is, therefore, no need for surprise at their being all far from the truth. The mean value of the emissive power deduced by me from more than 50 measurements carried out with homogeneous carbons of five different qualities is 158 *bougies décimales* per square millimetre, the figures varying from 152 to 163 *bougies décimales*. I think I may give as a practical figure 160 *bougies*

* Paper read before the International Electrical Congress at Chicago, August, 1893.

* Mr. Trotter has also drawn attention to the fact that the core usually appears darker than the rest of the crater. It is therefore pretty evident that the placing of the photometer at the corresponding part of the image must be avoided. In all my experiments I took care to keep the photometer in the part of the image where the carbon is homogeneous.

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décimales, that is to say, more than double the figure (70 candles) recently given by Mr. Trotter,* and more than six times the figure (2·55 carcels) given by M. Allard,† which, truth to tell, could inspire no confidence. Voit,‡ at the Munich Exhibition, found 4·84 *bougies* per square millimetre; a figure still further from the truth.

It is noticeable how rapidly the intensity of the luminous radiations increase with the temperature, since the intrinsic brilliancy per square millimetre passes from 0·02 *bougies* in the case of platinum at 1,775°C (Violle standard) to 160 *bougies*—that is to say, 8,000 times more—for carbon at 3,500°C (the temperature found by M. Violle). The differences in intrinsic brilliancy observed in the cases of different kinds of carbon only correspond, therefore, to very small differences of temperature.

Phenomenon of the Hissing Arc.

As is known, under certain circumstances, the arc sets to work to hiss loudly, the voltage decreasing and the current increasing at the same time. No satisfactory explanation of this phenomenon has been given up to the present. It is most often attributed to impurities, or to a want of homogeneity in the carbons.§ By means of photographic analyses‖ I have been able to show directly that the hissing is always accompanied by jerkiness in the flow of the stream of carbon, which explains the shrill sound produced; whilst, on the other hand, a silent arc is accompanied by an absolutely uniform flow. I have observed, moreover, that the violet tint of the ordinary arc is replaced by a very characteristic blue-green tint, which seems to point to a lowering of the temperature. In the course of my experiments with the arc-standard I observed the two following additional facts of interest:—

(i.) At the moment when the arc begins to hiss, and the voltage suddenly falls,¶ the arc loses its transparency, and is transformed into an incandescent mist which hides the crater. When the hissing ceases, the arc suddenly becomes violet and transparent again, and the surface of the crater appears to be covered with black specks, which gradually disappear, and point to a lowering of the temperature of the incandescent surface.

(ii.) Whilst the hissing lasts, the intrinsic brilliancy is decidedly lower (10 to 20 per cent. at least) than it is during the normal silent state.

All these observed facts lead to the following conclusions, which seem to me to afford the true explanation of the phenomenon. The silent arc is one in which the transportation of the carbon takes place, owing to volatilisation at the surface of the positive crater. In the case of the hissing arc, on the other hand, the molecules of carbon are torn away by a disruptive discharge before being volatilised. They can, therefore, be carried across in greater numbers; the work done in this process of tearing away being less than that necessary for volatilisation, the temperature of the crater and of the arc and the fall of potential all decrease. The volatilisation theory and the disruptive discharge theory of Wiedemann** are in this wise reconciled. Hissing occurs whenever the current density becomes too great (0·5 ampere per square millimetre according to M. Luggin, 0·3 ampere per square millimetre according to my experiments). The disruptive tearing away takes place more easily when the carbons used are friable. This effect explains several phenomena observed in the case of the alternate-current arc; and it may also account for the slight difference previously mentioned which exists between soft and hard carbons by assuming that a very small portion of the carbon may be carried across disruptively even in the case of a silent arc.

Conclusions.

In conclusion, it seems to me that the law of the constancy of the intrinsic brilliancy is one of those theoretical laws accurate in their essential principles, but affected in practice by various secondary causes which it is difficult to eliminate. So long as we are concerned with mere commercial applications we may consider the intrinsic brilliancy as constant for all *homogeneous* carbons and to be about 160 *bougies décimales* per square millimetre. But for more accurate work, such as photometry, it must be admitted that, according to their origin, commercial carbons may exhibit appreciable differences. In order, therefore, to make use of the arc as a standard of light, it is necessary, until we are able to obtain pencils of pure carbon having a constant emissive power, to always employ the same kind of carbon and standardise it directly. The best for the apparatus I have described are hard, high-voltage, cored carbons giving a very steady light, the projected core appearing as luminous as the surrounding homogeneous portion. *Such a standard does not at present fulfil the necessary conditions for an absolute standard of light;* and it would not be a desirable one from several points of view. But, assuming a more modest position, it might form a *secondary standard* which would be very useful in the case of arc lamps, and would have a sufficient certainty. With the carbons I have just mentioned the relative error may be reduced to 2 per cent., a very low figure if we compare it with the light emitted by the lamps in question, and especially with the grave errors that arise from comparing arcs with a standard of different colour which does not enable us to measure the arcs in definite terms.

* Institution of Electrical Engineers, June, 1892. This difference, however, in no way affects the value of the noteworthy work of Mr. Trotter, who only referred as a matter of fact to the *average* brilliancy of the entire crater, which is always less than the maximum.

† M. Allard compared the arc to a luminous sphere of 1cm. diameter, a hypothesis which has no connection with the facts.

‡ "Traité de Photométrie," Palaz, p. 232.

§ Wiedemann: *Die Lehre der Elektricität*, Vol. IV., p. 845.

‖ *La Lumière Electrique*, January, 1892.

¶ A 20-ampere 50-volt arc changes abruptly to 28 or 30 amperes and 42 volts.

** Wiedemann: *Die Lehre der Elektricität*, Vol. IV., p. 835.

THE VERDIER ACCUMULATOR.

In a diminutive central lighting station recently started at Dieppe trial is being made of the Verdier accumulator. The Verdier plate is arranged horizontally, and consists of a sort of tray divided into a number of compartments by a series of vertical partitions, between which the active material (shown shaded in the accompanying

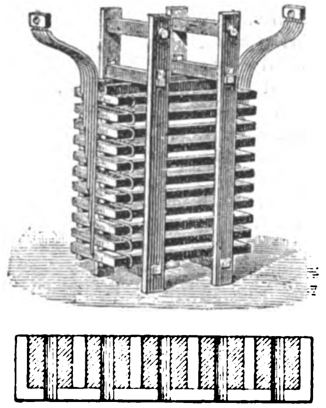

figure) is lodged. The plugs of active material and the bottom of the tray-like plate are perforated to permit of the circulation of the liquid and the liberation of the gases. The plates are placed one on the top of the other, and secured by an elastic frame.

LEGAL INTELLIGENCE.

The Medical Battery Company.

C. B. Harness, Managing Director of the Medical Battery Company (Limited), J. M. M'Cully, C. B. Hollier, and Dudley Towers, again surrendered before Mr. Hannay at Marlborough-street Police Court, on Wednesday, to answer the charges of having conspired together to obtain money by false pretences from divers persons with intent to defraud.

ARNOLD JACOB MARKS, managing clerk to Messrs. Morris and Co., one of the firms of solicitors prosecuting in the case, said that in his capacity as managing clerk he had the conduct of the action in which the Medical Battery were concerned. The one action was brought against the proprietors of *Science Siftings* for libel. The action was settled by a cheque purporting to be signed by Harness and one Smith. The cheque was for £1,300, and was given on April 29th last. On May 1st Mr. Harness and Mr. Fleet called upon him, and the former asked for the names of the people who had instructed Messrs. Morris and Co. to recover small amounts in respect of goods that had been sold by the Medical Battery Company, in order that he might return the amounts. A general conversation took place about the electrical appliances. Mr. Harness declined to join in a technical discussion, saying, "I have never bothered my head about the elementary parts of electricity. I took it up at the fag end." At one part of the interview Harness said to Mr. Hayman, "Now the matter is over I hope you will not further mention it in your paper. You have had your say, and the thing is settled." Mr. Hayman replied that he could not give him any such assurance. Mr. Fleet then asked that the compromise should not be mentioned in the paper, which request was also refused. Messrs. Woolf and Hayman left, and just as Mr. Harness was about to leave he said that he had plenty of business, and as Mr. Fleet was sick of his legal business he would give Messrs. Morris some of it.

Cross-examined by Mr. AVORY: Mr. Harness said he would give Messrs. Morris and Co. some of his legal business, but he had not done so. In certain cases where the people were poor Messrs. Morris gave their services for nothing in taking up the prosecution. The case of Mrs. Willcocks was taken up for nothing. Mr. Woolf, Mr. Hayman, and others were the proprietors of *Science Siftings*. He thought the circulation of *Science Siftings* had been increased by the action it had taken in the matter. About the middle of October he was in communication with the *Pall Mall Gazette*. A very small portion of the material supplied to that

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journal was from him, and what he did supply was on the instructions of Mr. Hayman.

JOHN BELL, a linen factor, of Bow-lane, City, said that he was 82 years of age. In April, 1893, and for some time previously, he was suffering from hernia. On April 24th he went to 52, Oxford street, owing to the advertisements he had seen, with the object of getting a belt. He was ill for five weeks, and in bed all the time, owing to the treatment he received at Oxford-street. He brought an action subsequently against the Medical Battery Company, which was stayed. He did not purchase a belt from the Company.

Cross-examined by Mr. AVORY: The action was stayed owing to the liquidation of the Company. In the action he claimed damages for the injuries he received at Oxford-street. He might have suffered slightly from hernia for a year or two. Before he went to Oxford-street he had, under surgical advice, purchased a steel belt, which was of no use to him, and he was obliged to discard it. When he used the word "belt" he meant "truss," and it was to buy a truss that he went to Oxford-street.

M'CULLY said that he should like to make a statement, which was that as nothing material had been given in evidence against him he either should be discharged or, at all events, liberated on his entering into his own recognizances.

Mr. HANNAY: Is there any more evidence against M'Cully?

Mr. TERRELL: I have about 400 more witnesses to call.

The proceedings were adjourned till next Wednesday, the same bail being allowed for the defendants.

Under the winding-up order recently made against this Company the first meeting of creditors was held on Friday last at the Holborn Restaurant, London, W.C., under the presidency of Mr. Warley, Assistant Official Receiver. Proofs have been lodged for nearly £16,000. The Official Receiver's statement shows unsecured creditors £15,767, with Preferential claims, £106; and loans on Debentures, £8,150, the total liability to rank reaching £19,781. The assets include cash £592, the stock-in-trade is expected to produce about £500, other items being machinery, estimated to produce £1,000; fixtures, &c., £1,000; leasehold premises, £1,000; book debts, £48, and doubtful debts, £100. The Official Receiver states that the most important duties of a secretarial nature were performed by Miss A. Smith, who was nominally book-keeper and chief cashier. The Solicitor of the Company was a Mr. A. Fleet. Branch offices had been opened in Liverpool and Leeds, and very large sums had been expended in advertising. The receipts increased from year to year considerably until the beginning of 1893, when the articles in the Press, calling attention to the quackery associated with the business, seriously affected the Company's takings. Money being required it was resolved, in March last, to issue Debentures for £10,000, but the response from shareholders was unsatisfactory, and finally a scheme for increasing the capital of the Company to £200,000 by the issue of 20,000 Preference shares of £5 each was attempted. This, however, proved too much, and enabled a prominent journal to expose the quackery of the electric belts in a manner comprehendable by the general public. The money received on application for these Preference shares was returned, and the prospectus withdrawn. On November 3rd it was decided to wind up the Company. The salary of £1,000 per annum to Mr. Harness was increased in January, 1891, to £2,000 per annum, £4,500 was paid in dividends, and £10,000 during each of the three following years, while the Directors' fees during the same period amounted to £1,650. The largest shareholders in the Company were Mrs. Harness, £38,205; Mr. Harness, £7,225; Major Elers, £14,205; Mrs. Elers, £5,250; and Mr. M'Rae, £5,000. The accounts show a gross profit during the Company's existence of £274 260, and a present deficiency of £119,760. £15,862 was spent in advertising in 1889, £26,610 in 1890, £42,074 in 1891, £49,797 in 1892, and £36,535 in 1893, including contracts in hand up to the period when a receiver was appointed. Mr. Harness, who was present at the meeting, justified the large amounts taken by himself in various ways, and stated that the Company had been hounded down by the *Electrical Review*, the *Pall Mall Gazette*, and other papers. He regretted that the various libel cases had not been taken to the Court of Appeal, and expressed his intention to fight the matter out to the bitter end. Ultimately a resolution for the appointment of the Official Receiver as liquidator was put to the meeting, and carried unanimously.

At a subsequent meeting of shareholders, a committee of inspection was appointed, to consist of four creditors and three shareholders, in addition to Mr. C. B. Harness, Major Elers (another Director), and Mr. Fleet, who were selected to act on the committee of inspection in the interests of the shareholders.

The list of creditors in the winding-up of the Medical Battery Company is remarkable as containing the names of nearly every prominent journal throughout the country; and as evidence of the huge amounts of money spent in advertising the Harness belts, the *Illustrated London News* proprietors are creditors for nearly £480, and *The Sketch* (belonging to the same interest), £118. Items of £140, £360, £170, and similar large amounts, are sprinkled freely through the long list, which must in the aggregate represent an immense sum.

Strick v. Latimer Clark, Muirhead, and Co. (Limited).

This was a claim for commission, heard before Mr. Justice Wills on Tuesday.

According to the plaintiff's case the defendants requested him in 1889 to introduce them to certain persons who were about to acquire Parliamentary powers for establishing a system of electric lighting in certain areas of the city of Westminster, and the defendants promised the plaintiff that if he obtained for them the introduction, and if, in consequence, the defendants secured a contract or did business with the persons mentioned, the defendants would pay the plaintiff a commission. In February or March, 1889, the plaintiff introduced the defendants to Mr. Browne Martin, the Chairman of the Westminster Electric Supply Corporation, and that introduction resulted in a contract on December 5, 1889, by which the Corporation agreed to do certain work for not less than £100,000. The plaintiff claimed £1,000 commission. The defendants denied there was an introduction by the plaintiff, and, further, that if any commission was due the amount claimed was excessive, as the contract of December 5th was not definite, and, in fact, an action had been brought on it, and, after being heard for two days before Mr. Justice Hawkins and a special jury in May, 1891, a settlement had been arrived at, by which the defendants accepted £4,000 in satisfaction of all claims and costs. The defendants further contended that they had always been ready to give some gratuity to the plaintiff for obtaining the signature of Mr. Browne Martin to a document, and they paid £40 into court in satisfaction of all claims.

After hearing the evidence, and reading the correspondence between the parties, Mr. Justice WILLS gave judgment, and said that in cases of this kind, where there was a conflict of testimony about conversations, there could be no better way of getting at what actually took place than by looking at the correspondence. Here the plaintiff had claimed commission from the first. It was remarkable that if the Board, composed of the defendants, had always taken the view that no commission was due, and £40 was to be the only remuneration, nothing appeared to that effect on the correspondence. He thought the plaintiff was entitled to a commission as the introducer of a gentleman with whom the defendants afterwards did business. The only question was how much. It was understood that the amount was to depend on the business ultimately obtained. There was no principle on which the amount of commission in this case could be calculated, but, having regard to the settlement of the action before Mr. Justice Hawkins for £4,000, he thought £300 would be a proper amount to allow the plaintiff.

Judgment accordingly for the plaintiff for £260 beyond the £40 paid into Court.

Royce v. Feller.

In the Hull County Court Messrs. F. H. Royce and Co. sued Mr. Feller, proprietor of the Imperial Hotel, Hull, to recover £27. 8s. 8d. for electric-lighting work done and completed. It was stated for the plaintiffs that the work done amounted to £430, upon which the plaintiffs were willing to allow a discount of 5 per cent. for cash. Defendant did not acknowledge receipt of account until July 11th, when he sent a letter to the plaintiffs, in which he stated that he did not consider them entitled to charge for the switches for 22 extra lamps put in. Each lamp necessitated a switch, but he certainly never ordered switches. This appeared to be the only item in the account objected to by the defendant. He (defendant) had sent a cheque for the amount of the account, less the items for the extra switches supplied. Just before the action was brought on the defendant lodged a counterclaim against the plaintiffs, which Judge Bedwell, before whom the case was tried, declined to admit. After hearing evidence, judgment was deferred.

Liability for Injuries.

The case of Howard *v.* the London Electric Supply Company came before Judge Lumley Smith, Q.C., and a jury, in the Westminster County Court, on Wednesday, and was a claim for £50 damages for injuries alleged to have been received through the negligence of the defendants while laying mains in Rose-court, Dockhead.

Plaintiff's case was that she had to cross a trench, and trod on a stone which she thought was put for a bridge, and that toppled over, and she was precipitated into the trench, which had prevented her working since as a kitchen-maid, at 8s. a week and board, and it was quite probable that an operation would have to be performed, although the accident occurred as far back as the beginning of October. The defendants said all due care was taken to prevent accidents, and that plaintiff was at a place where there was no trench, and that she was more or less the worse for drink.

The jury found for the plaintiff for £20, and judgment was given accordingly, with costs.

CORRESPONDENCE.

VACUUM TUBE AND SECONDARY BATTERY EXPERIMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I desire to add a few words to my letter in your last issue. Since that communication was written I have succeeded, by means of a simple device, to produce in a vacuum tube any predetermined number of bright and dark discs.

I may take this opportunity of correcting one word in the letter you printed. The word "dissociation" should have been "discation."

I will now venture to turn to another matter which is of considerable importance to the owners of secondary batteries.

It has hitherto been supposed that if the cells are left at rest for a long period, or if completely discharged, the positive plates are ruined.

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In my little book on accumulators I studiously avoided referring to this question, having some doubts as to whether this was the case, and it is curious to notice that no one of my numerous correspondents has mooted this subject. To satisfy myself, I entered upon a long experiment, only ended a few days ago. Some cells were slowly discharged four years ago, and put on a shelf. The plates are now as good as ever, excepting that their colour is bad. As I anticipated, there is no loss of paste or buckling. I am now assured that if the exhaustion of the plates is not effected too rapidly, no harm is done by letting them stand for years. The next point is how to charge them up again? The plates are certain to buckle if charging is resorted to in the ordinary way. This point I have proved. A simple and certain way of proceeding, without injury to the plates, is to brush all the positives over with a stiff brush, or rubbed over with a slip of wood, without disturbing the section, in order to remove the surface scale. After this process charging may be resorted to, slowly to begin with, and without fear.

The knowledge of these facts increases the usefulness of secondary cells, and removes the chief deterrent to their use in cases where they have to be idle for long periods.—

Yours, &c., David Salomons.

Broomhill, Tunbridge Wells,
December 9, 1893.

THE COMMUTATION OF ALTERNATE-CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of November 3rd you comment on M. Pollak's proposal for obtaining continuous currents, or rather direct intermittent currents from harmonic electromotive forces; and you point out, among other objections, the waste which must inevitably occur in using a transformer with saturated core. M. Pollak's object in flattening his curve, as I understand it, is to prevent the heavy maximum current

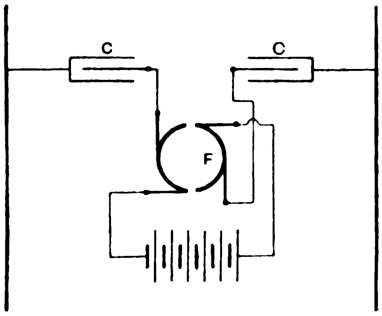

Fig. 1.

which would occur in charging accumulators from a harmonic electromotive force. I can see no other object in flattening the curve, because, for other purposes, an intermittent current would have the disadvantages of a fluctuating one.

The charging of accumulators is undoubtedly the principal end for which it is desired to re-dress an alternating current; and it appears to me that this might be done much more simply from the primary mains, with the aid of condensers. I believe that there is now no great difficulty in constructing condensers, to stand 1,000 volts or so, at moderate cost. The following is a method which should give satisfactory results. I may say at once that I have not had an opportunity of practically testing it, but some of your readers may think it worth while to do so. In Fig. 1, C C are two condensers, the outer coatings of which are connected to the primary mains, and the inner ones to two brushes on the commutator F, which for simplicity is shown as two-part. The other two brushes are connected to the terminals of the battery. The commutator is driven by a small synchronising motor. In Fig. 2 the curve A B C D E represents the voltage curve of the mains. This may be of almost any form which is likely to be met with in practice, but will probably not deviate much from a sine curve. Now, if the battery is cut out and the inner coatings of the condenser are joined together, the voltage curve will also represent the curve of charge in the condensers, and the current curve will be in exact quadrature with it, so that, neglecting small losses, no power will be expended in the system. When, however, the battery and commutator are in circuit, the charge curve will be displaced, vertically and will take the form A′ B′ B″ C′ D′ D″ E′ where B B′ represents the charging voltage of the cells, and B′ D′ are the points of commutation. The curve of current through the battery will now be O P Q. If the reversal takes place instantaneously, there will be at the point O a sudden discharge, probably of an oscillatory nature, from the battery, the total quantity of which will be equal to 2 v k, where v is the voltage of the battery and k the capacity of the condensers. The whole of this discharge is subsequently returned to the battery. I doubt whether this small quantity, however rapidly it may pass, would do any harm to the cells, inasmuch as it would hardly come from the plates at all, but from what may be called the polarisation at the surface. Be this as it may, there is no object in reversing instantaneously, and it would be better to provide an air-gap in the commutator, corresponding to O R (Fig. 2). The current curve will now be R S P Q, and there will be no discharge from the battery. The size of the air-gap need not be exactly correct. The capacity of the condensers will not be prohibitively large for moderately-sized cells. If the charging voltage is 100, and that of the mains 2,000, with a period of 100 ∾, then supposing the curve of electromotive force to be harmonic, the maximum will be about 2,900 volts. In calculating the effective charge the electromotive force of the battery must be deducted from this. The mean current (not mean square) will then be

$$C = 200 \times 2{,}800 \times k,$$

and

$$k = \frac{C}{560{,}000},$$

$$= 1{\cdot}8 \text{ microfarads per ampere.}$$

Each condenser must, therefore, have a capacity about 3·6 microfarads for each ampere of mean charging current, or 2·3 microfarads per ampere of maximum current. As

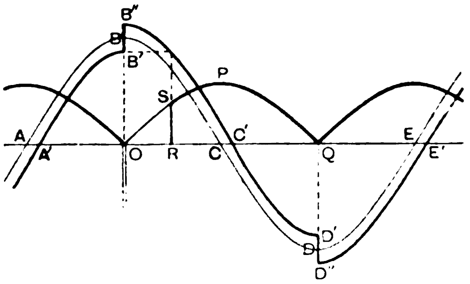

Fig. 2.

far as effect on the plates is concerned, it will probably be found to be correct to make the mean current equal to the usual charging current of the cells; but if the maximum is taken, then, of course, the charging must be carried on for a longer time.

The above-described method would have several advantages, the principal being that it would make little difference in the current whether one cell was being charged or a hundred cells. Theoretically, also, it would not affect the efficiency. Again, errors in setting the brushes on the commutator cannot produce violent currents likely to damage the cells. It is true that there would be some difficulty in measuring the current, but if the brushes are set at the sparkless position, the quantity of electricity passing through the cells can be calculated from the capacity of the condensers, care being taken, of course, that it is passing in the right direction. The large idle current may be urged as an objection, but it must be remembered that this is more or less in opposition to that of all the open-circuit or lightly-loaded transformers on the mains, and therefore little of it would come through the dynamo.

The leakage to earth, which is inevitable in all accumulators, would render it quite safe to handle the battery during charging, and the firework display at the cells, which would probably take place in the event of a condenser breaking

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down, would give sufficient warning of such mishap. Some safety device might, however, be added to guard against this contingency.—Yours, &c., JOCELYN H. THOMSON.

18, Draycott-place, S.W.,
December 6, 1893.

HEDGEHOGS AND CONDENSERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Our attention has been drawn to your issue of the 3rd, in which you give an abstract of a Paper read before the American Institute of Electrical Engineers. At the conclusion of this abstract the authors are made to express the opinion that "the experiments with the condensers demonstrate the practicability of their use to diminish the line-current in transformer circuits, and point to their more extended use, as their manufacture is perfected and cheapened, not only in this, but also in other systems of alternating-current distribution." As the paragraph implies the non-existence of any practical condenser, we ask your permission to point out that we have ourselves been manufacturing condensers commercially (under the Swinburne patents) for the last two years, principally for Germany; and out of the total number supplied by us in this time only one has been returned broken down. We think, therefore, we are fairly justified in claiming to have solved the problem of condenser manufacture on a commercial scale, price being, of course, largely a matter of demand.

The Stanley Condensers used in these tests were made with waxed paper, a method discarded by us several years ago as quite useless for practical engineering work.—Yours, &c., SWINBURNE AND CO. (LTD.).

Broom Hall Works, Teddington, December 12, 1893.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

The 1893 Edition of "'THE ELECTRICIAN' ELECTRICAL TRADES DIRECTORY AND HANDBOOK" contains over 1,000 pages, several new and handy features having been added. Price 7s. 6d., post free 8s. 3d.; abroad 8s. 10d. *Comparison with any similar electrical publication is specially invited.*

The 1894 Edition is in preparation, and will be published in January next. New names, alterations of addresses, &c., should be sent in at once. The Directory blanks and circulars are not sent out until late in the year, in order that the most recent, and consequently the *correct*, addresses *only* shall appear in the book. Full printed particulars can be obtained, post free, from "The Publisher," *Electrician* Office.

TENDERS INVITED.—The Corporation of Harrogate invite tenders for the supply of concentric insulated cables for high-pressure distribution. Specifications may be obtained from Mr. Samuel Head, borough surveyor, and tenders, addressed to the Chairman of the Electric Lighting Committee, must be sent to the Town Clerk's office, on or before Saturday, the 30th inst. Further particulars appear in our advertisement columns.

TENDERS ACCEPTED.—The Newport (Mon.) Town Council have accepted the tender of Mr. W. Gradwell, Cardiff, for the erection of an electric lighting station, at £4,750. Fifty-two separate tenders have been received for the supply of electric light plant and apparatus, and these have been referred to Mr. R. Hammond, the Council's consulting engineer, for examination.

———— The Ealing Local Board have accepted the tender of Messrs. Wilkinson Bros., of Finsbury-park, London, N., for the erection of an engine and boiler house and accessories for £7,381. A tender for this work had been previously accepted, but the original contractor withdrew.

———— The contract for switchboards and connections for the Bolton Corporation's electric lighting scheme has been placed with the Manchester Edison-Swan Company (Limited), of Brasenose-street, Manchester.

———— The Dundee Police Commissioners have accepted the tender of Messrs. D. and G. Graham for the lighting of the Central Police Station at £107. 17s. 6d.

———— The tender of Messrs. W. H. Allen and Co. has been accepted for supplying electric lighting plant to the cruiser "Talbot," to be built at Devonport.

TENDERS RECEIVED.—The following tenders for plant in connection with the electric-lighting works have been received by the Halifax Town Council:—

	£	s.	d.
Pollitt and Wigzell, for two non-condensing steam engines (£1,480) and one small non-condensing engine (£380)	1,860	0	0
Yates and Thom, for three steel Lancashire boilers	1,688	0	0
Yates and Thom, for a Green's Fuel Economiser (£357) and brickwork for same (£132)	489	0	0
Electric Construction Company, for alternators (£1,785) and exciters (£270)	2,055	0	0
John Fowler and Co., for switchboard	460	0	0
C. A. Parsons and Co., for transformers	844	6	0
Siemens Bros. and Co., for supplying and laying underground cables, pipes, manholes, &c.	7,450	0	0
House service boxes	14s. each.		
Making house connections	15s. „		
Service cables	25s. „		
Watkins and Wilson, for excavating trenches: 1ft. 0in. deep	9½d. per yd.		
2ft. 6in. „	1s. 7d. „		

FOR SALE.—The Blackpool Corporation have for sale their arc-light plant, particulars of which are given in our advertisement columns.

PARTNERSHIP.—An old-established firm of manufacturing electrical engineers requires a partner. Some further particulars are given in our advertisement columns.

LIQUIDATIONS.—At meetings held at Taunton on the 9th and 24th of November, it was resolved that the Taunton Electric Lighting Company (Limited) be voluntarily wound up, and that Messrs. Albert Goodman and William James Villar, of Taunton, be the liquidators. It will be remembered that the Company's undertaking has recently been acquired by the Corporation of Taunton. Creditors must send in their claims on or before January 5, 1894.

———— The shareholders of the Aladdin Primary Electric Battery Company (Limited) have resolved to voluntarily wind up, and have appointed Mr. W. Hope, 5, Fenchurch-street, E.C., liquidator. A petition has been presented for the compulsory winding up of the Company (*see* last week's *Electrician*).

———— At a meeting of the shareholders of the Wenham Company (Limited), held at the offices, Upper Ogle-street, Fitzroy-square, on the 8th inst., it was resolved that the Company be wound up voluntarily, and that Mr. E. Cooper, 14, George-street, Mansion House, be the liquidator.

———— A petition has been presented for the compulsory winding up of Newington, Priddle and Co. (Limited), by Messrs. Bilbie, Hodson and Co., and is down for hearing at the Royal Courts of Justice, Strand, on December 20th.

———— The first meeting of creditors in Messrs. Woodhouse and Rawson United (Limited), under the winding-up order of May, 1893, is to be held at the Cannon-street Hotel, E.C., on the 21st inst., at 12 o'clock noon. Proofs must be lodged with Mr. C. J. Stewart, the official receiver and provisional liquidator, 33, Carey-street, Lincoln's Inn, London, W.C., not later than noon of the 19th inst. A statement of the Company's affairs has been lodged, and the summary will be forwarded to the creditors immediately.

———— Mr. Registrar Emden has directed separate meetings of (1) the debenture-holders and secured creditors, (2) the unsecured creditors, and (3) the shareholders of Elmore's French Patent Copper Depositing Company (Limited), to be summoned for the purpose of considering and, if thought fit, approving a scheme of arrangement proposed between the Company and its creditors. Such meetings will respectively be held on Wednesday, December 20, 1893, at 11 a.m. for the debenture-holders and secured creditors, at 12.15 p.m. for the unsecured creditors, and at 2.15 p.m. for the shareholders, at the Holborn Restaurant, London, W.C.

———— Creditors of J. R. Powditch and Co., Limited (in liquidation), must send in their claims to Mr. E. Hayes, the liquidator, 107, Cannon-street, E.C., on or before February 6, 1894.

BANKRUPTCY.—Amy Hall, trading as A. Hall and Company, electrical engineers, at South John-street, Liverpool, and Dolgelly, has executed a deed of assignment for the benefit of her creditors. The liabilities are given at £1,445, of which £120 are secured, and the net assets at £961. Among the creditors are Crompton and Company (Limited), £36; the Telegraph Manufacturing Company (Limited), £270; Wilson Hartnell, £99; Edison and Swan Company, £10; Woodhouse and Rawson United (Limited), £49; General Electric Company (Limited), £41; A. and R. Cochran, £18; G. Braulik, £20; Bayley Bros., £72.

AWARD.—Mr. H. T. Steward, who was appointed to arbitrate in the matter of the alleged injuries to the Monte Carlo Hotel, Leicester-street, London, W.C., by the electric-lighting engines used at the Empire Palace, and for which £2,000 damages were claimed by M. Guffanti, the claimant, has decided in favour of the Empire Palace Company on all points, M. Guffanti having to pay all costs.

REMOVAL.—Messrs. J. H. Tucker and Co. have, owing to the increased demand for their electric light fittings and accessories,

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removed from Charles-road to larger premises at Ryland-street, Birmingham.

Messrs. Carrick and Ritchie.—This firm send us their recently-issued circulars relating to the Waverley turbine, in which particulars are given of water-power installations already completed. The circulars are illustrated, and can be obtained on application to the firm.

Electro-Magnetic Machinery.—The Thames Ironworks and Shipbuilding Company (Limited) have acquired the sole right of manufacture for the United Kingdom of Rowan's electro-magnetic, drilling, riveting and caulking machines, which have already met with favour amongst ship builders and bridge builders, owing to their portability and handiness, which give them advantage over hydraulic tools.

Calendars for 1894.—As usual, the close of the year brings a variety of sheet, pad, and book calendars, and one of the earliest to come to hand is a pad calendar issued by the Direct United States Cable Company, which, for general office purposes, will be found useful. Messrs. Street and Co., the well-known advertisement contractors, of 30, Cornhill, London, E.C., send us a framed and glazed sheet calendar of ornamental design.

Christmas and the Post Office.—A notice is issued calling particular attention to the fact that Christmas Day falls this year on a Monday, and that therefore it will be necessary for letters, book packets and parcels to be forwarded early, in order to reach their destination on Christmas morning.

Aberdare.—The Local Board are to discuss, at their first meeting in January, the question of lighting the town by electricity.

Alleged Forgery.—Henry Hunt, manager of the Taunton Electric Light Works, was again brought up before the Taunton magistrates to answer to the charge of having forged two promissory notes to the amount of over £276, with intent to defraud a coal merchant named Wyatt, who supplied coal to the electric light works. The local electric light company had duly paid for the coal supplied by Mr. Wyatt, but Hunt, instead of handing over the amount due, only made payments on account, giving the alleged forged promissory notes as security for the balance. Prisoner withheld his defence, and was committed for trial at the next assizes.

Ashover.—The Directors of the Ashover Hydropathic Establishment are debating the question of introducing the electric light into their establishment.

Blackpool.—Horses have taken the place of electricity on the Blackpool Tramways during the winter months, pending considerable alterations and improvements in the electrical equipments.

Bristol.—The Electrical Committee of the Town Council have presented their report on the Council's electric lighting scheme. It has been found that a balance is due to the contractors for the work done of £18,922. Extensions beyond the original contracts have been made in order to supply the light beyond the limits of the mains originally fixed. Considerable further demand is anticipated, which will necessitate the expenditure of £5,000 for additional plant, and an application is to be made to the Local Government Board for sanction to borrow £24,000.

Chatsworth.—The lighting of the famous Derbyshire seat of the Duke of Devonshire by electricity has called special attention to the value of electricity as a lighting agent for the ancestral homes of the great English families. Rooms at Chatsworth which were previously inaccessible to the public have now been opened, and the magnificent store of books and pictures may now be viewed.

Camberwell.—By a majority of 10 (32 against 22) the Camberwell Vestry have decided to postpone proceeding with the electric lighting question. The subject is to be prominently brought forward at the municipal elections in May next. It was estimated that an outlay of £50,000 will be required when the electric lighting scheme is proceeded with.

Church Lighting.—Messrs. J. S. Willway and Sons have installed the electric light in Broadmead Chapel, Bristol. This is the first place of worship in the district so lighted.——The Leamington Parish Church is to be lighted electrically at a cost not to exceed £260.——A proposal of the Gas Committee of the Aberdeen Town Council, for introducing the electric light into the city churches, was met by an amendment to the contrary, which was carried.——Greenhill Church, Derby, is to be lighted by electricity at a cost of £120.——The session of St. Paul's Episcopal Church, Edinburgh, are considering the advisability of introducing the electric light into the church.

Cork.—With regard to the City tramways, the Corporation have agreed to the proposal of the promoters, that the use of electricity or horse-power in the working of the tramways should be optional.

Decorative Electric Lighting.—Mrs. J. E. H. Gordon is contributing to the *Gentlewoman* a series of illustrated articles under the above title. The illustrations include several beautiful designs.

Devonport.—Messrs. Veale and Co., of St. Austell, Cornwall, have recently lighted by electricity the spacious premises in Tavistock-street, Devonport, occupied by the Wiltshire Bacon Curing Company.

Dover.—The seal of the Town Council was at the last meeting affixed to the transfer of the Provisional Order from the Council to the Dover Electric Light Company (Limited).

Dublin.—The report of the Electric Lighting Committee states that the excess of income over expenditure for the current year, and also for the year 1894, results in an estimated surplus up to December 31, 1894, of £1,129 odd, and that, therefore, no provision out of the rates will be necessary for the maintenance of this department for the coming year. About £3,000 increased expenditure is to be incurred, which is balanced by savings and estimated increased income. It is contemplated that a reduction will be made in the price to consumers. The report was adopted, Mr. Robinson stating that the electric light department promised to be the most profitable undertaking the Corporation possessed.——In the House of Commons, on Tuesday last, the Postmaster-General stated that no proposal was under consideration for lighting the General Post Office in Dublin, but that the new Parcel Sorting Offices in Amiens-street are to have the electric light.—In the House of Commons, on Monday, Sir John T. Hibbert stated, in answer to a question as to whether the Government were prepared to arrange for a system of electric lighting for the New National Library in Dublin, that the matter was under the consideration of the Board of Works and the library authorities.

Dumfermline.—The large works of Messrs. A. E. Walker Reid and Co. have recently been installed with the electric light by Messrs. J. H. Holmes and Co. The total number of lamps in the works is 1,500. Several other large works in the neighbourhood are being equipped for the electric light by Messrs. Holmes and Co.

Folkestone.—The Borough Association has forwarded a resolution to the Town Council, recommending that the electric lighting of the borough should be undertaken by the Corporation rather than by a local company. The Town Clerk has replied that the Corporation intend to keep the supply of electric current in their own hands.

Glasgow.—The long range of shops and buildings known as Argyle Arcade, at the back of Buchanan-street, Glasgow, have been purchased by Mr. S. Cranston, who intends to introduce the electric light throughout the buildings.

Grimsby.—The Council decided at their last meeting to approve the application for a Provisional Order for electric lighting. Many of the tradesmen of the town have promised to take the light, and the Mayor stated that doubtless, if they found it an advantage, they would be supplying it to the town before the expiration of two years, the period allowed by the Board of Trade for the completion of the works.

Guildford.—With regard to the proposed application of the Holloway Electricity Supply Company (Limited) for a Provisional Order for lighting Guildford by electricity, the matter has been referred to the General Purposes Committee, who will shortly present their report.

Hanley.—It has been decided to submit the plans and estimates for electric light and power to the Local Government Board for their approval, and to apply for sanction to borrow the necessary amount for the work required for the lighting and sewage schemes.

Harrogate.—At the last meeting of the Town Council a discussion arose as to the site for the plant of the electric light, and as to whether a refuse destructor should form part of the electric lighting plant and works. It was ultimately decided that a refuse destructor should be included.

Jedburgh.—Hartrigge House, the residence of Lord Stratheden and Campbell, is being fitted with the electric light, for which the current is generated by water power. A pond capable of holding 100,000 cubic feet of water has been made at the Tower Burn, and from this the water is taken along to the turbine, where there is a fall of 37ft., developing 20 H.P. The installation includes 140 lights for the house, 15 for the stables, and five for the laundry. An electric motor is employed in the stable yard for working chaff-cutting and other light machinery.

Lancaster.—The Market Place is be lighted by electricity, under the supervision of the Markets Management Committee. Satisfactory progress is being made with the electric lighting works.

Larne.—The Town Commissioners have had under consideration the tenders for lighting the town for the ensuing three years. The local Electric Light Company offer to light the town with eleven arc lamps of 1,200 c.p. at £11 per lamp per annum, six 32-c.p. incandescents at £4 per lamp per annum, and sixty-six 16-c.p. incandescents at £2 per lamp per annum, from dusk to midnight every day, except that no public lighting should be required for three

days before and two days after the full moon in each month. In the event of any failure the Company to forfeit a sum equal to the cost of lighting during the period of failure, at the price set out in the tender. The Company further state their opinion that the Commissioners would be well advised to purchase the installation, spreading the payment over a term of years. It was decided that the Board should come to a decisive understanding with the Electric Light Company as to price before deciding. The offer from the Gas Company was not entertained.

LONDONDERRY.—The Veterinary Department of Dublin Castle has sanctioned the use of the electric light by the Port and Harbour Commissioners for the inspection of cattle during the winter months, provided the installations consist of arc lamps erected to the specification of the Department. The work is, however, not to be proceeded with at present.

MELBOURNE.—The lighting of the City of Melbourne by electricity is expected to be complete by the beginning of the new year, and will cost between £70,000 and £80,000.

NEWPORT (MON.).—It has been decided to constitute an Electric Lighting Sub-Committee of the Town Council, consisting of Aldermen Davis, Moses and Huzzey, and Councillors Parnall, Jones and Pugesley. The Council have unanimously decided that a memorial should be presented to the Board of Trade, asking for a Provisional Order for lighting the borough by electricity.

PLYMOUTH.—A resolution that the Town Council apply to the Board of Trade for an electric lighting Provisional Order has been adopted. It will be remembered that the local gas company have applied to Parliament for powers for lighting the town by electricity.

RICHMOND MAIN SEWERAGE WORKS.—Messrs. Drake and Gorham have completed the electric lighting installation at Mortlake, and the trial run of twelve hours, with the whole of the plant and of the lights, was satisfactory.

SCARBOROUGH.—The Scarborough Electric Supply Company (Limited) notify that, in consequence of the success which has attended the introduction of the electric light, a reduced scale of charges has been fixed upon, to take effect from October 1st last. The new scale ranges from 6½d. per unit for supply of current not exceeding 200 units per quarter, to 5¾d. per unit for current supply exceeding 800 units. A reduction in the meter charge is also made.

SANTIAGO EXHIBITION, 1894.—Reference was made in our issue of November 24th to a forthcoming exhibition at Santiago. This is to be inaugurated in September and has the support of the Government. The object of the Exhibition is not to demonstrate the mining wealth of the country, but to collect in an international exhibition all the elements effectively contributing to the development of the mining industry, and more especially of metallurgy. It has been decided to make the conditions under which foreigners exhibit very favourable. Foreign firms desirous of participating must forward their applications to the Secretary of the Special Committee, which has been formed in Paris under the presidency of the Chilian Minister to France, 25, Rue Marbœuf, or to any of the Chilian Consuls. The Committee will defray the cost of sea and land transit of machinery and other objects exhibited, as well as the passage of workmen to instal and take charge of the exhibits. Motive power will be supplied free of charge to exhibitors.

THE "EXPLOSION" AT MANCHESTER.—The following is a sample of literary fare prepared for the readers of the *Somerset Express*. After referring to the accident at Manchester, of which a full account has appeared in *The Electrician*, the *Express* states that "about eight o'clock one morning pedestrians at the corner of Piccadilly, the heart of the city, were alarmed by a loud subterranean explosion. This was followed by the upheaval of a large stone trap-door, which closed the manhole of the electric-light wires. At the same instant a bright flame burst from the aperture, and mounted to a vast height. When it collapsed, and examination could be made, it was found that the cable was in a state of combustion. The electric supply had to be cut off before the fire could be extinguished. The people in Staplegrove-road are hardly so well situated as those in North-street for an affair of this kind, should it occur in Taunton."

SOUTHPORT.—Tenders are to be invited from the firms who tendered under the old specification for fresh tenders for high-tension mains under a new specification prepared by the Town Council's engineer.

STOKE.—Considerable improvements, extensions, and alterations are being made at the Stoke Railway Station belonging to the North Staffordshire Railway. Included in the improvements is the introduction of the electric light under the superintendence of Mr. J. Neale, the Company's telegraph superintendent, the work having been carried out by Mr. A. H. Lewis, under Mr. Neale's direction. Included in the installation is the North Stafford Hotel and several neighbouring buildings. The fittings have been supplied by the General Electric Company, of London and Manchester. The plant includes a 9½in. vertical high-speed engine by Messrs. Bumsted and Chandler, an Elwell-Parker dynamo, in addition to a 5½in. vertical Marshall engine, which drives a compound-wound Gülcher dynamo. The boiler and switchboard were made in the Railway Company's shops.

SWANSEA.—The question of the electric lighting of the borough is receiving the attention of the Corporation, who have called in an expert for consultation.

TAUNTON.—In consequence of the arrest of Mr. Hunt, as elsewhere reported, the Electric Lighting Committee of the Town Council have appointed Mr. W. H. Couzens as engineer-in-charge, *pro. tem.*

WALSALL.—As indicated in our last issue, the Town Council have discussed the special report presented in reference to the electric light and tramway schemes for the borough. The total amount of the tenders accepted for the work proposed to be done is £17,150. 10s., and the committee recommend that a further £2,500 be set aside as working capital, making the total outlay £19,650. 10s. The recommendations of the committee have been adopted. The Streets Committee also submitted a special report from Mr. F. Brown, the Corporation's electrical engineer, stating that the electric tramcar system had worked very satisfactorily, and that the line was in a good condition throughout. The number of passengers carried had increased from 1,871,816 in 1892 to 2,245,660 in 1893, and the public seemed thoroughly satisfied with the cars.

WEYBRIDGE.—Prof. A. B. W. Kennedy has presented his report to the Weybridge Electric Supply Company, which gives a description of the capacity and condition of the plant at the lighting station. The report is very favourable as to the condition of the machinery, &c., but Prof. Kennedy expresses his surprise at the very low price paid by the authorities for the public lighting, and recommends an early advance of not less than 50 per cent. If a local company is formed it will be necessary to expend about £16,000, from which an annual income is calculated at £1,755, which would leave a reasonable margin for profit.

WOLVERHAMPTON.—The Lighting Committee of the Town Council have presented their report, which states that, since the appointment of Mr. F. H. Lewis as electrical engineer to the Council, he had revised the original scheme of December 5, 1892, under which the tender of the Electric Construction Corporation was accepted at £28,772. 10s., subject to certain modifications, and the Committee have approved his recommendations, whereby the work, which was originally entrusted to the one firm, had now been subdivided. The scheme, as now approved, provides for a generating station at Commercial-road, from which the electrical energy will be transmitted to a central switch station at the Town Hall. From this central station the high-pressure current will be transmitted to various sub-stations in the compulsory area, which, to commence with, will be at the Art Gallery, Free Library, and Town Hall, where it will be transformed into low-pressure energy for distribution. The total of the tenders, plus the £1,320 estimated for arc lamps, &c., is £18,762. 14s. 2d., as against £28,762 in the original estimate. The total amount of capital expenditure for which a loan is sought will, therefore, be as follows:—Plant, as per tenders recommended, £17,442. 14s. 2d.; arc lamps, posts, &c., as estimated, £1,320; other capital items, as per list above, £4,020; add for estimated cost of buildings and for contingencies, £7,228. 5s. 10d.; total, £30,011. This shows a reduction of £10,000 as against the amount of the original tenders, which is partly due to the reduction of the plant to 5,000 lamps and partly to the economical revision of the scheme. The Committee recommend that the scheme be proceeded with, and that applications be made to the Local Government Board for a loan of £30,000.

YACHT LIGHTING.—Messrs. J. H. Holmes and Co., of Newcastle, have just completed the lighting throughout by electricity of Mr. Gordon Bennett's steam yacht "Namouna," the lights being arranged for decorative as well as useful purposes. A Belliss compound engine is used, coupled direct to a Castle dynamo, and the plant includes a battery of accumulators. The whole of the lighting of the yacht is by electricity. A number of novelties have been introduced, including the playing of a piano by means of an electric motor. The entire work is considered a great success.

BOOKS RECEIVED.

"Electro-Magnetism and the Construction of Continuous-Current Dynamos." Vol. I. By Dugald C. Jackson, B.S., C.E., Professor of Electrical Engineering in the University of Wisconsin. (New York: Macmillan and Co. Price 9s. net.)

"The Indian Engineers' Diary and Reference Book, 1894."

"A Manual of Electrical Science." By Geo. J. Burch, B.A. (London: Methuen and Co., Bury-street.)

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PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

November 11, 1893.

21,496. I. A. TIMMIS. Westminster. Improvements in the working of railway points and signals by electricity.

21,529. L. MOND and R. L. MOND. Liverpool. Improvements in electrolytic cells.

21,551. H. T. BARNETT. London. A device for the prevention of local action in electric batteries and improvements in connection therewith.

November 13, 1893.

21,580. T. DAVIS and E. DAVIS. Liverpool. Improvements in electrical signalling, recording, and detecting apparatus.

21,592. H. REID. Glasgow. Improved means of obtaining electrical contacts, disconnections, and reversing currents for operating electrical indicators or signals.*

21,609. A. R. UPWARD. London. A method and apparatus for the production of light by electric and electro-magnetic oscillations and vibrations.

21,619. J. NIXON. London. An electro deposit of zinc.

21,624. E. A. MCLACHLAN. London. Improvements in or connected with electrical storage batteries.

21,628. P. B. DELANY. London. Improvements in telegraphy.*

21,629. P. B. DELANY. London. Improvements in cable and submarine telegraphy.*

21,630. P. B. DELANY. London. Improvements in telegraphy.*

21,631. W. H. CALDWELL. London. Improvements in electrolysis and in apparatus therefor.

21,637. H. O. FISHER and W. W. PHILLIPS. London. An automatic electric signal for tramways and the like.

November 14, 1893.

21,714. S. D. WILLIAMS. Newport, Mon. Improved electric exchange systems with apparatus therefor, applicable also for telegraphic and electric type-writing purposes.

21,716. J. CLEGG. London. Improvements in the means of producing electric light.

21,734. D. H. WILSON. London. Improvements in dynamo electric machines.*

November 15, 1893.

21,812. A. R. UPWARD. London. Improvements in electrical means of advertising.

21,850. H. A. NABER. London. Improvements in voltameters.*

November 16, 1893.

21,932. F. W. SCHINDLER. London. Improvements in electric cigar-lighters and analogous objects.

21,933. F. W. SCHINDLER. London. Improvements in electrical cooking appliances.

21,958. H. H. LAKE. London. Improvements in and relating to electric lamps for bicycles and similar vehicles. (G. Mayr, United States.)

November 17, 1893.

21,966. E. BEAL. Manchester. An improved electrical drop indicator.

22,027. H. REASON. Brighton. Improvements in electric instrument protectors.

22,030. H. M. HUBERT, Comte Delamarre. London. A method of applying electricity to the mechanism of lights for lighthouses, buoys, beacons, and the like.

22,032. G. R. BLOT. London. Improvements in accumulator batteries.

22,053. V. C. DOUBLEDAY. London. Improvements in or connected with so called "dry" electrolytes for secondary batteries. (M. Süssmann, Germany.)

November 18, 1893.

22,075. C. F. PARKINSON and THE LANCASTER RAILWAY CARRIAGE AND WAGON COMPANY (LIMITED). Manchester. Improvements in electric furnaces for welding or heating metals.

22,089. H. BERNETT. Berlin. Compound plates for etching purposes, consisting of zinc electrically plated with copper or the like.

22,109. J. J. WILKS. Beckenham. An improved matchbox whereby matches may be struck without exposure to the wind.*

22,131. W. LOWRIE. London. Improvements in switches for controlling electric current circuits in parallel supply systems.*

November 20, 1893.

22,140. W. S. SMITH. Bradford. Improvements in incandescent electric lamps.

22,184. C. D. ABEL. London. Regulating apparatus for electromotors. (Berliner Maschinenbau Aktien-Gesellschaft vorm. L. Schwartzkopff, Germany.)

22,186. E. TYER. London. Improvements in lock and block electric apparatus.

22,195. A. T. COLLIER. London. An improved permanent magnet.

22,214. G. W. PRIDMORE and T. J. STURGEON. London. Improvements in glass bulbs relating to incandescent and other lighting.

November 21, 1893.

22,253. C. H. BRADRICK and B. A. KARR. Glasgow. Automatic railway electric signals.*

22,255. H. D. FITZPATRICK. Glasgow. Improvements in signal telegraphy. (The Boughton Telephotos Company, United States.)*

22,274. A. V. NEWTON. London. Improvements in primary electric batteries. (A. Nobel, France.)

22,304. J. T. FULLER. London. Improvements in or connected with trolleys for electric railways.

22,311. E. P. USHER. London. Improvements relating to storage batteries.*

22,312. E. P. USHER. London. Improvements in storage batteries.

22,319. J. GELL. London. Telegraph type-writing apparatus.

November 22, 1893.

22,335. J. WORTHINGTON and R. PARKINSON. Blackpool. The electrical and explosive method for extinguishing fires.

22,359. F. KING and W. P. MENDHAM. Bristol. An improved electrical detachable joint.

22,363. F. T. TROUTON. Killiney. An improved multiple-circuit microphone transmitter.

22,366. W. H. DUNKLEY. Birmingham. Improvements in phonographs.

22,379. S. MILLER and C. J. GRIST. London. Improvements in charging primary batteries.

22,395. P. E. POWNALL and R. B. POWNALL. London. Improvements in electric systems and apparatus.

November 23, 1893.

22,437. F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, and A. SOAMES. London. An improved electrical measuring instrument.

SPECIFICATIONS PUBLISHED.

All Specifications 8d. each.

1893.

813. POLLAK. Electric accumulators.

1,198. BROCKIE. Arc electric lamps.

1,951. MARSH. Arms for supporting telegraph pole insulators.

2,703. BATES. Electrical fuses.

18,066. LAKE (White). Supporters for electric lamps, &c.

19,423. VON DOLIVO-DOBROWOLSKY and Others. Electric-current distributing system.

19,534. DAVIS. Electric light switches.

COMPANIES' MEETINGS.

The General Electric Power and Traction Company (Limited).

The third general meeting of this Company was held at Winchester House, Old Broad-street, E.C., on Tuesday, the Right Hon. Lord Egerton of Tatton presiding.

The SECRETARY (Mr. Wm. Bulloch, C.A.), read the minutes of the last general meeting and the notice convening the present meeting,

The CHAIRMAN then said: Gentlemen, I regret to say that I have been asked to take the chair by the Board in the unavoidable absence of the Earl of Albemarle, who is prevented by serious indisposition from attending to-day. I am sure you will regret his enforced absence very much, as he is familiar with all the affairs of the Company. I have now to move the adoption of the report and balance-sheet. The Board have thought it well to call the shareholders together as soon as possible after the passing of the accounts and the closing of the books to the end of September, in order that they may be kept fully informed of the affairs of the Company, and the balance-sheet and profit and loss account be presented for the past year. I think they are drawn up in such a way as to show the position of the Company clearly and the result of the trading in the various departments. I am sorry to say that the general depression of trade still affects this Company, and that all the four businesses which in the first instance we thought there was a good prospect of developing, have not been as successful as we had hoped. With respect to the electric traction business, in consequence of the North Metropolitan Tramways Company not taking up the experiment which we had successfully instituted at Barking, and also owing to the general indisposition of municipal authorities to undertake any general system of electric traction, we have been unable to carry on that work at all; and at present, as you see from the balance-sheet, there is a depreciation, in consequence of the plant at Barking, which we are endeavouring now to dispose of, but which is at present unprofitable. In regard to the launches, there has been a slight profit during the past year, but it is not such as to induce us, I think, to go on and increase that branch very largely. There does not seem to be any very large demand for that class of business, and I think it would be wise if we could profitably dispose of that plant and concentrate our operations upon the manufacturing business and the copper-depositing business, to which I will allude further on. The profit and loss account is divided into two statements. Statement No. 1 deals with the result of the year's operations, which has, I think, been very clearly made out. Statement No. 2 shows the amounts which have had to be written off in the past year in respect of matters appertaining to previous years. You will see that on the manufacturing business there has been a profit in the past year of £1,010, and there has also been a small profit on the launch department, whereas in previous years there was a considerable loss. How-

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ever, those two items of profit have not been sufficient to cover the standing charges and the maintenance of plant and launches, and there is a loss therefore in the general balance-sheet. On the other hand, we have very much diminished all the expenses of management. The management has been undertaken by the Electric Construction Company, who, as preference shareholders, are the most largely interested in this undertaking. You will also see by the balance-sheet that we have struck off all the Directors' fees, amounting to £862, which appeared in the last balance-sheet. That sum has been cancelled, and the Directors' fees have been reduced to the very lowest amount during the present year. With respect to statement No. 2, the £8,718 is not hard cash paid out, only two items of £572 and £1,318 representing money paid away—namely, the expenses connected with the upkeep of Barking, Windermere, and Manchester plants, including the sums paid for determining leases at Windermere and removing the Barking plant, and the expenditure and book items written off relating to liabilities incurred in former years, and settled or compromised this year. With respect to the manufacturing works, it was necessary, owing to the termination of the lease at Kentish Town, to come to some decision. There was an idea, which was mentioned in the last report, that the Kentish Town Works should be transferred to Millwall, where the copper-depositing process has been set up, but that would have been a very costly removal, and therefore we decided to recommend an amalgamation with the Acme Electric Works, that Company having good premises in close proximity to our Kentish Town works. Those premises are already equipped with suitable machinery for carrying on the manufacture of electrical apparatus, and the plant we have at Kentish Town will be transferred there. The premises are large enough to hold all the plant we have, and there will be comparatively little expense in the transfer, the premises being so near to our works. The Directors consider it desirable that this amalgamation should be effected by the formation of a new company, to be called the Acme and Immisch Electric Works, and it is proposed that the new works should be managed, as now, by the Electric Construction Company, in order to save the expense of a separate staff, and by that means a great deal of the subsidiary work which the Electric Construction Company perform will be carried out, and the works kept fully employed, at very much less cost than if there was a separate management. The terms of the amalgamation are based on the relative value of the two works, and this Company will receive five-eighths and the Acme Company three-eighths of the capital, which it is proposed should be £25,000, £20,000 being in fully-paid Ordinary shares, in the proportions I have just mentioned; and it will require an issue of £5,000 in Preference shares for the purpose of working capital. With reference to the copper-depositing works at Millwall, they have been finished, but the present state of the copper trade, which is in a very different position to what it was when the works were first begun, has rendered it a question how far it would be profitable to start them at the present time. We are waiting for a favourable opportunity, and are considering the question of providing the necessary capital for commencing operations there as soon as the market is in a favourable position for our doing so. With regard to the general position of the Company, it is quite evident that, under present circumstances, the capital of the Company is not fully represented by its assets, and that there is already a balance against it of £76,800. It is quite clear, therefore, that some reorganisation of the Company will have to be undertaken, and the deficiency of the capital account must be written off before any dividends are paid. At present the Preference shareholders would have the first claim on any profit that was made. The present time is certainly not favourable for starting any new commercial transaction, and therefore, although the general policy of the Board has been to try and reduce expenses, and to dispose, in the most favourable circumstances they can, of the existing works, which have been a source of loss hitherto, they are sensible that a general scheme of reconstruction must before long be carried out, and they are giving the matter their most earnest consideration. Whenever they see their way to submit any suitable proposal they will call the shareholders together and present it to them. I regret that I cannot give any more rosy description of the state of our affairs, but this is consequent on the general depression in all manufacturing concerns, owing to the financial difficulties of the past three years, but I think I have shown you that we have tried to reduce the expenses of the Company. Under the management of the Electric Construction Company we have introduced great economy, and have shown a profit in the launch and the manufacturing departments, and we are endeavouring if we possibly can to get some offer for the launch business. Nothing, however, has been brought before us which I can submit to the shareholders on this point, but the matter is receiving the earnest consideration of the Board.

Mr. MORITZ IMMISCH seconded the resolution.

In reply to several shareholders,

Mr. EMILE GARCKE stated that with regard to the management of the Company's affairs by the Electric Construction Company, it might be well if he explained what was the position at the last general meeting when the arrangement in question was entered into. At that time the Company had no manager, and the secretary had also resigned. The Electric Construction Company were very largely interested in this Company, and they had conferences with the Directors with a view to devising some scheme by which the management might be carried on more satisfactorily in the future. The result of these conferences was a suggestion that the management should be taken in hand by the Electric Construction Company. That simply meant that that Company should take up the position towards this Company which would ordinarily be held by a manager. There had been no other change. The Electric Construction Company simply attended to the details of the affairs of the Company. The Board met, as before, very regularly, and received a report from the manager of the Electric Construction Company, and the Directors determined on the policy of the Company, leaving it to the Electric Construction Company to carry out their instructions. The result of that policy had been that a very decided economy had been effected in the expenses. The Electric Construction Company received a fee for management, which included Secretary's services and the use of offices; and in referring to that point he might, perhaps, be allowed to explain that, although the volume of business done might appear to be small, judging from the results shown in the balance-sheet, it must be borne in mind that at one time the Company had a very large business from the point of view of the transactions it entered into. With reference to the manufacturing business carried on by the Company, the Company was established to carry on the business of Immisch and Co., which was doing a very satisfactory business in the making of motors and other electrical apparatus. That business had not been quite as satisfactory as it was formerly, and it had been their desire to work it up again; and he thought that the proposed amalgamation, which he hoped the shareholders would agree to that day, would have the effect of reviving the former credit of the previous firm of Immisch and Co. The profit shown in the first portion of statement No. 1 of the accounts had been made entirely on manufacturing and contracting; and this year, although the profit was not large, still it was stated in four figures. Information had been asked with respect to the position of the Ordinary shareholders in connection with the proposed amalgamation. The proposal was to form a new company, and to transfer their manufacturing business to that new company, receiving in consideration for the transfer fully paid up shares in the new company. It was the new company which would issue preference shares, and this company would be in precisely the same position as before, with this difference—that instead of holding the plant and machinery represented by their manufacturing business, they would hold shares in a company which would own those assets. The Preference shares referred to by the Chairman would be issued by the new company, and the shareholders of this company would be in precisely the same position as before. The profits would be divided in the proportion of five-eighths to this Company and three-eighths to the Acme Company. With regard to the management of the launches on the Thames, there had been mismanagement in the past, he thought, but it would be very difficult and altogether unprofitable at this stage to try and distribute the blame and to determine in what proportions it should be borne by parties who were not present. They had done much better on the Thames this year than in former years. He was not a Director of this Company, but he knew what great attention was being given to its affairs by the Board, and he assured the shareholders that the Directors were giving their very earnest attention to all the matters in question.

Mr. IMMISCH stated that he could add nothing to what had been said by Mr. Garcke regarding the manufacturing, but as far as the proposed amalgamation with the Kentish Town Works was concerned, he might say that he looked upon the scheme very hopefully.

The motion was then adopted.

Sir HENRY C. MANCE, C.I.E., afterwards proposed the re-election as Directors of Mr. Moritz Immisch and Mr. James Pender, which was approved, and Messrs. Ward and Wilding were re-elected auditors.

The CHAIRMAN then proposed the following resolution:—

"*That this meeting approves the agreement submitted to it, made between this Company and a trustee for the Acme and Immisch Electric Works (Limited), relating to the sale to the latter Company of the Kentish Town branch of this Company's business, and authorises the Directors to carry the same into effect subject to such modifications, if any, as they may determine.*"

After some discussion, this resolution was carried, and a vote of thanks to the Chairman concluded the proceedings.

The following is the report of the Directors referred to above:—

At the last annual meeting the shareholders were informed that arrangements had been made with the Electric Construction Company (Limited), by which that Company undertook the management of the affairs of this Company. The Directors have pleasure in stating that this arrangement has worked very satisfactorily, and the following comparative figures indicate the economies which have been effected in the management. The trading accounts for the past year show a profit on the manufacturing department of £1,010. 12s., and a profit on launch department of £31. 14s. 2d., whereas for the previous year the accounts showed losses of £3,121. 14s. 2d. and £570. 10s. 3d. respectively. Furthermore, the expenses of management, exclusive of Directors' fees, have been reduced from £3,727. 5s. 5d. in 1892 to £556. 17s. 2d. in the past year. The Directors have decided to cancel the amount of £862. 10s. standing to their credit at the end of September, 1892, and have debited the past year with only £186. 18s. in respect of remuneration. During the past year the Directors have determined sundry unprofitable transactions by sales and closing of leases, and have made provision for possible depreciation on such of the dismantled plant as is still unsold. The accounts, however, do not deal with the larger question, raised by the auditors in their report of January last, whether the book value of patents and goodwill should be further reduced. The Directors regard it desirable that the capital should be brought into conformity with the real position of affairs, and they are giving this matter their further consideration with a view to a re-organisation of the Company. The question of removing the manufacturing works referred to in the last report has received the anxious consideration of the Directors, and, with the assistance of the new management, they hope to overcome this difficulty in a way which offers many advantages over the original plan of removing the works to Millwall. An agreement has been made, subject to the approval of the shareholders, for an amalgamation with the Acme Electric Works at Kentish Town. This arrangement has the merit of providing suitable manufacturing works already equipped, at a smaller annual cost for rent and other standing charges than that at present incurred by the Company, and avoids the heavy cost of removing machinery to a distance, and the serious disorga-

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nisation of the current business which this would involve. The copper-depositing works at Millwall are now completed, and the question of providing the necessary capital for commencing operations is receiving the consideration of the Directors.

Hove Electric Lighting Company (Limited).

The first annual general meeting of this Company took place in the Hove Town Hall on Tuesday last, Col. A. J. Filgate, R.E., presiding.

In proposing the adoption of the report (which appeared in our last issue) the CHAIRMAN pointed out that up to September 30th the Company had issued 3,290 shares, producing £16,450; that on that date they were in debt to their bankers to the extent of £2,500 on account of a loan guaranteed by the Directors, and that their other liabilities amounted to over £8,500, the bulk of which was due to the contractors. Against these liabilities they had the value of the actual work executed in the temporary and permanent generating stations, mains, plant, &c., £24,761; cost of meters, £583; office furniture, £69; and outlay on preliminary expenses and installation suspense account, £908. The revenue account up to September 30th showed a debit balance of £261. 10s., and considering the small demand during the early months of the Company's operations, that must be deemed satisfactory. On July 1st they had 52 houses connected with their system, representing 3,778 33-watt lamps; at the end of September the houses supplied had increased to 72, and the 33-watt lamps to 5,478, and at the present date they had 86 houses, and were supplying the equivalent of 6,225 33-watt lamps. Agreements had been signed for 14 additional houses, which would shortly be connected with their system, and from inquiries they had received they believed that number would soon be considerably increased. They understood that the Hove Commissioners were about to extend the light to the Town Hall, and they hoped the lighting of some portions of the town with arc lamps would soon be put in hand. On the whole there was every probability of the demand for the current being largely increased at an early date. But for the action of the contractors in carrying out the work of their contract largely in excess of the amounts for which the Company were able to pay they could not have attained that position. The capital needed for the construction of the first portion of the mains and the temporary generating station was, as they were aware, found by the Directors and their friends, and no appeal was made to the public for subscriptions until after the supply of electricity was commenced. The appeal then made did not produce the amount of capital they anticipated, nor did a second appeal made in the spring of the year. Being, however, fully satisfied with the progress made in the demand for electricity in Hove, and believing in the ultimate financial success of the undertaking, the Directors and Messrs. Crompton and Co. (the contractors) determined to do all in their power to push on with the work and fulfil the contract with the Commissioners. A main item in the contract was the erection of a permanent generating station, and as the demand for electricity was steadily increasing, it became apparent that, in addition to the contract obligation of the Company, the increased power provided by the permanent plant would soon be needed to meet the requirements of the public. Under those circumstances, the Directors obtained a temporary loan of £5,000 on their personal security to be devoted to the construction of the permanent generating station and electrical works, and the result was that those works were now approaching completion, and would, they hoped, soon be brought into use. In the meantime the demand for the electric current had so rapidly increased, while the days were also becoming shorter, that they were obliged to increase the temporary plant to ensure the demand being satisfied. The work the Company was doing in supplying electricity was largely in excess of what it was ever anticipated the temporary plant would be called upon to perform. Over six miles of mains had been laid, and more would have been put down but for a difficulty experienced in getting a sufficient supply of the casings which had to be used in the places where, owing to the position of the cellars, they were unable to construct concrete culverts. Their general policy in constructing mains was to tap the streets most likely to yield customers for the current—a policy which had been approved by the Commissioners, and one which they intended to adhere to as far as possible. From an approximate account of the working of the Company each week since July 1st he said that while in the earlier weeks the accounts showed a loss, that loss gradually diminished until near the end of September, when the returns commenced to show a profit, which had steadily increased since, and he thought it might be safely anticipated that the accounts for the half-year ending December 31st would show some profit after meeting all administration and other charges. Having devoted a considerable amount of time to looking into the affairs of the Company, he believed it was likely to prove a financial success. Their progress was distinctly more rapid than he had anticipated, and everything pointed to its continuing. Their undertaking was a local one, and so far as he could gather their reputation was good, and it was generally believed that the Company would be a remunerative investment, and they had no hesitation in recommending their enterprise to the people of Hove, and hoped they would soon supply the necessary capital to complete it. In regard to their future prospects in the deed transferring the Provisional Order to their Company, it was provided that no charge could be required from the Company in their schedule of charges during the first seven years of their existence. After that period the Hove Commissioners could only move the Board of Trade to reduce their scale of charges if the Company, in the seven years preceding, should have earned such a profit as would enable them to pay dividends at the rate of 10 per cent. per annum for the whole of such period. The Chairman concluded by expressing the satisfaction of the Directors with the excellent way in which the works had been carried out by Messrs. Crompton and Co. and their staff, and moved the adoption of the report and accounts.

Mr. CARLETON E. TUFNELL seconded the motion.

Mr. R. E. CROMPTON supported the motion as an old hand at electric lighting, and as engineer, first to the Hove Commissioners, and afterwards as head of the firm of contractors who carried out the work. He knew of no case where such good results had been obtained under such circumstances as at Hove. A large proportion of the inhabitants had shown appreciation of the light, and he considered the success of the Company had been reduced to a mathematical certainty. He joined in the appeal of the Chairman to the inhabitants to make the undertaking a local one. They wanted local support, and the money paid by the users of the light to be a source of income to the residents of Hove themselves. The security was, in these days, exceptionally safe, being not dependent on the fluctuations of trade like so many other incomes were. Speaking of the generating plant, Mr. Crompton said the design was the latest, and would work most economically. The works' cost had been reduced to a certain figure per unit, 3·3 lower than had ever been accomplished before for the same outlay. The more widely the results of the enterprise so far were ventilated the better for the Company, which wished to increase their capital to complete their works, and for the users of the light, because cheap manufacture meant cheap prices eventually.

Mr. WOODRUFF (Chairman of the Hove Commissioners) said that already they had realised a success far more than Mr. Crompton ever promised the Commissioners when he advised them as engineer. He (Mr. Woodruff) advocated the provision of a temporary station very strongly. The Company acted wisely in adopting his suggestion. When they looked at what had been accomplished by the initiatory work, he thought they were fully justified in anticipating a rapidly-increasing demand for the ight. He gathered that they expected to turn out the current at about threepence or less a unit, and he could see no reason whatever why the Company should not prove a very great financial success.

The motion was then carried unanimously, and a vote of thanks to the Chairman terminated the proceedings.

NEW COMPANIES, STATUTORY RETURNS, &c.

[In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, *pages 320-348, &c., &c.]*

ARTHUR H. BATEMAN (LIMITED).—This Company was registered on November 29th, with a capital of £5,000, in £1 shares, to carry on the business of emery-wheel makers, machinery manufacturers, iron and brass-founders, mechanical engineers, &c.

BILLING AND COMPANY (LIMITED).—This Company was registered in November, with a capital of £5,000, in £1 shares, to carry on the business of art-metal workers, brass founders, ironsmiths, gas, electric, ventilating, and general engineers, &c., at Smart's-buildings, High Holborn, London, W.C., and elsewhere.

R. AND. J. DEMPSTER (LIMITED).—This Company has been registered with a capital of £100,000, in £10 shares, to acquire the business of gas engineers and contractors hitherto carried on by R. and J. Dempster at the Gas Plant works, Newton Heath, Manchester, and to develop and extend the same.

ROSE, DOWNS AND THOMPSON (LIMITED).—This Company has been registered, with a capital of £50,000, in £10 shares, to acquire as a going concern the business now carried on under the style of Rose, Downs and Thompson; and to carry on the business of engineers, oil refiners, general merchants, &c.

UNIVERSAL ELECTRIC LIGHTING COMPANY (LIMITED).—This Company was registered on December 7th, with a capital of £5,000, in 10s. shares, to generate, produce, store, accumulate, and distribute electricity, electromotive force, or other similar agency, for the lighting of omnibuses, tramcars, cabs, and other vehicles, and for public and private buildings, manufactories, mines, ships, lighthouses, railways, &c., to acquire the right to use and put up telegraphs, telephones, electric bells, phonographs and all electric apparatus, including the formation of telephonic exchanges, to construct railways, tramways, or waterways, and to apply to the same, by means of central stations for generating electricity or otherwise, any means of electric locomotion, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and manufacturers of and dealers in electrical, telegraphic, telephonic and scientific apparatus. The subscribers (with one share each) are:—James F. Rogers, 108, Penton-place, Kennington, S.E.; C. F. Croll, 8, St. Agnes-place, Kennington-park, S.E.; H. Gibbs, 65, Glyn-road, Homerton, N.E.; G. F. Wenborn, Shipbourne, Tonbridge, Kent; W. J. Griffiths, 40, Albert-road, Stroud Green, N.; H. H. Clayson, 27, Borthwick-road, Stratford, S.E.; and R. B. Webster, 3, Kendal-villas, West Dulwich, S.E.

ELECTRO-ALKALI COMPANY (LIMITED).—The statutory return of this Company, made up to February 10th last, has been filed. The nominal capital is £160,000, divided into 10,000 Ordinary, 5,000 Preferred, and 1,000 Deferred shares of £10 each. All the Deferred shares have been subscribed for and allotted, and a call of £2 per share made. The calls paid amount to £734, and £1,266 is in arrears. The Electric Construction Company (Limited) hold 623 shares.

D. HULETT AND CO. (LIMITED).—The annual return of this Company, made up to October 2nd, has been filed. 5,900 Ordinary and 100 Founders'

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shares of £5 each, out of a nominal capital of £35,000, have been subscribed for and allotted. Of these, 4,000 Ordinary and the Founders' shares were issued as fully paid, while the full amount has been called and paid on the remaining 1,900 Ordinary shares.

J. C. HOWELL (LIMITED).—The annual return of this Company, made up to November 13th, was recently filed. Out of a nominal capital of £25,000, in £5 shares, 2,907 shares have been taken up, of which 2,000 were issued as fully paid to John C. Howell, the vendor. Upon the remaining 907 shares the full amount has been called, resulting in the payment of £4,510, and leaving £25 in arrears.

ERNEST SCOTT AND MOUNTAIN (LIMITED).—The annual return of this Company, made up to October 23rd, has been filed. 5,663 shares of £10 each have been taken up, of which 2,200 have been issued as fully paid. Upon 972 shares the full amount has been called, upon 500 £5 per share, and on 1991 a call of £6. 5s. per share has been made. The calls paid amount to £24,412, leaving £251. 15s. as yet unpaid.

LINEFF ELECTRIC TRACTION AND LIGHTING SYNDICATE (LIMITED). The annual return of this Company, made up to November 27th, has been filed. The nominal capital is £15,000, in £1 shares, of which 11,431 have been taken up. Of these, 8,003 were issued as fully-paid, while £3,428 has been called and paid on the remaining shares.

MONTE VIDEO TELEPHONE COMPANY (LIMITED).—The annual return of this Company, made up to November 14th, has been filed. The nominal capital is £220,000, divided into 29,000 Preference and 15,000 Ordinary shares of £5 each. All the Ordinary and 28,000 Preference shares have been taken up, and 3,000 of each description have been issued as fully paid. The remainder have had the full amount called, resulting in a total payment of £185,000.

ORME'S ELECTRIC SIGNAL SYNDICATE (LIMITED).—This Company has recently entered into an agreement with John Orme, of 65, Barbican, London, E.C., for the acquisition of British patent No. 20,742 (1891), and a provisional patent dated February 17, 1893, granted to the vendor in respect of an invention in relation to electrical and automatic signalling, and all improvements therein, and in consideration has agreed to allot 6,000 Ordinary shares as fully paid to the vendor. Messrs. Samuel Jennings and William M. Grimshaw have joined the Board of Directors.

CITY NOTES, &c.

ALUMINIUM COMPANY (LIMITED).—Mr. Justice Wright will, on December 20th, hear the petition for confirming a resolution passed by the Company reducing the capital from £400,000 to £80,000.

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ending December 10th were £911, as against £933 for the corresponding period of last year, being a decrease of £22. The total receipts for the half-year amount to £19,132, as against £18,976 for the corresponding period of 1892, an increase of £156.

COMMERCIAL CABLE COMPANY.—This Company has decided to redeem on January 15th next the whole of their outstanding mortgage debentures, amounting to £80,000.

CONSOLIDATED ELECTRIC COMPANY.—This is the title adopted by the amalgamation of the St. John's Street Railway Company of St. John's, New Brunswick, the Eastern Electric Company, and the New Brunswick Electric Company, which have recently amalgamated.

DOVER ELECTRICITY SUPPLY COMPANY (LIMITED).—The prospectus of this Company invites applications for 7,000 Ordinary shares of £5 each, being part of a share capital of £50,000. The Company is formed to undertake the supply of electricity in the Municipal Borough of Dover under the Provisional Order granted to the Corporation and transferred to the Company, who, by the agreement with the Corporation, are empowered to supply current to the public lamps to be erected in the principal streets of the borough. The term of this contract for the public lighting is for 21 years from the date of the first supply of current, and the Corporation have the right to purchase the undertaking within six months after the expiration of a period of 21 years from the date of transfer, and again within six months after the expiration of a subsequent period of ten years upon payment to the Company of the value of the undertaking and goodwill as a going concern, with an allowance of 10 per cent. for compulsory purchase, the value to be determined, in case of difference, by arbitration. The maximum price per unit for current is fixed by the Provisional Order at 8d., and a sliding scale is provided under the agreement with the Corporation. The Brush Electrical Engineering Company have contracted with the Company for the supply of the necessary generating plant and apparatus, and for the laying of the necessary mains for current equal to 10,000 8-c.p. lamps and for 25 2,000-c.p. arcs. The subscription list opened on Monday last, and closes on Saturday at 4 p.m. Prospectuses can be obtained at the offices of the National Provincial Bank of Dover and London, or from the office of the Company, 49, Queen Victoria-street, E.C. The Board of Directors includes the Mayor of Dover. (Sir William Crundall), Mr. B. H. Van Tromp, and Mr. R. Percy Sellon, The engineer and manager is Mr. A. J. Lawson, and the secretary Mr. B. Broadhurst.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announce the payment on January 15th next of interest of 3s. per share, less income-tax, being at the rate of 6 per cent. per annum, on the Preference shares for the quarter ending December 31st, and the usual interim dividend of 2s. 6d. per share on the Ordinary shares, free of income-tax, in respect of profits for the quarter ended September 30th. The transfer books are to be closed from January 8th to 15th, both days inclusive.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY (LIMITED).—The Directors of this Company on Wednesday declared an interim dividend, for the quarter ended September 30th last, of 2s. 6d. per share, free of income tax, payable on the 16th proximo. The Share Register will be closed from the 8th to the 15th proximo, both days inclusive. The coupons on the Company's Five per Cent. Australian Government Subsidy Debentures, due on the 1st prox., will be paid on and after that date at Messrs. Barclay, Bevan and Co.'s Bank, 54, Lombard-street, E.C. Coupons must be left three clear days for examination.

ELECTRIC CONSTRUCTION COMPANY (LIMITED).—The numbers are published of 117 Six per Cent. Second Mortgage Debentures in this Company, which were drawn on the 8th inst. in accordance with the deed of trust dated August 16, 1893. The debentures are for payment at par on the 1st proximo.

ELMORE'S FRENCH COPPER DEPOSITING COMPANY (LIMITED).—Messrs. Maddisons, solicitors, point out that the 5,000 Founders' shares forming part of the purchase price of the French factory and patents have no face value, but are to receive £4,500 a year after the payment of 10 per cent. on the £80,000 new capital found. These Founders' shares are also entitled to half the surplus profits beyond such prior payments after a provision for reserve, as required by French law. It will be remembered that Mr. Duncan, who is receiver for the debenture holders, was asked to accept the office of liquidator, and expressed his willingness to do so as soon as the sale in France was actually completed. Messrs. Maddisons further state that they have already received the £8,600 in cash which forms part of the purchase price, and hope that before the 20th inst., when Mr. Duncan's appointment is to be confirmed, they will have received the obligations (£60,000) and Founders' shares.

EXPLORATION COMPANY (LIMITED).—The Directors of this Company have just issued their report to November 30, 1893. The Company are concerned in the promotion of the Central London Railway, and the report states that the formal approval of the City Commissioners of Sewers to the plans of the station and subways was obtained in June last, and that all necessary Parliamentary and other powers for the carrying out of the undertaking have been obtained, but that owing to the unfavourable state of the Money Market the issue of capital has been postponed. The report shows that the rumour that other than electrical power is to be used on the railway is unfounded.

GLOBE TELEGRAPH AND TRUST COMPANY.—The Directors of this Company have declared an interim dividend of 1s. 3d. per share, payable on the 18th proximo.

NIAGARA.—The *Financial News* states that a firm of real estate agents at Buffalo, New York, are issuing a circular calling attention to the utilisation of the Falls of Niagara for generating electrical motive power, and urging capitalists on this account to come in and purchase large plots of building land in the neighbourhood of the Falls, as "building land is very cheap in this territory, and as it will all be required for building purposes during the next five years it is reasonable to suppose that the values will go up by leaps and bounds." It is pointed out in the circular that a company consisting of the Vanderbilts and other multi-millionaires has been at work for some years, "and on or about March 1st next will be ready to supply 120,000 H P.," which will have the effect of revolutionising the value of real estate in the present small city of Niagara Falls and all along the twelve miles from Niagara to Buffalo.

PANULCILLO COPPER COMPANY (LIMITED). — An extraordinary general meeting of this Company was held on Wednesday last at Winchester House, E.C., under the presidency of Sir John Pender, G.C.M.G., M.P., Chairman of the Company, for the purpose of confirming resolutions disposing of the property to a new company in course of formation. The resolutions were confirmed, and Sir John Pender, Mr. F. J. Johnstone, and Mr. Frank W. Bond were appointed liquidators for the formal winding-up of the old company.

SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).—The eleventh ordinary general meeting of the shareholders in this Company will be held at the Westminster Palace Hotel, Victoria-street, London, S.W., on Wednesday, the 20th inst., at 12 o'clock. The Directors, subject to audit, have resolved to recommend the shareholders to declare a dividend as follows:—3s. 6d. per share on the 78,949 Ordinary shares of the Company, £3. 10s. paid, and 4s. 3d. per share on the 19,750 £5 fully-paid shares, free of income-tax. This, together with the interim dividend paid on June 20th last, will make a total distribution of 7½ per cent. for the year on the Ordinary £3. 10s. paid shares of the Company.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have ordered the Seven per Cent. Preference shares (Nos. 1 to 12,845) and the Ordinary shares (Nos. 1 to 120,000) of the Electric Construction Company (Limited) to be quoted in the Official List.

VENEZUELA TELEPHONE AND ELECTRICAL APPLIANCES COMPANY (LIMITED).—On behalf of this Company Messrs. E. D. Oppert and Co. offer for sale, at £87. 10s. per £100 debenture, £50,000 in £100 debentures, payable £10 on application, £25 on allotment, £25 one month after allotment, and £27. 10s. two months after allotment. The prospectus states that the net revenue of the Company has at all times considerably exceeded the requirements for the service of the whole of the First Mortgage Debentures, and the accounts to June 30th last show a gross income of £18,444, against expenditure of £12,580. The estimated revenue for the Company's current year is expected to considerably exceed that of the previous twelve months, and it is anticipated that it will be sufficient to much more than cover the interest on the present issue of debentures, which are calculated to return 6½ per cent. interest per annum. The bonds are redeemable at par in 1910, if not previously redeemed at £105. The prospectus is not overburdened with particulars, and inquiries should be made by intending investors before subscribing. A copy of the trust deed and the Directors' report and balance-sheet can be obtained from Messrs. Oppert and Co., 33, Old Broad-street, London, E.C.

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WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the week ending December 8th (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £3,453.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the two weeks ended November 30th were £2,340, as compared with £2,338 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Dec. 6.		Price Wednesday, Dec. 13.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Dec. 13. Highest	Lowest
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,134,640	Stock	12/6	Anglo-American	43	45	42	44	6 5 0	Jan., Apr., July, Oct.	44	..
£2,932,680	Stock	25/0	Do. Preferred	82	83	81	82	6 14 2	,, ,,	83¾	81⅝
£2,932,680	Stock	5/0	Do. Deferred	7½	8	7½	8	..	.. ..	8	7⅝
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	100	103	101	104	3 16 11	January and July	101½	..
130,000	£10	4/0	Brazilian Submarine	11¾	12¼	11¾	12¼	5 6 1	Mar., June, Oct., Dec.	12⅛	–
£18,700	£100	5%	Do. 5 per Cent. Bonds	100	103	101	104	4 16 2	January and July	..	–
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	108	112	4 9 3	June and December	109½	–
10,000,000	$100	7%	Commercial Cable Capital Stock	140	150	140	150	4 13 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11½	12½	11½	12½	6 8 0	February and August	..	12
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	,, ,,	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	,, ,,	..	..
60,710	20	3/6	Direct United States Cable, 1877	11½	11½	11⅜	11⅝	6 0 2	Jan., Apr., July, Oct.	11⅝	11½
400,000	10	2/6	Eastern	14¾	15¼	15	15¼	4 5 3	,, ,,	15½	14¾
70,000	10	6%	Do. 6 per Cent. Preference	15½	16½	15½	16½	3 12 9	,, ,,	15¾	15½
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	116½	115
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	108	111	108	111	4 10 1	February & August	..	..
250,000	10	2/6	Eastern Extension	15⅝	15⅝	15½	15¾	4 8 11	Jan., Apr., July, Oct.	15¾	15½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	114	117	114	117	3 8 5	February & August	117	116
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	102	105	103	106	4 14 4	January and July	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	102	105	103	106	4 14 4	,, ,,	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	102	105	103	106	3 15 6	February & August	..	–
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	105%	108%	106%	109%	3 13 5	May and November	106¾	–
180,227	10	1/6	Globe Telegraph and Trust	8¼	8¾	8⅝	8⅞	5 1 5	Jan., Apr., July, Oct.	8 13/16	8⅝
180,042	10	6%	Do. 6 per Cent. Preference	15½	15⅞	15½	15⅞	3 18 1	,, ,,	15⅞	15½
150,000	10	5/0	Great Northern	20	20½	20	20½	4 3 0	Jan., April, and July	20⅜	..
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	103	106	104	107	4 14 4	March & September	..	..
17,000	25	12/6	Indo-European	40	43	40	43	5 16 3	May and November	..	..
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	3 6 8	,, ,,	..	–
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	105	108	5 11 1	March & September	..	–
£100,000	£100	4%	Pacific European Telegh. 4% Guar. Debs. "Red" 1942	102	105	102	105	3 16 2	..	..	..
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	..	..
3,381	£100 Cert.	35/0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	,, ,,	–	..
15,609	10	5/0	West African Telegraph	5½	6½	5½	6½	7 13 10	January and July	..	..
£249,900	100	5%	Do. 5 per Cent. Debentures	98	101	98	101	4 19 0	March & September	–	..
30,000	10	2/0	West Coast of America	2	3	2	3	..	January and July	..	–
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	103	99	103	7 15 4	June and December	..	..
88,321	10	1/0	West India and Panama	1	1½	1	1½	..	..	–	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10¼	9¾	10¼	5 17 1	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	,, ,,	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	108	111	108	111	4 10 1	June and December	–	..
64,242	15	4/6	Western and Brazilian	5½	6½	6	6½	3 9 4	May and November	..	..
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5¼	5¾	5¼	5¾	..	..	5½	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1	1½	1½	1¾	..	..	1½	..
£178,200	100	6%	Do 6 per Cent. Debs., Series "A" 1910	103	106	103	106	5 13 2	February & August	..	..
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	103	106	103	106	5 13 2	,, ,,	..	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	105	102	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	..	..	..
224,800	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
220,000	£1	4·76d.	Oriental Telephone and Electric (11s. paid)	3/16	5/16	¼	..	6 7 9	Yearly	..	–
484,597	5	2/6	National	4¾	5	4¾	5	5 0 0	June and December	5	4 13/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14	15	14	15	4 0 0	,, ,,	..	..
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	13½	14½	13½	14½	4 2 9	,, ,,	..	..
119,234	5	2/0	Do. 5% Non-Cumulative 3rd Pref.	5¼	5¾	5¼	5¾	4 10 11	..	5 7/16	5 5/16
925,017	£100	4½%	Do. Deb. Stk. 4½%	113	115	113	115	3 18 3	January and July	114½	114
58,000	5	1/0	United River Plate	2	2½	2	2½	..	January and July	..	..
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	,, ,,	–	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11½	11¾	11½	11¾	–	–	11⅝	..
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	12¾	13¼	10¾	13¼	..	–	13¼	13 1/16
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	–	..
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	–	–	–
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	..	–
8,322	£5	..	House to House Electric	..		..		–	–	–	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		..	–	–	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	–	–
30,000	£5	1/9	Liverpool Electric Supply (£3 10s. paid)	4½	4¾	4½	4¾	..	–	–	–
15,000	£5	2/6	Do. (fully paid)	6½	6¾	6½	6¾	..	–	..	–
111,000	5	..	London Electric Supply	¾	1	¾	1	..	..	..	..
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	7¾	8¼	7¾	8¼	2 8 5	..	8⅛	7⅞
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	103	106	103	106	4 14 4	June and December	104	..
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	–	–	..	..
19,980	£5	9½%	St. James' and Pall Mall	5¾	6¼	5¾	6¼	..	–	5 15/16	5⅞
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	–	8	–
59,900	5	1/6	Westminster Electric Supply (fully paid)	5	5½	5	5½	3 3 8	–	5⅝	5½
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	8	2/1	Brush Electrical Engineering	2⅝	2⅞	2⅝	2⅞	6 5 8	–	2 11/16	2⅝
90,000	2	6%	Do. 6 per Cent. Preference Non-Cumulative.	2⅛	2⅜	2⅛	2⅜	5 1 1	–	2¼	2 3/16
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	105	107	105	107	4 4 1	March & September	105	..
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	4	4½	4	4½	..	January and July	..	..
12,139	5	..	Edison and Swan United	–		–		–	–	..	..
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	–	..	..
49,900	10	12/0	Electric Construction	..		..		..	–	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜	–	–	–	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	–	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21½	22½	21½	22½	5 11 1	February & August	22⅛	21⅜
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	–	–
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	..	–	–
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	–	–
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/0	4/0	3/0	4/0	..	–	..	..
78,949	5	1/9	Swan United (£3. 10s. paid)	2	2½	2	2½	..	May and November	–	..
37,350	12	12/0	Telegraph Construction and Maintenance	36	38	36	38	4 9 1	March and July	37½	36½
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	104	107	104	107	4 13 6	January and July	–	..
37,514	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		–	–	..	..
41,098	£5	..	Do. Preference (fully paid)	..		..		–	–	–	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	¾%	City and South London Railway	28	33	28	33	2 5 5	May and November	..	–
37,500	£10	..	Liverpool Overhead Railway	5½	5½	5½	5½	–	–	–	–

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THE ELECTRICIAN:

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NOTES.

In another column will be found an abstract of the whole discussion on Prof. Forbes' Paper on "Electrical Transmission of Power from Niagara Falls." The Paper should never have been presented to an engineering society, and would have been premature even for a popular audience. The subject, as a practical problem, was clearly quite unripe for discussion. Many of the details were unanimously condemned by practical engineers. Mr. Ferranti's incisive and fearless speech was received with unusual applause, and while we echo his candid statement that no blame can be attached to Prof. Forbes, the important subjects on which he dwelt cannot be allowed to remain where they were left when the meeting rose. The less said about Prof. Forbes' reply the better. To say that the various criticisms have refuted each other is a very old device, and was quite inapplicable to this discussion.

We should like to leave this unpleasant subject alone, but in justice to Mr. Mordey, who was unable to defend himself from the attack made upon him, we must allude to the experiments cited by Prof. Forbes. We happened to be present at Thames Ditton on July 14, 1891, when these or similar experiments on parallel running were made, and we refer our readers to a description of them in the leading article in *The Electrician*, Vol. XXVII., p. 298. We did not learn at the time the precise object in view when a number of Sunbeam lamps were interposed in the circuit connecting the two machines. The result was, however, what might have been expected: that so long as no very great resistance, say half-a-dozen lamps, was used to throttle this circuit, the alternators fell into step as before, even when purposely switched together a little before the moment when they synchronised. But, on increasing this resistance, a time came, as it was obvious it must, when the alternators could no longer hold each other in step. We have no record of this resistance, but have some recollection of eight or nine 100-volt Sunbeam lamps in series, and that when from one-third to one-half of the 2,000 volts were absorbed, the machines began to hunt. But, we ask, what has this got to do with Niagara? What alternators, designed on their own experience by practical dynamo builders, or evolved from the inner consciousness of a consulting engineer, will behave otherwise? We do not ask Prof. Forbes these questions; for all we know he is proposing to put such a resistance into the circuit at Niagara; but we ask our readers to judge of the fairness of using this as an argument on an occasion which gave Mr. Mordey no chance of a reply. We do not for a moment suggest that the machines known as Mordey alternators are suitable for the proposed work at Niagara, and we should be very much surprised if Mr. Mordey, on being asked to design 5,000-H.P. vertical-shaft machines, were to propose to follow his ordinary pattern; but that Prof. Forbes should have thought so does not surprise us.

The article on driving alternators by gas engines, which will be found in another column, calls attention once more to the remarkable difference which exists between the theoretical economy of this source of power and the practical value of its use. Handicapped by the complexity of valves and cams, by the great waste of heat in the water-jacket, and by the cost and clumsiness of an engine which gives only one effective stroke out of four, gas can and does easily compete with steam under certain conditions. If some of these penalties could be removed, the field for competition would be greatly extended. It is only by large flywheels, whether forming part of the dynamo or otherwise, that parallel running with some alternators can be achieved. Gas engines are already seriously loaded with massive wheels, and the limit of size that can be reasonably hung on an armature shaft seems to have been reached. It might be worth while to provide a separate flywheel in a line with the armature shaft, coupled by a flexible coupling, and running, perhaps, on ball bearings. The crude method of governing by omitting explosions is, of course, inadmissible. We are glad to learn that Messrs. Willans and Robinson are taking up the manufacture of gas engines. The result will be watched with the greatest interest, and we cannot do more than hope that it will be equal to their steam engine.

A difference of opinion has arisen between the London County Council and the London Gas Companies as to the precise kind of candle that is supposed to meet the definition of the Metropolitan Gas Acts, namely, "sperm candles of six to the pound, each burning 120 grains an hour." This difference has been settled by the Metropolitan Gas Referees, who have issued a "Notification" prescribing various details of candle making. We learn about the wick that "the strands shall be plaited with such closeness that, when the wick is laid on a rule and extended by a pull just sufficient to straighten it, the number of plaits in 4in. shall not exceed

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34, nor fall short of 31." We also learn that the *Physeter Macrocephalus* is the precise kind of beast to furnish the spermaceti. From a scientific point of view this notification compares very unfavourably with the Board of Trade instructions for setting up Clark cells; but then we do not regard a standard candle from a scientific point of view. If, at the end of this document, a line had been added, giving authoritatively the value of a candle-power in terms of an amyl-acetate lamp or any other standard, its usefulness would have been increased a thousand-fold.

THE engagement into which a French cable company has just succeeded in bringing the colonies of New South Wales and Queensland for the laying of a cable to New Caledonia is one which we should have thought the home Government had an unquestionable right to veto if it sees fit. The conditions imposed by the French contractors are distinctly matters of "foreign relations," as to which no colony can claim perfect freedom so long as it forms part of the British Empire. The excuse put forward by the Prime Minister of Queensland has nothing to do with the conditions—the escape of New Caledonian criminals being preventible without those conditions. In the event of war between England and France the Government of Queensland would have to break her engagement unless we relieved her of the necessity by breaking the cable. But how about the French operators? They would have to quit the country; and in that case they would leave the cable behind them! Perhaps this is a contingency which the French contractors have not taken into account, though the Queensland Government could hardly have been unmindful of it. We observe that the agreement is for thirty years; we should not like to insure it for as many months.

THE figures supplied by Herr CLARENCE FELDMANN with regard to the working of the Cologne municipal central station for the twelvemonth ending March 31st last, are of no little interest, showing as they do what a Board of Trade unit "made in Germany" may be taken as costing. The output at Cologne for the year 1892-93 was in round figures 307,000 kilowatt-hours, almost the exact output of the House to House Company during 1892, whose station is moreover run on the same system. The total expenses per unit sold at West Brompton were, however, 6·1d., at Cologne 3·29d., or about 14 per cent. better than the *best* London figure, viz., the 3·8d. of the Charing Cross and Strand Electricity Supply Corporation; no money being set aside for depreciation in any of the three cases. Again, in the item of cost of coal per unit metered the Cologne figure of 0·77d. is ahead of our best London stations, viz., the Kensington and Knightsbridge with its 0·92d. and the St. James's with its 0·94d. Another noteworthy fact is that, at Cologne, the units delivered to private houses form only 3·14 per cent. of the total output of the station, whilst shops, restaurants, hotels, clubs, and offices take no less than 83 per cent. The price of gas at Cologne is now 4s. 1d. per thousand, and the average price of the kilowatt-hour about 8d.

THE Compagnie Parisienne de l'Air Comprimé, commonly known as the Popp Company, recently took to supplying its customers' 110-volt lamps with only 95 volts, and as a consequence lost the best part of its *clientèle*, and obliged the Municipal Council, in face of the "intolerable situation" thus created, to allow rival companies to invade the Popp territory. Some five years ago, speaking at the Society of Arts as a private person, knowing nothing whatever about electricity, and merely as one having a few glow lamps in his house, Prof. AYRTON formulated a demand for a light meter as the *ultima thule* of the meter maker; "he did not care anything about watts, or volts, or amperes, or any technical units, but what he did care about was this: he bought light, and he wanted his meter to measure more or less approximately what he was paying for." If the Popp system of extra-low voltage distribution should become general, the demand for a payment-by-result meter would not long be confined to its originator. A 110-volt 16-c.p. lamp run at 95 volts may be taken as equivalent to a 100-volt 16-c.p. lamp run at 86 volts, and would, therefore, give about 5½ candles, or 34 per cent. of its proper light, whilst the consumer's wattmeter would be registering something like 70 per cent. of the original watts. When we have arrived at a light-meter another meter will still be needed before strict justice is meted out. Who can measure the inconvenience caused to unfortunate consumers by supplying their lamps with 14 per cent. less than their proper volts?

WITH almost as great regularity as the tides themselves, but fortunately with a less frequency, proposals are made to utilise by tide-mills the vast power which is "running to waste." A pamphlet sent to us this week is written almost as though the author had made a discovery. One river in the West of England is said to "waste twenty billions of foot-pounds per annum," but every competent engineer who has looked into the matter has found that the prime cost of the works and plant is altogether prohibitive. About ten years ago a patent was granted for utilising a miscellaneous collection of waste energy, amongst others, the audience entering a theatre was expected to generate sufficient electric light for the whole performance, by the rotation of turnstiles at the doors. This is not much more absurd than some tide-mill schemes.

Obituary.—The death is announced of Henry Goebel, the unsuccessful rival of Edison in the matter of the invention of the carbon filament for electric lamps.

The Waddell-Entz Accumulator.—The Hagen Accumulator Company, says *Industries and Iron*, has acquired the sole right to manufacture the Waddell-Entz accumulators in Germany.

Bolton.—The ceremony of laying the foundation stone of the Bolton Corporation electricity buildings took place last week. The scheme adopted is on the alternating-current high-pressure system.

The Joule Memorial Statue.—On Friday, the 8th inst., Lord Kelvin unveiled, in the vestibule of the Manchester Town Hall, a statue of Joule. The movement was promoted by the Manchester Literary and Philosophical Society, and a sum of £2,611 was raised.

The Crompton-Brunton Alternator.—In connection with the notice in our last issue of the Crompton-Brunton alternator, the second point to which special attention has been paid

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should read "facilities for easily removing and replacing armature coils."

Institution of Civil Engineers.—The Council of this Institution has nominated for election as honorary members the Duke of Devonshire, Dr. Edward Frankland, Capt. Sir Douglas Galton, Prof. von Helmholtz, and the Marquis of Salisbury. At present, out of a gross total of 6,490, there are only 15 honorary members.

Faure's Accumulator Patent in Germany.—The Imperial Court of Appeal at Leipzic has just decided, in an action brought by the Hagen Accumulator Company against certain manufacturers of secondary batteries in Germany, that the employment of lead in the state of super-oxide, oxide, or insoluble salts as a filling material for accumulator plates comes under Faure's patent.

The Telephone in Manchester.—Mr. Haldane Gee recently delivered a lecture on "Electricity in the Service of the City," to a large audience at the New Islington Hall, Ancoats, Manchester. As illustrating the progress of Telephony in Manchester he said that since February, 1891, 2,213 miles of copper and silicium bronze had been used in the New Telephone Company's system. The number of calls for the week ended December 7th last amounted to 80,630.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
Singapore-Saigon	December 11th. ...	December 16th.
Cayenne-Paramaribo	October 25th. ...	—
Cayenne-Vizeu	November 25th. ...	—
Jamaica-Colon	November 25th. ...	—
Kotonou-Accra	December 4th. ...	—
Lagos-Brass	December 4th. ...	—
San Domingo-Martinique	December 10th. ..	—
Haiphong-Hongkong	December 11th. ...	—
Bonny-Cameroons	December 18th. ...	—

Oils, Soaps and Electricity (Limited).—A daily paper announces that Messrs. ———— Bros., Limited, "was registered on the 9th inst. with a capital of £10,000 in £10 shares to carry on in the United Kingdom the business of manufacturers of and dealers in cake and other feeding stuff, and oils, soaps, scents, essences, manures and all like products; and also the business of electrical engineers, suppliers of electricity, light, heat and motive power." This reminds one of the story about Roger Giles, who announced that he sold "cocks, hens, owls and other moosical instruments."

The "Telephotos."—Last Friday afternoon Colonel Gouraud delivered a lecture at the United Service Institution on an invention by a Mr. Boughton, of Buffalo, N.Y. The idea is to actuate a number of incandescent lamps placed horizontally or vertically. Colonel Gouraud explained that the theory of the telephotos was the production by incandescent lamps of the symbols of the Morse code, in dashes of 5ft. length made with ten lighted lamps, and dots of 3in. made with one lighted lamp, and with unlighted intervals of 5ft. between each, which will bring under the eye the complete symbol at once, and is intended for use at any points within vision.

Western Union Telegraph Company.—The latest figures published with regard to this gigantic telegraph undertaking show that its growth is satisfactory and steady. In 1892-93 the Western Union Company owned 769,201 miles of wire, or 4 per cent. more than in 1891-92. Messages increased by 6 per cent., the total for 1892-93 being 66,591,858. The gross revenue for 1892-93 was £4,995,688, and the net profit £1,499,207, being an increase of respectively 5·3 per cent. and 1·3 per cent. upon the figures for the preceding twelvemonth. In 1892-93 more than twice as many telegrams were dealt with than in 1879-80, and the revenue was nearly twice as large, but the advance in net profits during that period has only been 28 per cent. The capital of the Company now stands at £20,000,000.

Dublin and Belfast Telephone Trunk Wire.—It is expected that the Dublin and Belfast telephone trunk line will be completed early in January. Already the arrangements as far as Drogheda are perfected, and spoken messages may now be passed between that town and the Irish capital. It will be remembered that Belfast has been coupled up to Glasgow since April last, so that when the line between Dublin and Belfast is completed, it will be possible to communicate verbally between these three great centres of industry. It is not yet stated what the tariff will be, but since the charge between Belfast and Glasgow—a distance of 150 miles which includes 25 miles of submarine cable—is only 1s. per minute, the charge between Dublin and Belfast will probably not exceed this sum. The conductor is a solid copper wire weighing 800lb. to the mile.

Chemical Interchanges.—In a letter to *Nature* on the subject of chemical interchanges in connection with the theory of flame Prof. Armstrong concludes as follows:—"The study of flame affords problems of the highest interest and importance, but of proportionate complexity and difficulty. There is little doubt, however, that we are inclined to take too narrow a view of this as of many other inquiries—that we have an unreasoning belief in what we are pleased to call facts, forgetting that these same 'facts' are but phenomena interpreted by our own limited intelligence. On studying the views that have been taken at various times, it is only too obvious that fashion is not confined only to garments, nor is dogma the exclusive privilege of theologians; and it is time that we realised that very many of our conclusions regarding chemical interchanges are but the crudest dogmas, based on a thoroughly superficial consideration of the phenomena. If we are to deserve the title of scientific workers—workers exact in deed, thought, and word—we must be far more careful in the choice of our language, and guarded in our conclusions."

Refuse Utilisation Scheme for Harrogate.—A scheme of electric lighting by power derived from refuse has been drawn up, and is intended to be tried at Harrogate. The process in outline is as follows:—The refuse is brought in carts or otherwise and tipped upon a platform, whence it is automatically carried into a rough-sifting apparatus which separates the old pots, cans, &c., the smaller material passing through the sifter and into a large hopper, from which it is forced in regular quantities into a drying cylinder which extracts nearly one-third of its weight in the form of moisture. It then passes on to another sifter which takes out the fine dust, the resultant fuel being passed down a shoot and automatically injected into the special boiler furnaces. The dust is said to form a valuable manure, and the consulting engineer thinks that the metal separated from the refuse might be reduced to copperas by a simple process, and the rags will be available for paper manufacture. Electrical engineers will await with interest the practical results of this experiment, the details of which have been drawn up by Mr. George Wilkinson.

Telegraphy in France.—At the end of the year 1892 the entire network of French telegraphs comprised 103,280 kilometres of line, the length of wire amounting to 318,733 kilometres. The apparatus in use included 12,123 Morse instruments, 768 Hughes printing telegraphs, and 4,716 of various other kinds. The number of home telegrams sent in 1892 amounted to 34,820,302, of which 2,163,629 were free messages. The number of telegrams transmitted from France to other countries amounted to 2,726,940, as against 2,623,923 received from abroad. In addition 1,571,168 telegrams were transmitted across the country from frontier to frontier. If we compare these statistics with those of other countries at the same date, we find that in point of the number of miles of line Germany takes the leading place, with 117,871 kilometres, France the second position, while Great Britain could at that date show only 54,337 kilometres. In regard to receipts, however, Great Britain takes precedence of France, the annual receipts of the latter having amounted to £1,466,220, as against £2,486,790 in the first-named country.

Triphase Current Transmission in California.—In the city of Redlands, California, the power house contains at present two 250-kilowatt triphase generators, each directly coupled to the shaft of a Pelton wheel. Though but a short time has elapsed since the plant started, there are now in operation 30 arc lamps about the town and 1,000 incandescents of 16 c.p. Besides these, a concern supplying artificial ice has contracted for 150 H.P. to be delivered twenty-four hours a day for twenty-five years. This is supplied by a 120 kilowatt motor especially designed by the General Electric Company. It has eight poles and runs synchronously with

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the generators at a speed of 750 revolutions, or 6,000 alternations, a minute. The ice house is four miles and a-half from the power house and the motor is started by first short-circuiting the fields until the machine is brought into synchronism with the generator, and then cutting in the exciter. It has thus far proved perfectly satisfactory and the tests show a high degree of efficiency for the entire plant. No transformers are used except directly at the points where light and power is delivered. The lights and small motors are operated at 110 volts, and the ice company is supplied from a separate circuit.

The Pacific Cable.—In the House of Commons last week Mr. Henniker Heaton asked the Under Secretary of State for the Colonies whether he was aware that a contract was entered into last year, and now completed, between a French cable construction company and the Governments of New South Wales and Queensland for the construction of the first section, from Queensland to New Caledonia, of a proposed Pacific cable to America; whether he was aware that the French Government contributed two-thirds of the subsidy (the remaining one-third having been contributed by the British Colonies aforesaid) on the binding condition that the cable material should be constructed in France, that only French officers and men should be employed to undertake the management and working of the cable during a period of 30 years; whether any remonstrance on the subject had been made to the Governments of New South Wales and Queensland by the Secretary of State for the Colonies; and whether he had any objection to state the nature of the reply from the Prime Minister of Queensland to Lord Ripon's communication. Mr. Buxton stated that the answer to the first three questions was in the affirmative. With regard to the last question, a reply had been received from the Prime Minister of Queensland, in which he pointed out that the cable in question would enable the authorities to prevent much more easily the escape of French criminals from New Caledonia.

Electric Cooking.—The advent of electric cooking apparatus seems likely to evolve a highly-scientific species of cook, with, we may be sure, highly up-to-date notions about the "living wage." "Cookery," we are told by a daily contemporary in a description of the electric process, "is raised from the rule-of-thumb level to that of an exact science by the use of a graduated thermometer. For bread or puff pastry a temperature of 370deg. Fah. is required; for pork, veal, or ordinary pastry, 350deg.; for beef, 340deg."; and so on. All this must mean a table of constants in the kitchen, with possible formulæ with different coefficients for jam tarts, mince pies, and Christmas puddings. Perhaps some method of integrating the specific heats, latent heats, and density of the heterogeneous mass to be cooked will be found necessary before the temperature can be finally determined. This will mean Royal Society Papers on the subject. Besides all this, the cooking appliances are depicted as being fitted with a whole battery of switches, various combinations of which, like the stops on an organ, will be necessary to produce various effects. "Afterwards," says our contemporary, in an account of the destructive distillation of a joint, "four of these switches are turned off, and the heat is applied from one side only." Just think of the high scientific knowledge required in order to be able to manipulate these cookery stops, so as to produce any given thermal distribution on the three Cartesian axes of the kitchen oven!

Flexible Trolleys for Canal Boats.—It would seem from a note of Mr. J. Dennis, in the *Electrical Engineer* of New York, of December 6th, that the recent official trials of an electrically-propelled canal boat were not so entirely successful as we were at first led to understand. In some respects the supplementary trials of the pioneer canal boat, the "F. W. Hawley," at Pittsford, have, says Mr. Dennis, been more satisfactory from a technical view point than the official trial in the presence of Governor Flower and the canal officials. One of the vexatious features of the official trial was the long delay incident to the difficulty in placing the heavily-laden canal boat under the trolley wires. Even when the boat was fairly under way, extreme care in steering was necessary to keep the under-running trolleys in position, and almost no variation from the course under the wires was admissible; and the services of a steam tug were required in making the turn, preparatory to the return voyage. Early in the week following the official trial Mr. Dennis was invited to witness some experiments with improvised flexible trolleys. The flexible trolleys were extremely simple temporary devices, and consisted of insulated copper wires, with hooks at the ends. The trolley arms had been removed, and the wires were connected to the standards. The hooks were passed out to the trolley wires by means of a pike pole, and the motors, reversed, backed the boat out into channel. It was then sent ahead regardless of its position under the trolley wires. The boat was steered from side to side, taking any desired position, no difficulty being experienced with the trolleys. While the Westinghouse engineers are silent regarding the ultimate type of trolley to be used, it is probable that it will consist of an over-running carriage, easily removable in case it is desirable for one boat to pass another going in the same direction; these carriages being connected with the motor by means of a reel of flexible wire.

The Utilisation of Water Power.—A committee consisting of Profs. W. C. Roberts-Austen, W. C. Unwin, G. Forbes and Colonel J. Pennycuick was appointed some time ago, says the *Iron and Coal Trades' Review*, to consider the question of the utilisation of the water power derived from the Periyar Irrigation Works in India; this committee, we understand, has now concluded its investigations and issued its report. The committee is of opinion that by the adoption of the arrangements proposed, motive power can be supplied in the towns of Madras, Madeira and Trichinopoly at an annual cost of £3, £2 and £1. 10s. per horse-power respectively. From Colonel Pennycuick's note on the hydraulic apparatus required, we gather that the water for driving the motors will be brought to them in iron or steel pipes, a separate pipe being provided for each motor or pair of motors. He says that the side slopes of the valley are such that there will be no difficulty in laying the pipes, and that the total fall available is a little over 1,000ft., which he recommends for the sake of economy be divided into two stages of 500ft. each. The calculations that he gives are based on this assumption, and that the length of pipe for each stage will be 1,500ft., for, as the slope is 2½ to 3 vertical to 1 horizontal, the average length of the pipes may be taken as three times the head, and his calculations lead to the result that at the works the capital cost per horse-power would not exceed £4, or the annual charge about 10s. per horse-power. The motors, according to Prof. Unwin, should be either Girard turbines, as used at Turin, or tangent wheels. Prof. Forbes, in his report, deals with the cost of the electrical part of the works, including the generation of electric current and its transmission to certain points, as yet undecided on, and its utilisation at these points. He appends a most exhaustive note on the character of the machinery to be employed, illustrating his arguments by his experience of the experiments between Lauffen and Frankfort in 1891, and his knowledge of the machinery in use at Niagara. Briefly, he decides in favour of an alternating current. He is rather undecided whether the current should be single-phase or two-phase, which he says must depend largely on the uses to which it is to be applied. For general purposes, however, he prefers the two phase system, and bases his further calculations on that, and finally decides that the type of machine required is each motor to be 5,000 horse-power, vertical shaft, generating 50,000 or 40,000 volts, direct frequency, 50 per second, two phases, and says such a machine can be got out at a remarkably low figure. He then deals with the cost of transmission, and concludes his proofs by saying that it seems quite clear that up to a distance of 350 miles, that is to say to Madras, it will be possible to supply electricity at any low pressure suitable for electric lighting or for motive power at a cost of not more than £4 per horse-power per annum including all costs, with a margin for contingencies. Prof. Roberts-Austen deals with the question as to whether it is possible to obtain aluminium by electric energy, and here it is only a question of the material whence the aluminium is to be extracted. The professor has analysed a specimen of corundum from Salem, and found it of high purity, but he had no means of ascertaining whether it is an average sample, and he is therefore unable to say whether the establishment of an aluminium works in the vicinity of Periyar is likely to prove a profitable undertaking or not.

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THE DRIVING OF ALTERNATORS BY GAS ENGINES.

BY J. EMERSON DOWSON, M.INST.C.E.

The opinions of electricians seem to be as conflicting on the merits and demerits of continuous and alternating-current systems, as were the opinions of engineers in the days when the "battle of the gauges" was fought. Happily for my peace of mind I am not a partisan of either system, but I am often consulted about the engine-power required for small central stations; and as many of the proposals brought before me are for alternating currents, I have to face the question: Can gas engines be used for driving alternators in parallel? It is admitted that gas power with generator gas is cheaper than steam power, especially in small stations with light day-loads; not only is the fuel consumption less per horse-power used, but the stand-by loss of boilers with light loads, or with no loads at all, is almost entirely avoided. The inducement therefore to adopt gas power is great, and with the best type of gas engines, as now made for electrical work, it is as easy to drive continuous-current machines, as with steam engines; moreover, the dynamos can now be coupled to the engines if necessary. With alternators, however, certain difficulties present themselves, and the solution of them will to a certain extent depend on the co-operation of electricians with the makers of gas engines.

Of course a gas engine can drive one or more alternators, as well as one or more continuous-current machines; but so far as I am aware, two or more gas engines have not been used for driving two or more alternators in parallel. The trial has yet to be made, and let us for a moment consider the difficulties involved. The alternations must be at frequent intervals, and when No. 1 alternator is running with its load on, No. 2 alternator must be brought up to the same voltage, with precisely the same speed as No. 1. With a steam engine there is at least one impulse every stroke, and the admission of steam can be regulated with great nicety, so that with care No. 2 engine and alternator can be put into step with No. 1, and the load is equalised between them.

With a gas engine working on the Otto cycle, there cannot be more than one impulse in four strokes, in each cylinder, and when the engine has a light load (as would be the case with No. 2 alternator before it is connected with No. 1), the impulses would be at still longer intervals. It is obvious that with two cylinders there would be twice as many impulses as with a single cylinder; and that with a double-acting engine the number of impulses would be proportionately increased. With the double-acting engine, however, more oil and more water must be used to prevent overheating of the pistons, and there are twice the number of gas, air, and exhaust valves, as well as twice the number of ignition tubes and valves to keep in order, compared with those of single-acting engines. Therefore the extra number of impulses involves greater complication, in an engine already more complicated than a steam engine, and there is greater wear and tear of delicate cams and other working parts, as well as increased working cost. However ingenious these double-acting engines may be, it is tolerably certain that as they are now made they will not be used to a large extent, and for practical purposes we need only consider the well-known single-acting engines until something better has been devised.

Even in the double-acting engine, as well as in the single acting, the four-stroke cycle is adhered to, and variations in speed, when the engine is running light, have still to be taken account of, although they are not great if heavy fly-wheels are used. I do not for a moment say that alternators in parallel cannot be driven by gas engines. I do not even know that it has been tried, and I am merely pointing out what has to be considered. In the usual way, when No. 2 alternator has to take up the running with No. 1, it would not have any load on, and if the connection were made immediately after an impulse in No. 2 engine, the latter might go on happily; but if the connection were made a little before the impulse there would be the risk that No. 2 engine would not keep step, and might be pulled up by the sudden drag put on it. Such a point can only be settled by a trial on a practical scale, and to insure success it is not unlikely that a temporary load may have to be put on No. 2 alternator, by means of resistances, so as to get a steady speed and voltage before the connection is made with No. 1. This, however, is not a serious matter, as it involves little more than an extra consumption of fuel for a few minutes.

It may be said that all troubles of running in parallel would be avoided if a continuous current were used, but a low-tension current can only be used within a short radius of the central station, and if a high-tension current is used for the distant areas it must be transformed down for the lamps. Then if the current is continuous, the transformers must be moving machines, which have a low efficiency when working with a light load, and moving machinery must also be looked after while running. With an alternating current, however, the transformers are stationary, and the loss with light loads is less than with continuous-current transformers. On the other hand, accumulators cannot be used with alternating currents; there is no reserve of current, and at least one machine must be run however light the load may be. There is also the disadvantage that accumulators cannot be used to keep the engines fully loaded, and when they are driven with light loads their efficiency is low. There are other electrical considerations; but these I will not attempt to deal with, as I merely want to get the general bearings of the case, so far as it concerns the driving of alternators by gas engines.

The use of accumulators, to a moderate extent, is, I believe, important, as they steady the current sent to the lamps, they can serve the day-load, and they can keep the engine or engines connected with them fully loaded; but I know that some electricians consider that these advantages are outweighed by the trouble and loss of current due to the accumulators themselves. It may also be arranged that gas for the engine power, during the hours of light load, should be stored in a gasholder, instead of storing electricity in batteries. For the moment, therefore, I will put the question of storage on one side, and then we shall be left with the comparison that continuous-current machines in parallel are easier to drive, but that high-tension alternating currents are more easily transformed down for the lamps. The *via media* is often the best, and Mr. Rankin Kennedy's proposal that a low-tension continuous current should be taken from one end of the dynamo, and low-tension alternating currents in quadrature from the other end, is at least worth consideration. In this system the continuous current would be used for serving the district near the central station, and for charging accumulators if desired. The low-tension alternating currents would be raised to high pressure, by step-up transformers, and then transformed down for the lamps in the usual way. To prevent the step-up transformers working at a low efficiency, during the hours of light load, transformers of small size could be used during that time.

Mr. Kennedy proposes this system of working for various reasons, electrical and economical, and I have ventured to refer to it because it seems to me to simplify the use of gas engines for producing alternating currents, as it avoids the trouble of driving alternators in parallel. Compared with a continuous-current system, there is the extra cost of the step-up transformers, and the loss of current due to them; but on the other hand, stationary step-down transformers can be used, so that all the moving machinery would be within the central station. At the same time all, or a portion of the light load, could be served from accumulators, and in small stations no engine need work for several hours. On this point I think it worth while to quote Mr. Kennedy, who says: "It is a remarkable fact, not generally known, that a dynamo running from a storage battery, *i.e.*, as a motor converting continuous into quadrature current, can give without heating about twice the output as quadrature current that it can give when worked simply as a dynamo by a belt."

The adoption of the system would seem to depend chiefly on what will be the loss due to the step-up tranformers, but what this loss may be I do not know. I understand, however, that the system has already been tried, and if those who have had actual experience of it will be good enough to make known their results, they will, I am sure, help forward the solution of this important branch of electrical engineering.

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COMPENSATION FOR HYSTERESIS.

BY A. B. FIELD AND M. WALKER.

A method of overcoming the ill effects of hysteresis of iron in measuring instruments, similar in principle to those described by M. Abdank Abakanowicz and E. B. Vignoles in *The Electrician* a week or two ago, has been suggested by Prof. Perry, and the following experiments to carry it into effect were conducted in the early part of this year (1893) at Finsbury Technical College :—

The principle of Prof. Perry's method is shown in Fig. 1.

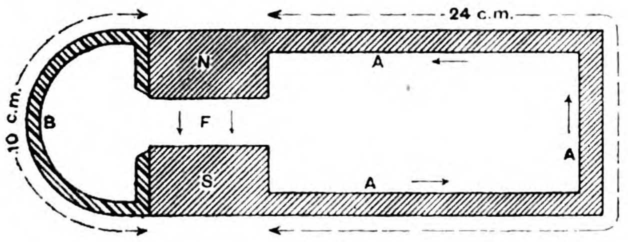

Fig. 1.

A is the iron core of an electromagnet, having its poles at N and S. B is a strip of permanent magnet steel placed as a shunt to the field F. When a current is passed round A, lines of force are generated in A, F, and B of the direction indicated by the arrows. When the current is broken, lines of force due to hysteresis still circulate in A and B in the same direction, and if the length and section of B are chosen (having regard to the greater residual magnetism of the steel), so that the number of lines of force in B shall be equal to the number in A, then none will appear in F.

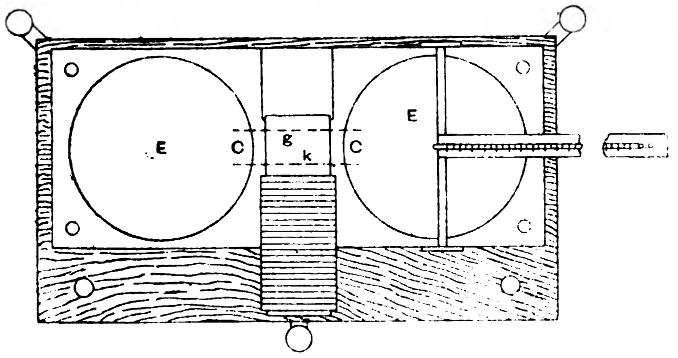

Fig. 2.

Further, it is conceivable that the magnetisation curve of the steel of B might bear such a relation to the magnetisation curve of the iron of A, that at all times during the decreasing of the current the extra induction in A due to hysteresis would be just balanced or taken up by the induction in B. In this way there would be produced, whether increasing or decreasing, a definite field for a definite current, and so long as the straight part of the magnetisation curves were not exceeded, the former would be proportional to the latter.

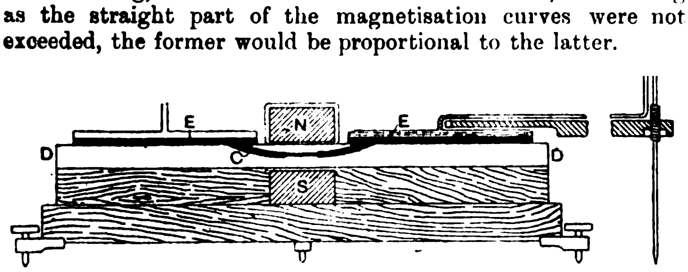

Fig. 3.

Before commencing experiments to practically realise these conditions, it was necessary to have some instrument which would indicate the strength of a magnetic field accurately and at the same time expeditiously. The apparatus which was ultimately constructed for this purpose is shown, in plan, in Fig. 2 and, in sectional elevation, in Fig. 3. N and S are sections of the poles of the iron magnet. C is a little tunnel in the ebonite plate, D D, connecting two large pools of mercury, E E. The section of this tunnel, where it passes through the field to be measured, is rectangular, 1·5cm broad by 2mm deep. To the sides of it, at the points g and k in Fig. 2, were laid conductors, so that current could be made to flow *across* the tunnel. This current, if there is a field between N and S, creates a tendency in the mercury to flow *along* the tunnel from one pool to the other. The pools of mercury are contained in short glass cylinders, one of which communicates with an almost horizontal glass tube about 50cm's in length. A little alcohol placed above the mercury flows along the tube, over a scale, and indicates by its position the pressure exerted by the mercury

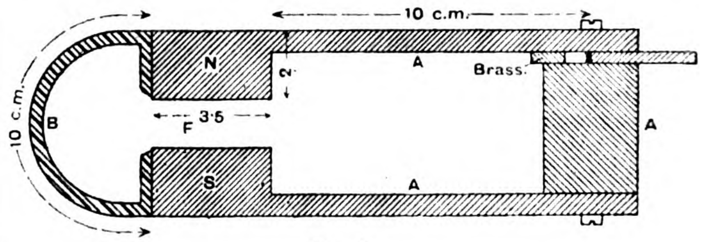

Fig. 4.

carrying the current in the magnetic field. The current through the mercury being constant, this pressure is proportioned to the strength of the field, and it is possible to obtain visible readings for minute variations of the field, whether it be strong or weak.

Experiments were made upon iron cores, of the dimensions and shapes shown in Figs. 1 and 4, by affixing pieces of steel to the ends of the poles as there shown, and taking curves of which the strength of the current passed round the iron were abscissæ, and the strength of the field ordinates, the object in view being to vary the length, section, quality, and temper of the steel, until the curve obtained during the decrease of the current coincided with the curve of increasing current.

One of the best curves obtained is shown in Fig. 5, in which figure is also shown, for the sake of comparison, the curve of the iron alone. It will be seen that the addition of the steel only reduces the strength of field 25 per cent., while the effect of the hysteresis is practically reduced to nothing. The sectional area of the steel in this case was 0·4 that of iron. The break in the iron circuit shown in Fig. 4, was for the following purpose :— It was found that with a continuous core it

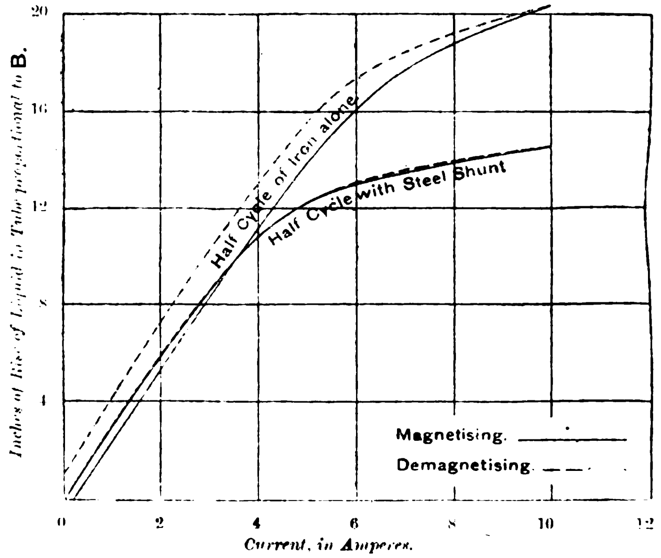

Fig. 5.

was not possible to reduce the effect of hysteresis without using such a large section of steel that the maximum field was reduced to less than one-third. In order to enable a smaller section of steel to be used, the reluctance of the iron circuit was increased by an adjustable gap.

If we consider the residual flux as being due to magnetomotive forces in the iron and steel represented by M and m

respectively, and represent the reluctances of the iron and steel by R and r respectively, then the condition under which there will be no flux across F is $\frac{m}{M} = \frac{r}{R}$, for the flux in A and B is $\frac{M+m}{R+r}$, and if there is no difference of magnetic potential between N and S, $\left(\frac{M+m}{R+r}\right) R - M = 0$. If it is undesirable to decrease r we can make $\frac{r}{R}$ small enough by increasing R. This can be done by the adjustable air-gap, so as to give zero field for zero current, with almost any piece of steel, and the removal of a restriction as to the length and section of the steel facilitates the obtaining of coincidence in other parts of the curve.

The experiments, however, were not wholly successful, for if the current, after being carried to a maximum and reduced to zero, were reversed, and carried to such a value as to reverse the induction in the iron but not in the steel, then the effect in the field F of the hysteresis was as great or greater than if no steel were used. If the current were reversed at all, it was necessary to increase it to the same maximum value as before in order to get satisfactory curves. This mode of neutralising hysteresis, therefore, would only be of service in instruments in which the current is never reversed. If, however, the current, or a fraction of the current, passed round the iron be also passed round the steel it is possible to reverse both simultaneously.

This was tried in several cases, but the introduction of a new variable (namely, the ratio of the ampere turns on the iron to the ampere turns on the steel) made the field of experiment so wide that the investigation was postponed until a time of greater leisure.

SOME FIGURES RELATING TO AN ALTERNATE-CURRENT CENTRAL STATION.

BY CLARENCE P. FELDMANN.

The following is an abstract of the official report of the Municipal Central Station of Cologne, and it covers the twelve months April 1, 1892—March 31, 1893, and forms thus a continuation of the report and description of this station which were published in some of your previous issues.*

The year ending April 1, 1893, shows an increase in the number of lamps connected to the network amounting to 43·7 per cent.; unfortunately, however, the number of kilowatts delivered to the customers has not increased in the same rate. This is due partly to the bad state of trade, and partly to the introduction of the Welsbach burner, &c. Though the statutory price per unit delivered is slightly higher than in most of the other German central stations there is an extremely large difference between the cost of a 16-c.p. incandescent lamp and a split burner of equal lighting power. Table I. shows the relation between the cost of electric and gas lighting for several German towns, the last line of the table relating to the changes which took place at the Cologne Gas, Electric, and Water Works after April 1, 1893. From that day the statutory price of electric energy was reduced from *eight* pfennigs per hectowatt hour to *seven*, while the price of gas per cubic metre remained the same. The apparently higher gas prices of the last line are due to a reduction of the rebates granted to large consumers; the scale of rebates for customers of the electric plant not being altered. Of course, this is a very good plan for increasing the output of an electric central station; and besides, it is not an unjust one, as the numbers of Table I. show; but, unfortunately, it can only be used where gas and electric works go hand in hand.

The total capital invested up to April 1, 1893, was distributed as follows:—

Table II.

	Marks.		Marks.
1. Buildings	424,054	8. Tools and instruments	6,342
2. Engines	223,216	9. Measuring instruments	3,045
3. Dynamos	472,953	10. Furniture	2,603
4. Boilers	124,601	11. Stock of cables, transformers, &c.	17,707
5. Cables	471,640		
6. Transformers	157,903		
7. Electricity meters	34,389		1,948,453

The total energy delivered to the customers which had been 1,549,086 hectowatt hours during the first half-year, October 1, 1891, to March 31, 1892, increased to 3,070,749 hectowatt hours in the last year. As the number of lamps and their distribution are known, and as each consumer has at least one meter, it was possible to compile the figures in Tables III. and IIIa.

With regard to the financial results I am glad to state that the year closed with a net earning of 141,354 marks, which was distributed as follows:—

Interest	64,750	marks
Redemption fund	37,000	„
Fund for renewals..............................	39,604	„
Total	141,354	„

The total output was 3,070,749 hectowatt hours, of which 280,807 were taken up at the station for lighting and testing purposes. The statutory price per hectowatt hour was 8 pfennigs, the price obtained, including the rebate granted to the customers, was 7·66 pfennigs.

Table III.

Distribution of Energy Delivered to Consumers.

—	Number of customers on Mar. 31, 1893.	Energy delivered in the year 1892-1893. Hecto-watt-hours.	Energy delivered in the year 1892-1893. Per cent. of total delivery.	Number of lamps on Mar. 31, 1893. Arc lamps.	Number of lamps on Mar. 31, 1893. Glow lamps.	Equivalent number of 16-c.p. lamps (55 watts).	Mean annual hours for mean annual number of lamps.
1. Shops, &c. ...	111	1,098,533	35·77	164	3,828	5,468	413
2. Restaurants, hotels	28	669.991	21·82	44	2,746	3,186	550
3. Clubs, concert halls, &c. ...	5	326,471	10·64	38	1.835	2,215	268
4. Banks and offices	39	464,243	15·12	8	2,299	2,379	420
5. Privte. houses	13	96,294	3·14	...	1,439	1,439	122
6. Churches, schools, museum	3	11,118	0·36	6	28	88	200
7. Hospitals ...	1	4,422	0·14	...	50	50	160
8. Factories, workshops, & warehouses..	7	118,870	3·87	13	249	379	535
9. For lighting and testing purposes, & for experiments at the station	1	280,807	9·14	9	35	125	4,085
Total	208	3,070,749	100·0	282	12.509	15,329	...
Mean value......	...	...	...	...	...	...	422·3

Table I.

Name of Station.	Gas lighting. Cost of one cubic metre for large consumers.†	Cost of a 16-c.p. split burner taking 180 litre per hour.‡	Cost of a 16-c.p. glow lamp, taking 55 watts per hour.	Ratio of gas to electric lighting.
	Pfennigs.	Pfennigs.	Pfennigs.	
Berlin	16·00	2·88	3·60	1 : 1·25
Barmen	17·50	3·15	4·00	1 : 1·27
Breslau	17·64	3·18	4·20	1 : 1·32
Elberfeld	16·00	2·88	4·00	1 : 1·39
Hanover	15·50	2·79	4·07	1 : 1·46
Dusseldorf	15·00	2·70	4·75	1 : 1·76
Cologne before April 1, 1893...	13·00	2·34	4·40	1 : 1·88
Cologne after April 1, 1893...	14·83	2·67	3·85	1 : 1·44

* See *The Electrician*, Vol. XXVIII., November 13, 1891, p. 35; and Vol. XXX., March, 3, 1893, p. 519.

† To reduce pfennigs per cubic metre to pence per thousand multiply by 3·3.

‡ 180 litres per hour equals 6¼ cubic feet per hour.

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Table IIIa.

Distribution of Energy Delivered to Consumers.

—	Number of customers on Mar. 31, 1892.	Energy delivered in the half-year 1891-1892. Hecto-watt-hours.	Per cent. of total delivery.	Number of lamps on Mar. 31, 1892. Arc lamps.	Glow lamps.	Equivalent number of 16-c.p. lamps (55 watts).	Mean annual hours for mean annual number of lamps.
1. Shops, &c. ...	85	669,039	43·19	149	3,415	4,905	325
2. Restaurants, hotels	23	311,615	20·11	31	1,264	1,574	524
3. Clubs, concert halls, &c. ...	4	144,411	9·32	23	1,508	1,738	151
4. Banks and offices	32	264,154	17·05	8	1,695	1,775	331
5. Privte. houses	6	21,905	1·41	...	412	412	97
6. Churches, schools, museum	...	...	...	...	...	...	...
7. Hospitals ...	...	...	...	...	...	...	...
8. Factories, workshops, & warehouses..	4	43,703	2·82	13	48	178	457
9. For lighting and testing purposes, & for experiments at the station	1	94,259	6·10	9	35	125	1,371
Total	155	1,549,086	100·0	233	8,377	10,707	...
Mean value......	...	...	...	...	...	...	352·6

The total cost was distributed as follows :—

Table IV.

—	For the year 1892-93. Total.	Per 1,000 hecto-watt-h'rs	For the half-year 1891-92. Total.	Per 1,000 hecto-watt-h'rs
	Marks.	Marks.	Marks.	Marks.
Coal	19,816	6·448	12,028	7·765
Wages	19,277	6·272	7,296	4·710
Maintenance of engines and dynamos	9,632	3·134	5,743	3·708
„ of mains and transformers	9,652	1·189	350	0·227
„ of meters.....................	242	0·079	—	—
Repairs	1,777	0·578	568	0·367
Condensing water	2,676	0·871	1,869	1·207
Salaries.....................	17,935	5·836	5,297	3·420
Rents..	4,500	1·464	1,500	0·968
Miscellaneous expenses	4,861	1·582	4,699	3·034
Total...........	84,368	27·453	39,350	25,406

The total income was made up of the following items :—

Table V.

Revenue from—	For the year 1892-93. Total marks.	Per 1,000 hecto-watt-h'rs	For the half-year 1891-92. Total marks.	Per 1,000 hecto-watt-h'rs
		Marks.		Marks.
Current sales	212,732	69·227	116,386	75·132
Meter rents	4,653	1·515	929	0·600
Testing and certification of private installations.............	2,491	0·811	6,047	3·904
Erection of private installations ...	1,566	0·510	2,176	1·405
Miscellaneous	4,281	1·392	19	0·013
Total.....	225,723	73·505	125,557	81·054

As your former notes relating to the Cologne central station did not contain the annual rents for meters, I give them below, and besides, I should like to mention that since July 1st the statutory price for electric motive power has been fixed at 2·5pf. per hectowatt-hour, the same rebates being granted which were detailed in your issue of November 13, 1891 (*The Electrician*, Vol. XXVIII., p. 35) :—

Table VI.

Annual Rents for Electricity Meters.

	Marks		Marks.
Up to 10 16-c.p. lamps............	12	Up to 400 16-c.p. lamps	66
„ 25 „ „	15	„ 500 „ „	84
„ 50 „ „	21	„ 625 „ „	105
„ 125 „ „	30	„ 750 „ „	120
„ 250 „ „	48		

THE DANGERS OF THE LEAD INDUSTRIES.

The following is an extract from the Report from the Departmental Committee appointed to inquire into the White Lead and the allied industries. The original committee, appointed in April, 1893, consisted of Mr. J. Henderson, E. Gould, and H. J. Cameron, Inspectors of Factories, Dr. T. Oliver, of Newcastle, A. P. Laurie, and H. J. Tennant, Assistant Private Secretary to the Secretary of State. Dr. A. Dupré was appointed a month later.

X.—Electric Accumulator Works.

57. The Committee are directed to inquire into the use of red lead in electric accumulator works, and to consider whether such works should be included in the special rules they have under their consideration. They visited works in Wolverhampton and London.

The Committee have found this trade, which, judged from the standpoint of most of our staple industries must be said to be still in its infancy, to be conducted in a somewhat crude manner. They trust that ere long much that is now done by hand may be effectively performed by machinery.

The Process.

58. The process consists of rubbing red lead, which has been previously damped with dilute sulphuric acid, and has attained the consistency of clay, on to embossed or perforated leaden plates. The interstices of the plates are thus filled with red-lead mud, so that when finished an even surface is produced.

This is done on both sides of the accumulator plate.

Other plates are similarly treated, litharge instead of red lead being employed.

One man mixes the dry red lead and dry litharge with dilute sulphuric acid, and in this part of the process a considerable amount of dust is produced.

Others rub the red lead or litharge, as the case may be, into the interstices of the plates. They do this with gloves on, using a sort of wooden spatula. But a good deal is rubbed on with the gloves. These latter are put to severe usage and do not last long, and, unless they are in good condition, let the material which is being manipulated through the seams or holes.

A glance at the hands of the worker, when he has taken off his gloves, will at once show whether he has been working with red lead or litharge.

There are other modifications of this method, such as using a piece of lead with small arms branching from it which fits into a mould, and the red lead is put into the mould with it. It is rubbed in tightly with a roller or a small tool, and is put to dry on a tray over an argand burner for a few moments. The piece of metal with red lead adhering to it, in the shape imparted to it by the mould, will readily come away, and the mould can be used over again.

This cake of red lead may sometimes be surrounded by a piece of linen, and it may be mixed with finely-chopped horse-hair to give it a firmer consistency. Another process is to make the red lead clay in the form of square biscuits. For this purpose a mould is also used.

In each of these processes it is necessary for the hands of the workers to be in almost continuous contact with the material used. In some cases gloves were not worn.

Recommendations.

59. The Committee recommend that the person who does the mixing should be obliged to wear a respirator and overall suit, and that all rubbers be obliged to wear gloves and aprons, to be supplied by the occupier, and that the gloves should be inspected constantly by the foreman, and renewed when defective ;* and that there be ample washing accommodation for all in the works, *i.e.*, lavatories with hot and cold water, soap and towels supplied by the firm.

* In order to obviate the three sources of danger mentioned in paragraph 9, page 9, the Committee, in reference to 9 (*a*), cannot recommend that gloves be worn by any *employé* in handling white lead. They have come to the conclusion that although gloves, when well made and sufficiently often renewed, are a fairly effective safeguard in the handling of more or less hard materials, such as blue lead or damp corrosions, their supposed protection is, in a great measure, illusory when the article to be handled is either very moist or very friable and dusty, in both of which conditions it readily penetrates the gloves and comes into contact with the skin under circumstances highly favourable to absorption. Consequently, the Committee cannot recommend their use, nor do they see their way to recommend their abolition in all cases.

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XIV.—REMARKS APPLICABLE TO ALL THE FOREGOING TRADES.

Recommendations.

84. The Committee recommend that in all copies of special rules it be made manifest that it is incumbent on the employer to perform what is therein stated to be his duty, and that it is also incumbent on the *employés* to carry out the regulations laid down for their comfort and safety.

It is further necessary that it should be made clear that, for a breach of the rules, the contravener is liable to a fine, or in default to imprisonment; and that this applies to employer and *employé* equally.

In order that there may be no mistake the Committee recommend that every copy of all special rules be headed with the Royal Arms, and that the distinction between "Duties of Occupiers" and "As to Persons Employed" be abolished, "Duties of Persons Employed" being substituted for the latter heading.

There should be a clause at the end of the special rules stating that contravention of these rules involves a liability to a fine not exceeding forty shillings, or in default to imprisonment.

85. The Committee recommend that it be the duty of all occupiers to report to Her Majesty's Inspector of Factories and to the Certifying Surgeon for the district any case of lead poisoning, in the same way as they would at present report an accident.

It has been suggested that the medical attendant of the works should be appointed by the Government, but the Committee, in view of their recommendation that cases of lead poisoning should be reported to the Certifying Surgeon for the district, do not consider it necessary to change the existing system of these appointments.

HYDRAULIC-POWER SUPPLY IN LONDON.*

BY E. B. ELLINGTON, M.INST.C.E.

The Paper first recorded the considerable progress made in the distribution of hydraulic power during the past five years—the number of machines worked from the system in London having risen from 609 in December, 1887, to 1,755 in December, 1892, and the length of mains laid from 27 to 58 miles in the same period, whilst the available horse-power had increased from 800 to 2,600. A public supply was now given in Liverpool, and works were in progress at Birmingham, Manchester, and several foreign towns.

The first pumping-station in London, at Falcon Wharf, Blackfriars, was described by the author in a Paper read before the Institution in 1887. Since that time other pumping stations had been erected at Millbank, near the Houses of Parliament, and at Wapping, near the entrance to the London Docks, while a fourth station was in course of erection at City-road, near the Regent's Canal. The general arrangement of the latter stations was much the same as that at Falcon Wharf, except that at Wapping triple-expansion engines had been employed, with a steam-pressure of 150lb. per square inch. The water used was obtained at Millbank from the gravel bed overlying the London clay. Through this bed about 150ft. of headings had been driven. The water contained iron, which was deposited on exposure to the air. For getting rid of this iron and filtering the water, the Porter-Clark lime process was employed at a cost of 1·05d. per 1,000 gallons. The average output from the station was 1,500,000 gallons per week.

The water at the Wapping pumping-station was obtained partly from the gravel bed, as at Millbank, and partly from the London Dock. The quantity of iron in the water was much less than at Millbank, and the Pulsometer Company's "Torrent" charcoal filters were used at that station. For the purpose of clarification, "alumino-ferric" had been successfully employed. The capacity of the Wapping station was 800,000 gallons in 24 hours. The water used at the several stations was pumped into tanks situated over the engine and boiler houses by pumps worked by hydraulic pressure. These pumps had proved to be economical machines, and possessed the great advantage of being able to work by the pressure in the mains when the main engines and boilers were stopped during the night. The only station worked continuously was that at Falcon Wharf. The total capacity of the accumulators in connection with the system was 1,600 gallons, while the capacity of the pumping-plant was 3,500 gallons per minute. This showed that the accumulators acted almost exclusively as regulators of the pressure, and had little effect in respect of storage.

The results of tests of the Wapping triple-expansion engines and boilers made by Mr. Bryan Donkin, showed a consumption of 1·3lb. of coal per 1 H.P. per hour. The increased economy gained by the use of triple-expansion engines and the high steam pressure of 150lb. per square inch were very striking. At Falcon Wharf, with compound engines working at 85lb. per square inch, 4,048 gallons, at a pressure of 732lb. per square inch, were pumped for every hundredweight of coal consumed. At Millbank, with the same engines, but with 100lb. per square inch of steam pressure, 4,130 gallons, and at Wapping 5,118 gallons, were pumped per hundredweight of coal. The efficiency of the plant in respect of coal consumption, working over long periods, was much below the efficiency of the trial runs, and it appeared that only about 60 per cent. of the coal burnt was utilised at efficiencies obtained in the trials; and 32 per cent. of the balance was wasted by the intermittent running of the plant. Notwithstanding that the total delivery of power had more than doubled since 1887, no diminution of this loss had resulted.

The author proceeded to discuss the question as to whether it was possible to increase this efficiency in practice by improving the load-factors; and especially whether a combination of power-supply during the day and the use of the energy for electric lighting during the night would produce such a result—and arrived at the conclusion that little or no advantage in this respect was to be gained by such combination. The load-factor of the hydraulic supply for the year 1887 was 0·275. For 1889, 0·338, and for 1892, 0·326. It was pointed out that the improvement of the load-factors in recent years over 1887 was due to the enlarged area of supply, and not to the increased quantity of power supplied—the time of maximum demand varying in the different districts supplied. Load-diagrams were given of the electric supply on December 21, 1892 (a foggy day) in Westminster, and of the hydraulic supply on the same day, and the two were combined. The load-factor for the combined curve was 0·522, while the electric load-factor alone was 0·533 and the hydraulic load-factor 0·495. It was further pointed out that under the most favourable conditions a supply approaching the maximum would only be given on 280 days in the course of a year, and that it was impossible, without storage, to obtain from any combination of supplies more than 12 hours' work out of 24—a condition which would only produce a load-factor of 0·380 against 0·325 actually realised. A low load-factor was likely, therefore, to be a permanent cause of low efficiency in all methods of supplying energy which did not admit of extensive storage. The load-factor had, however, a far greater influence upon the amount of capital outlay per unit of output than it had upon the cost of fuel and station expenses.

Particulars were furnished of the actual cost of the supply of hydraulic energy for the years 1884 to 1892 under the headings (1) Station and Distribution Expenses, (2) Repairs, and (3) General Charges. In the result it appeared that the amount of the supply was unlikely to affect the working cost favourably to any substantial extent. The experience of the cost of supply in London showed that the total expenses had increased in direct ratio to the total output, added to a constant representing the minimum cost of working the undertaking irrespective of the output. There was no reason to believe that experience in relation to hydraulic supply in London was likely to differ materially from that of other undertakings established for supplying energy in towns from artificial sources. If works were planned on a moderate scale in relation to the probable output and would allow of extensions as required, the minimum cost of supply would be approximated to within a comparatively short period, and further development was unlikely to exercise any material influence on the cost. The influence of capital expenditure on plant in relation to output was as important as the actual expense in determining the cost at which the consumer could obtain energy. The capital outlay for hydraulic supply in London had fallen from £2·8 per 1,000 gallons in 1885 to £1·24 in 1892, and a further reduction was anticipated in the future.

In conclusion, reference was made to the value of the high-pressure supply for purposes of fire extinction. Attention was also directed to the value of the Pelton water-wheel for high pressures, especially for driving dynamos, in substitution of the hydraulic engines hitherto used. By this apparatus 66 per cent. of the hydraulic energy could be converted into electrical energy, which could be obtained in this way at a cost of about 6d. per Board of Trade unit. The electric lighting of Antwerp was being established on a combined hydraulic and electrical system of this kind, devised by the late Prof. Van Rysselberghe, of Ghent.

* Abstract of a Paper read before the Institution of Civil Engineers, December 19, 1893.

The "Hermite" Process of Sanitation.—M. Hermite, whose electrical sanitation scheme has been described in *The Electrician* in connection with the experiments undertaken by the municipalities of Havre and Lorient in dealing with sewage by electrolysed sea water, visited Worthing by invitation on Saturday last, to make arrangements for a series of experiments. The spot selected as the scene of operations is close to the sea. The experiments will be commenced about a fortnight hence. Speaking of the experiments which are being carried on at Havre, it may be of interest to say that the plant is capable of dealing with sea water at the rate of 132 gallons per minute, under an electrolytic current of from 1,000 to 1,200 amperes. The cost of the process is stated to be about 2 francs per annum per inhabitant

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The Electrician.

(The Oldest Electrical Journal.)

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THE INSTITUTION OF ELECTRICAL ENGINEERS.

The annual general meeting of the Institution of Electrical Engineers passed off, as usual, with the brief consideration of two or three reforms, but, as usual, nothing was done to materially add to the usefulness of the Institution. So lightly are the suggestions of outsiders taken by the Council at these meetings, that the Annual Report was proposed, seconded, and adopted by mistake, before any remarks were invited upon it. This was, however, soon remedied in so easy-going a body, and what promised to be a stormy attack on the constitution of the Council was opened by Mr. W. T. ANSELL. Taking as his text the memorial which was printed in our last issue, the speaker alluded to the founding of the Society of Telegraph Engineers, complained that telegraph men were not properly represented on the Council, and vigorously urged that at least five members out of the twelve ordinary members of Council should represent telegraphs and telephones. If he had lamented that between 1882 and 1891 there were only 22 Papers on telegraphy, telephony, and earth currents as against 104 Papers on other matters, and had he called upon telegraph men to take part in the proceedings of the Institution, and to sit upon the Council when they were elected, he would perhaps have done more to justify his position. But further debate, and indeed Mr. ANSELL's own speech, was cut short by the dexterous chairmanship of the PRESIDENT, and it remains to be seen whether telegraph men will assert themselves, or, as was significantly hinted, withdraw from the Institution; and whether, if they re-establish, as they have

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every right to do, the Society of Telegraph Engineers, they will write, read, and discuss those Papers which have been so long conspicuous by their absence.

Differing widely from the first grumbler in lucidity and frankness, Mr. Madgen rose to suggest that the Institution was a mere scientific society, and neglected many matters of profound commercial importance to the electrical trade. Only one sample could be wrung out of Mr. Madgen by the President; this related to the "cutting" of prices for wiring, and he advocated the "rescuing from oblivion" of the wiring rules of the Institution as a remedy. It is quite possible that some of the other matters in Mr. Madgen's mind might have been of too delicate a nature for public discussion, such, for example, as the masquerading of a contractor in the guise of a consulting engineer, but surely Mr. Madgen takes the Institution of Electrical Engineers too seriously. It performs the functions of a scientific society so far as the reception, reading, discussion, and publication of Papers is concerned, and this very imperfectly; but other work on its own initiative, if any there be, is done so modestly, that no one has ever heard of it. The issuing of the wiring rules in 1883 and their revision in 1888 is a solitary exception. These rules have long been obsolete, and even if they are worth remodelling it is doubtful whether the Council elected at the last meeting are better capable of the work than the Councils of 1882, 1888, or the Council of 1889, from whom the Board of Trade invited assistance in connection with the overhead wire regulations. There are seven or eight practical engineers who would no doubt render good service, but they would probably be out-voted by the accumulation of past-Presidents and others. Mr. Madgen had better look elsewhere if he wants anything done. It will be remembered that after the reading of Prof. Fleming's Paper on "The Necessity for a National Standardising Laboratory for Electrical Instruments," in 1885, the author so far roused the meeting as to draw from it a formal request that the Council should consider the best means by which such standardising could be carried into effect; and it was promised in the next annual report that "The matter will accordingly receive the careful attention of your Council." Nothing was done, and it was only when the Electrical Trade Section of the London Chamber of Commerce appointed a committee to attack the subject, and resolved, in January, 1889, to approach the Board of Trade, that somebody remembered that the Council of the Institution of Electrical Engineers had made this promise, and it was thought polite to invite their co-operation. Another brilliant attempt of doing something was the spontaneous appointment of a committee on nomenclature and notation, on May 14, 1885, in connection with Prof. A. Jamieson's Paper on his favourite subject. In the following November, during the discussion on the Paper by Dr. Fleming, to which we have referred, Mr. Swinburne alluded to this committee, but the then President had already forgotten its existence; and, so far as we remember, the matter was, wisely perhaps, never referred to again.

Fruitless attempts are made year after year to induce the Council and officers of the Institution of Electrical Engineers to do for the members what is done by every other learned society, in the distribution of printed copies of the Papers before they are read. Mr. Evershed made a mistake in alluding to the practice of the Institution of Civil Engineers. Attempts on the part of the Electrical Engineers to copy this influential, wealthy, and, we may add, dignified body, are apt to be ridiculous: but, as we have remarked before, the Electrical Institution is now the only one that fails to do its work properly in this respect. The excuse offered by the President was altogether insufficient, but was characteristic of the Institution. He said that the fault lay entirely with the authors, who did not supply the Papers in time. In time for what? All other scientific societies of any repute insist, as a matter of course, that the Papers shall be submitted, generally, in a complete state to the Secretary, but in the less formal societies the author is allowed some indulgence in the way of addenda. The Paper is submitted to one or more members of Council for report, and after it is accepted, it is printed and revised by the author. Not till then is it safe to fix the date for reading. This done, proofs are sent out to members and to outsiders who are likely to take part in the discussion, and, in the case of the Civil Engineers, to any who are known to take an interest in the particular subject. At the Institution of Electrical Engineers it appears that if the author succeeds in seeing his Paper in proof before the meeting he is to be congratulated. Parts of Prof. Forbes' Paper on "Electrical Transmission of Power from Niagara Falls," such as the design of the conduit, or, what is, perhaps, of greater importance, the criticisms on it, are hardly intelligible without illustrations. Six weeks have elapsed since this Paper was read, and yet these have not been issued. To engrave them from no other source than the diagrams shown on the wall could have been done with ease in as many days. We cannot agree that any blame attaches to authors for the shortcomings of the Council or its officers. It was further suggested by the President that beggars cannot be choosers, for since there was such a difficulty in getting Papers at all, authors could not be dictated to. If this be the case, why not reduce the number of meetings? Many members who attend, at some inconvenience, rather lest they should miss something than anxious to listen to anything, would be very glad of a few more free Thursday evenings. The expense of printing, a large item of the annual expenses, would be reduced, and the quality of the remaining Papers might better compare with that of the electrical Papers read before the Institution of Civil Engineers.

Besides eliciting such an unusually large crop of suggestions the Annual Report of the Council contained the announcement that it had been decided to set aside a portion of the invested funds of the Institution for the purpose of forming a building fund. The first meeting of the old Society of Telegraph Engineers took place in February, 1872, so that, under one name or another, the Institution has been in existence close upon two-and-twenty years, and having thus attained its majority may well think of setting about to get a house of its own. Eligible sites are, however, few and far between, and a building worthy of electrical science and engineering will be costly, and it is to be hoped that the Council will not move further until they are amply provided with the wherewithal. No doubt by coalescing with other unhoused societies, the Institution might be provided with quarters, more or less its own, at an earlier date than would otherwise be the case, but if independence in this matter is desirable at all, complete independence should be aimed at.

While comparison with the doings of the Civil Engineers in the matter of circulation of proofs is, we think, not justified, another comparison, and one made by the President, calls for comment. He announced that the Council had carefully considered the question of the mode of election of associates and of members, and had decided that they were unable to make any alterations. The mode, he added, was the same as that of other societies. From this decision of the Council we do not for a moment venture to differ. The matter was deliberately left for their consideration, and they have, no doubt, the best possible reasons for their resolution. But comparison with the procedure of the

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Institution of Civil Engineers is not warrantable, especially in the case of Associate Members.

The conditions of the Institution of Civil Engineers are as follow:—

Every candidate for election into the class of Associates entitled to the privileges of Corporate Membership shall be more than twenty-five years of age, shall have been regularly educated as a Civil Engineer, and shall be actually engaged at the time of his application for election, in the design or in the construction of such works as are comprised within the profession of a Civil Engineer as defined by the Charter; or,

He shall satisfy the Council that he has had a sufficient training, and that he has been engaged for at least five years, and that he is actually engaged at the time of his application for election, in the design or in the construction of such works as are comprised within the profession of a Civil Engineer as defined by the Charter.

Any person desirous of being elected a member, associate, or honorary member, must be proposed and recommended according to the form A in the appendix, in which the name, usual residence, and qualifications of the candidate shall be distinctly specified. This form must be signed by at least six corporate members certifying a personal knowledge of the candidate, and a full conviction of his qualifications.

The statement of the qualifications of the candidate must embrace a full and complete (though concise) account, in consecutive and chronological order, *with dates*, of the whole of his professional career; including the names of the engineers under whom he served his pupilage, and has subsequently acted; enumerating the nature and extent of the works in or upon which he has been engaged, and the positions he has occupied, and giving an idea of the magnitude and importance of the works of which he has had the charge or the direction.

It is indispensable that the proposer and the seconders should be *personally* acquainted with the professional career of the candidate, and have a full conviction of the "Qualifications" upon which the application is grounded: and no exception can be made in this respect in the case of any candidate who has spent the greater part of his active life abroad. Every member who signs a proposition paper is liable to be called upon to state, specifically and categorically, exactly what he knows of the career of the candidate, and if unable to furnish satisfactory information then the application may be prejudiced.

We do not suggest that such qualifications are desirable in the case of the Institution of Electrical Engineers. The Institution is not strong enough, nor is the profession sufficiently mature. But what we do suggest is, that after these conditions have been complied with, and not before, the voting may be allowed to become a mere form. It is admitted that in the case of the Institution of Electrical Engineers it is a mere form, and yet no more conditions are imposed than for membership of the British Association. The result is that any ironmongers' assistant can acquire the right to affix A.I.E.E. after his name. Of this, the Council, after a twelvemonth, deliberately approves; we need, therefore, say no more.

REVIEWS.

The Incandescent Lamp and its Manufacture. By Gilbert S. Ram. (London: *The Electrician* Printing and Publishing Company. 1893.)

Very little has been written on the manufacture of real lamps, though a great deal of attention has been devoted to such questions as the simple ratio between the power and light of hypothetical lamps and the best efficiency to run them at when the blackening kindly follows a simple law.

The manufacture of incandescent lamps has not been a subject of general interest in this country for many years, for reasons which have been fully regretted in a recent leader in this journal, but it is strange that no books dealing with practical lamp manufacture have appeared in other countries.

The incandescent lamp is simple, but its manufacture is one of the most intricate and difficult examples of scientific industry, and it is understood by very few people, as it is seldom that any one man has both the necessary scientific knowledge and ability and the opportunities for acquiring practical experience. Mr. Ram is exceptionally well qualified, and his book appears just at the right time.

Mr. Ram generally writes from his own experience; but, of course, no one man can have worked practically at all the numerous processes. The result is that his account of some important processes, such as that for making filaments from nitro-cellulose, are rather meagre. Langhans' sulphuric acid process is not mentioned. There is a material called "viscoid" now coming into use in certain trades. It is a homogeneous mass made by coagulating a solution of cellulose. It can be made in thin transparent sheets, and should be very useful for lamp carbons. The Swan process is hardly capable of the highest uniformity. The chapters on the size of filaments and flashing are perhaps the most valuable in the book. They are full of numerical details, which are the result of enormous careful labour, and which cannot be obtained from any other source, as nothing like then has been published before.

There is a certain amount of dry humour about Mr. Ram's style, which always relieves the monotonous accuracy otherwise necessary in a scientific book.

Few scientific men, and no Cambridge man, could write a few chapters of laborious calculations and tables, taking into account all the phenomena of flashing, and could then admit that guesswork in many cases gives as good results. In discussing flashing, Mr. Ram does not seem to realise that a great deal of the fall of resistance is due, not to a highly-conducting coating, but to the heating of the carbon itself. A filament flashed at a high temperature in a vacuum will be found to have become very much harder. Its resistance will be enormously reduced, it will not burn like charcoal in a gas flame, and it will not decompose hot sulphuric acid. Carbons so prepared have been found more durable than after flashing. Whether this is universally true, or is only true of the particular carbon used, is, however, uncertain. It is doubtful how far Mr. Ram is right in saying that measuring the resistance during the act of flashing gives inaccurate results owing to temperature variations of resistance. Carbon varies greatly in specific resistance with changes of temperature, but at high temperatures the variation is much smaller, so that the error he fears should be avoided.

The author's remarks on the difficulty of cheapening lamps by employing substitutes for platinum, which add more to the cost of the lamp in labour and wasters, should be taken to heart by those who are experimenting on sealing alloys.

The question of mercury carrying air and moisture round into a pump so as to spoil the vacuum requires further investigation. Mr. Ram considers it does so. Then, how does a barometer preserve its vacuum for so many years?

Those who use mercury pumps in laboratories should read the chapter on exhausting, as well as Dr. Thompson's Society of Arts lecture. It is safe to say that all the improvements or modifications of mercury pumps, described in various Papers before learned societies, have been used or rejected years before in the various incandescent lamp factories.

Mr. Ram's explanation of the high-efficiency surface fallacy is clear. It was started by Lord Kelvin communicating a Paper by Mr. Mortimer Evans to the Royal Society. It spread like an epidemic, and every lamp maker had a particular kind of surface, which carefully sent out light rays, and held on to heat with more perspicacity than any other lamp makers' surfaces. For years the present reviewer was a minority of one on this point. Now he has at least a companion in solitude.

Mr. Ram's book can be recommended to those interested in the manufacture of incandescent lamps as the only work on the subject which is accurate and up to date. J. S.

A Manual of Electrical Science. By G. J. Burch. (Methuen and Co., London. 1893.)

This little book is one of a series published in connection with the University Extension system. Strange to say, it is free from triviality and cheap erudition, and gives a clear account of the elementary principles of the subject, with many and simple experiments. It fails, perhaps, to comply with the somewhat sententious announcement by the publishers

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that in this series of books "the subjects will be treated by competent writers in a broad and philosophic spirit." To the competence of the author, who many of our readers will recognise as a late member of the official staff of the Institution of Civil Engineers, we have not a word of objection; but the broad and philosophic spirit so sadly lacking in discourses on Elizabethan Poetry, Psychological Æsthetics and Peruvian Mythology, which form the mental food for omnivorous extension lecture-goers is also absent here. But it is not missed. The historical parts of this book show a great deal of research; the dates of many discoveries are given. As an example of the author's scrupulous accuracy, he traces the supposed share of Madame Galvani in the discovery of the contraction of the frog's leg to a mistranslation in French from Galvani's Latin account. The terms hydrogen sulphate and hydrogen acetate for sulphuric acid and acetic acid may be incontestably correct, but such nomenclature should become well recognised in the general literature of a science before it is employed in elementary handbooks. The treatment of several of the sections are original; an appendix contains a good summary of the C.G.S. system, and is followed by several tables and an index.

Provisional Orders of the Board of Trade. By FRANCIS J. CROWTHER. (London: Jordan and Sons.)

Guides to the maze which has to be trodden by all who are anxious to obtain a Provisional Order are as the sand of the sea-shore, and are for the most part of about the same value. Mr. Crowther's little book will, however, be of use not only to unsophisticated promotors (if any such there be), but should serve to jog the memory even of old parliamentary hands. The numerous and diverse items that have to be attended to between the serving of notices on Local Authorities in June, and the obtaining of Royal assent a twelvemonth or more after, are all set out in order of date, and in a manner calculated to catch the eye. Gas, Water and Tramway Orders are dealt with as well as those relating to electric lighting, with which we are alone concerned.

Kalender für Elektrotechniker, 1894. Edited by F. UPPENBORN. (Munich and Leipzig: R. Oldenbourg.)

In the eleventh issue of this well-known annual publication the sections dealing with iron testing, alternate current measurements, dynamo and transformer testing, glow lamp making, and transmission of power have been revised and extended, and new sections relating to the construction of transformers and electric railways have been introduced. The 106·3 centimetre ohm has been adopted in the resistance tables which have all had to be re-calculated in consequence. We are relieved to see that "Cable Network Calculations" are dismissed in a couple of pages, and to find that there is, at any rate, one German engineer who is of opinion that "the exact calculation of current networks leads to very complicated expressions." For an engineering pocket-book there is, of course, far too much matter, which would be more in place in a treatise; but as the editor admittedly seeks to make his pages of some use to beginners, as well as to practical men, the mistake consists in endeavouring to cover too much ground in a single publication rather than in not realising what sort of information a practical man really wants to have in a handy form.

INSTITUTION OF ELECTRICAL ENGINEERS.

ANNUAL REPORT.

At the meeting of the Institution on Thursday evening last week, the Secretary having read the Annual Report of the Council, the President invited observations from members.

DISCUSSION.

Mr. ANSELL said he rose to ventilate a question which was somewhat a burning one with a very large section of the members. There were very many young members of the Institution present who would probably have much knowledge of himself or of the old telegraphists of 1840-and therefore, by way of preamble, they might permit him to read a memorial which was in course of signature, and which would in due course be presented to the Council. The question at issue was the due representation of all classes of the profession on the Council. Having read the memorial (*see* p. 166 of our last issue) Mr. Ansell proceeded to say that as yet time had not admitted of their obtaining many signatures, but there was no doubt that when the matter was put before them clearly, a great many would adhere to the propositions therein laid down. It was sufficient now to state the idea that was current in their minds, and if the Council would adopt some such plan as they suggested it would go very far to smooth over the irritation which existed. One gentleman, general manager of an influential company, to whom he had spoken upon the subject had replied that the Institution was now so slightly telegraphic that he had lost all interest in it, and he wished therefore to be excused from signing the memorial. That was a feeling that was very widespread, and it behoved the Council to carefully consider their position, for unless telegraph interests were fairly represented—and they did not ask anything which was unreasonable—there would be a very large secession of members from the society. That was not an empty threat; he did not come there to threaten the Council. In support of the memorial he would take leave to be discursive and retrospective. He claimed to be heard because he was the sole living representative in active harness of those who were associated with telegraphic enterprise in 1845, prior to the incorporation of the Electric Telegraph Company. There were five men yet living, but he was the only one in active harness. Of those five one was present that evening, who laid down the first telegraph line that was ever laid in the world, the line between Thorpe and Norwich, the old five-wire telegraph—his old friend Mr. Wilkin, who had done him the honour to come there to support him that night as a representative of the old, old men. It was from the small body of men associated with the old Electric Telegraph Company that had sprung the magnificent institution which they now saw. The oldsters could not hold a candle—nor did they pretend to do—to the modern men of science; they had gone ahead of them. But by virtue of having laid the foundations of what was now a magnificent Institution they claimed to be represented on the Council.

The PRESIDENT (Mr. W. H. Preece) said he thought Mr. Ansell would find that the body of the Institution was with him on this question, and the Council also, and if he would propose that the writers of the memorial should form a committee to consult with the new Council the old Council would certainly advise the members of the new Council to meet the committee and discuss the whole question.

Mr. ANSELL said if the Council would accept the memorial as a basis the memorialists would be delighted to meet the Council, and he hoped they would be able to make some sort of arrangement that would satisfy the requirements of those he represented.

Mr. MADGEN said there were many members of that Institution who were fighting out among themselves very serious practical questions in electrical work which affected the well-being of the industry, and he would like to know if there were no means by which these questions could be brought before the Council and united action taken on behalf of the whole industry. He had been a member for many years, and had listened to the annual reports very attentively; but those reports seemed to mainly concern themselves with the tabulation of the Papers read, the bequests made, and so on, and he did not remember any serious practical question affecting the well-being of the industry being dealt with. He would like to know whether the wiring rules of the Institution were to be rescued from oblivion. It was notorious that wiring was being done at prices at which good, honest, reliable work could not be done. The time might come when this wiring would begin to give way, and some fearful holocaust would draw attention to it in a way that would be likely to do the whole profession incalculable harm.

The PRESIDENT said it was within the province of Mr. Madgen, or of any other member, to submit such a question or any other to the Council. He spoke from some experience when he said that the Council had never received any propositions of that kind without dealing with them properly.

Mr. GROVE suggested that some effort should be made to place copies of the Papers to be read in the hands of the members at an earlier period than they were now obtainable. With their large membership a general distribution might be troublesome and expensive, but he would suggest that if necessary a charge should be made to cover the cost of such a circulation.

The PRESIDENT said there were difficulties in the way of carrying out the suggestion, but the chief of them was the author. If authors would only let them have their Papers a week or two beforehand they might be able to do what was suggested.

Mr. EVERSHED asked what was the practice of the Institution of Civil Engineers, upon which they seemed to endeavour to model their Institution. He was not a member of the Institution of Civil Engineers, but when any Paper on an electrical subject was to be read there the Secretary very kindly forwarded him a copy of the Paper, as doubtless he did to other members of this Institution. If that were done by the Civil Engineers it seemed to him that it ought to be done by their own Institution or their own members.

The PRESIDENT said the Institution of Civil Engineers was a body of 6,000 members, and dealt with every branch of the profession, and they had no difficulty in getting Papers; here, however, the members were few, comparatively, and there was some difficulty in getting Papers, so that they rarely had any in hand. If members would give them plenty of Papers they would have them printed and circulated in time.

The report of the Council was then put to the meeting, and carried.

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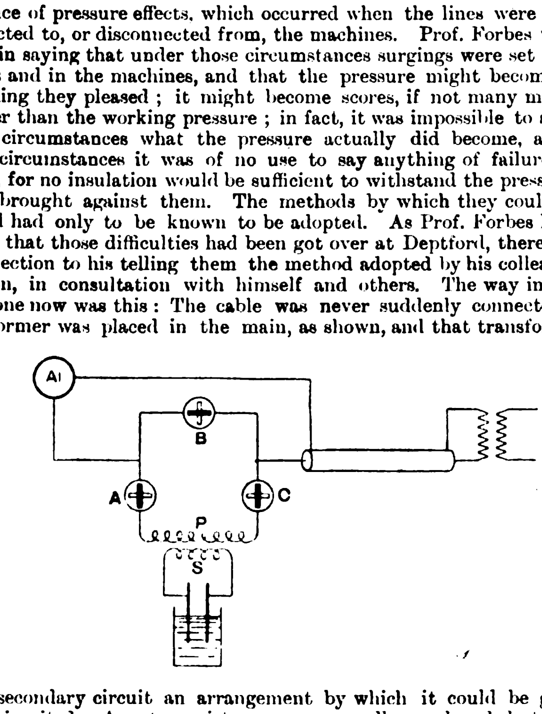
THE ELECTRICAL TRANSMISSION OF POWER FROM NIAGARA FALLS.

The following is an abstract of the discussion on Prof. George Forbes's Paper on "The Electrical Transmission of Power from Niagara Falls," which took place at the Institution of Electrical Engineers. Speakers whose remarks are prefaced by an asterisk have returned and revised their abstracts :—

DISCUSSION.

THURSDAY, NOVEMBER 23RD.

*Dr. FLEMING, in opening the discussion, said it was not always that engineers were to be found who were able or willing to take them into their confidence during the constructive stage of their work, and to tell them not merely what they had done, but what they were proposing to do. He would confine his remarks to two points, and the first was the difficulties which might be expected to appear in all cases where electrical transmission of power was conducted over long lines having capacity and self-induction. These difficulties were not merely hypothetical things which were discussed by Professors, and might, therefore, be safely neglected when coming to practice, but were exceedingly real, and capable of giving rise to very disagreeable and dangerous effects. One of the great risks which had to be avoided in the construction of these lines was the presence of pressure effects, which occurred when the lines were suddenly connected to, or disconnected from, the machines. Prof. Forbes was quite right in saying that under those circumstances surgings were set up in the cables and in the machines, and that the pressure might become almost anything they pleased ; it might become scores, if not many more times greater than the working pressure ; in fact, it was impossible to say under some circumstances what the pressure actually did become, and under those circumstances it was of no use to say anything of failure of insulation, for no insulation would be sufficient to withstand the pressures that were brought against them. The methods by which they could be controlled had only to be known to be adopted. As Prof. Forbes had mentioned that those difficulties had been got over at Deptford, there could be no objection to his telling them the method adopted by his colleague, Mr. d'Alton, in consultation with himself and others. The way in which it was done now was this : The cable was never suddenly connected, but a transformer was placed in the main, as shown, and that transformer had



on its secondary circuit an arrangement by which it could be gradually short-circuited. A water resistance was generally employed, but it might be carbon resistance. The first process of connecting the trunk main was to keep the switch B open and close A and C, the transformer being open-circuited on the secondary side. Under these circumstances the transformer offered a considerable impedance to the flow of current, and that nullified the capacity effect in the main. The next step was to gradually short-circuit the secondary circuit of the transformer, reducing the impedance of the transformer. When completely short-circuited the switch B was closed, and then the switches A and C were opened, and the transformer was disconnected from the main. In switching off exactly the reverse took place. When dealing with long concentric cables the capacity might reach a very high value—one-third of a microfarad a mile. It was almost impossible to get a cable, if it was concentric, that had not a capacity effect. If they were to adopt a pressure of 20,000 volts, and a frequency of 100, which was probably what they would have done had they started this enterprise in England, and a capacity of one-third of a microfarad with 18 miles of cable, the capacity current in that cable would be 72 amperes when nothing was connected at the other end. That could be easily calculated from the formulæ he gave some time ago. The capacity of that capacity current to do work, or rather mischief, was proportional to the square of the current and to the frequency. Hence the advantage of low frequencies, for the capacity was something enormous when they came to long lines. Concentric cables were, therefore inadmissable for long lines. He thought there was great safety in using an artificial load in putting machines into and out of parallel. In all Continental stations they did so. When he (Dr. Fleming) was at Rome last Easter he spent a long day with Prof. Mengarini at Tivoli, and the latter allowed him to experiment with the machines there as much as he pleased. They had an artificial load which took up 300 H.P., and this artificial load was made to resemble as closely as possible the real external line. The process of putting the machines in was this : First of all they put them on to the artificial line, and adjusted the incoming machines so as to give exactly the required current and volts. They then put on two machines and divided the current without any difficulty ; then a third was put into parallel, and then a fourth, and a fifth. They were taken out one by one by reversing the process. That artificial line was used in all the Ganz stations, and he thought Prof. Forbes was very wise in making provision for it in dealing with his machines. It was curious that we had not adopted it much in England. He did not know any place where it was used ; yet at the same time he hardly knew any large alternating stations on the Continent where it was not done. In the next place he would say one word on the question of pressure. He was very glad to hear Prof. Forbes say he never intended the primary circuit to be opened. But the question naturally occurred, would not the primary circuit sometimes open itself ? In other words, what was going to be done in the way of main fuses ? That was really a serious question in dealing with these pressures. What kind of main fuses did Prof. Forbes intend to adopt ? In his Paper he mentioned a transformer the secondary of which had a working arrangement which would gradually introduce impedance if the current rose above a certain value. He trusted that that arrangement would be found to work well ; but at the present moment one great want in connection with large distributions of alternating currents was an arrangement of main fuses which would not interrupt the circuit, but if the main current went above a certain value would put impedance into the circuit gradually but quickly, and then take it out again as required, but never allowing the main circuit to be broken. The great difficulty at present was that it *did* become broken, and a great rise of pressure took place, with disastrous results to the insulation. The question of pressure was one to which Prof. Forbes and his colleagues had doubtless given very serious consideration before deciding to adopt 20,000 volts. The difficulty which might be encountered with this high pressure was not the difficulty of working with the stock pressure of 20,000 volts, but the tremendous arcs which might be produced if they were started between the conductors. Prof. Forbes did not tell them, he believed, how far apart those cables were going to be in the conduits. He described a conduit in which copper strip was to be used as the conductor, but did not mention what distance they were to be apart. That was a very important matter. It might be impossible under some circumstances to prevent such rises of pressure that an arc would start, and what would be the state of affairs with naked conductors in those conduits if they were only, say, a foot apart ? The question was sometimes asked, what is the best frequency to work at ? It was very much like asking, what is the best speed to walk at ? It depended upon where you were going and what you wanted to do. Continental engineers had not been at work at the matter at haphazard when they adopted a frequency of between 40 and 50. Our adoption of 80 to 100 was necessitated by the circumstances under which we had to start alternate-current working ; and the same in America. But there was no doubt, he thought, about the wisdom of selecting this low frequency at Niagara, where the utilisation of power by motors was an important matter, and there were enormous advantages to be gained by the reduction of these capacity effects and other effects of the same kind by the employment of a reduced frequency.

* Mr. W. M. MORDEY said they were called upon to discuss a Paper on a subject of world-wide importance, and he believed a sense of responsibility would be felt by all speakers. What made the Paper so interesting was that Prof. Forbes not merely described the scheme and the works but went pretty fully into reasons and principles. It was a very important matter that after so much work had been done on alternate-current distribution of all sorts that Prof. Forbes should come there and throw the gauntlet down to the whole industry on two or three points of primary importance in connection with distribution. Those of them, for instance, who had been working at comparatively high periods had to justify their continued existence and to prove that Prof. Forbes was wrong. Prof. Forbes stated in the Paper that "it is a matter of common knowledge that parallel working is assisted by lowering the frequency." With all respect he (Mr. Mordey) would deny that. He thought there was no evidence whatever to show, with any good plant now running, that lowering the frequency had any connection with parallel working. If there was no difficulty whatever in working at 100 periods there could be no improvement in working at a lower rate. It might be that, with certain types of machines, there were advantages in working at lower rates, but he believed that a machine that was incapable of working at 100 periods would work worse at 16 or 40 periods than a machine that would work at 100 periods successfully. The only definite argument Prof. Forbes put forward was a letter from Messrs. Ganz, who had written him "that their reason in adopting the frequency of 42 periods per second was that it is the lowest frequency that is available with arc lights so as not to produce any serious flickering, and their desire was to lower the frequency as far as practicable in order to ensure parallel working." Now, Messrs. Ganz were very important people ; they had large experience all over the Continent, but it was very necessary to examine and sift statements of this sort, and not to accept them as facts. He thought they ought to ask if Messrs. Ganz had not been a little forgetful in making such a statement as that. In his Paper on alternate-current working in 1889 he made a similar statement ; he quoted a letter by Mr. Zipernowski to *The Electrician* of May 10, 1889, stating that their low periodicity was "chosen on principle," "that we by this means are enabled to couple our dynamos in parallel is not a secondary result, but just the end we are aiming at." His (Mr. Mordey's) surprise was, therefore, very great when during the discussion Mr. Zipernowski wrote : "We state that we have not reduced the periodicity because of the coupling in parallel," and adding that they had always kept to 85 alternations with only slight variations. He happened to know that this last statement was correct. For a considerable time before parallel working Messrs. Ganz had been making alternators of 42 periods per second ; when parallel working was recognised to be a necessity they made experiments and adhered to 42 periods and gave out that they adopted it because it gave the best results in parallel working. I am not aware of any other support than that of Messrs. Ganz to Prof. Forbes's statement, and these words taken from Mr. Zipernowski's own writing showed that his last published statement contradicted

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his first, and acknowledged that they had made these machines for low periods for years before parallel working was thought of. The question of artificial loading in putting machines on to mains in parallel had also been dealt with by Prof. Forbes, and had been approved very strongly by Dr. Fleming. Now, that was an old, primitive, and he thought an obsolete method. He explained a plan was got out some years ago by Mr. Rawerth and himself, and published in his Paper "On Testing and Working Alternators," by which the regulation of each alternator was entirely controlled by controlling the steam supplied to its engine. There was another question affecting the periodicity to which Prof. Forbes referred as probably the most important. He said: "I am not sure that it ought not to be said that the greatest advantage of low frequency is in connection with the conductors used for transmission, and in the parts of the apparatus that require high insulation." Then he referred to what was strongly pointed out by Lord Kelvin, and which was found out independently by those wonderful experiments of Prof. Hughes's, namely, the surface effects in conductors at high frequency, the tendency of the current to seek the outside of conductors. That was, no doubt, in low tension alternate-current distribution, an extremely important matter. But in the case of high pressures and long distance transmission he did not think those Hughes effects, as he would call them, were by any means serious, even for the large powers Prof. Forbes proposed. In 1889 he gave a table of the virtual resistances of conductors, based on Lord Kelvin's figures. In the Niagara scheme at 20,000 volts the full current on one of the machines, with 2,000,000 watts, was only 100 amperes. Prof. Forbes selected 350 amperes to the square inch as a suitable density; he thought a larger density would be more economical unless their power was going to be very costly. But taking that density from his table of Lord Kelvin's results he found that at 100 periods per second, or six times as high as Prof. Forbes intended to use his conductor, there was scarcely any Hughes effect at all. Was it worth while going down to 16 or 25 periods per second in order to get this gain? Still, keeping to the subject of low periodicity, they came to the question of transformers. He believed it was impossible by any amount of money, or space, or time, or thought, to make a transformer anything like as good at a low period as at a reasonably high. It was not a question of design or of money. The ordinary idea that they could design a transformer to be equally good under any given set of conditions, so far as periodicity was concerned, was an entire mistake; it was not possible. If they took a transformer made for 16 periods or 40 periods, and ran it at a higher periodicity it would give a very much better result. Prof. Forbes said that by using this low periodicity he had a gain of 3 per cent. more power at his disposal at the other end, and that the transformer only cost about 50 per cent. more. But what did that mean? Prof. Forbes said a transformer would give 132 units instead of 100 if they doubled the frequency, and if the frequency were quadrupled they would get 174 instead of 100. Suppose he took it at double the output, the hysteresis and C^2R losses remained the same, therefore the proportion of the losses had doubled. He had gone down much further than he need have done. He had a triple transformation, first up from his dynamo to his mains, then from his mains down to the 2,000 volt transformers, and then down to 100 volts probably for his motors, for they were going to be worked at low voltages and with transformers. Therefore, there was a triple transformation, and at the very least a sixfold loss. What did he gain? The author supposed that he got a motor that had 3 per cent. more efficiency than if he used a high periodicity one—a supposition that had no sufficient basis. One thing he approved of, and that was the transforming up from the generator. That was very much better than attempting to generate at 20,000 volts. He did not see why they should transform up from 2,000 volts to 20,000; 2,000 was not so safe as 500 volts, and it was just as easy and cheap to transform from 500 to 20,000 as from 2,000 to 20,000. He would pass over what he had intended to say about the commutation of current, but would just say this: Prof. Forbes had, by this low periodicity, cut himself off from the possibility of using the alternate current directly. He had cut himself off from using current directly in any way except for power; he must always transform up to a higher periodicity if he was going to use his power for lighting.

*Mr. GISBERT KAPP said there was one point which struck him on reading the Paper for the first time, where the author was discussing the merits of the number of phases, whether they should have a single phase or two or three phases. When he (Mr. Kapp) was in America in the summer he had a long talk with Prof. Thomson upon this subject. He was very hazy at the time, he must confess, and Prof. Thomson tried to convince him that three phases would require less copper than two. He could not see it then, but he had since studied it, and read all that Dobrowolski and others had written on the subject, and at last he could see light. The result of his investigation was this: Suppose they found the copper in the line weighed 100 tons when a continuous current is employed. If they now worked a different line with the same length and the same efficiency of transmission and the same stress on the insulators with an alternating current, they would double the copper, which would now weigh 200 tons. If they used two phases with four wires they would again require 200 tons; but if they thought to save copper by using only three wires and working two-phases they would require 290 tons, so that the system which Prof. Forbes recommended as the most economical in copper was actually the worst. If they now had three wires, and worked at three-phases, they would use 150 tons only. Two-phase working with three wires was out of the competition altogether; it was too expensive. As regards the motors, he had again the misfortune to differ from Prof. Forbes. The latter thought that the low-frequency motor would be more efficient, and at the end of his Paper a calculation was given to show that the losses in the high frequency motor were 42 per cent. greater than in the low frequency. He quite agreed with the 42 per cent., but he was afraid Prof. Forbes had overlooked the fact that with the high frequency they would have to supply two and a-half times the electromotive force, and it would give two and a-half times the power, and, consequently, what appeared to be an increase in the loss of 42 per cent. became actually a gain of 33 per cent., so that on his own showing the high frequency was the more efficient. One reason which Prof. Forbes had given for the use of low frequency, and which had appealed to him (Mr. Kapp) very strongly, was that you could make a synchronising motor out of any dynamo. If they wanted to rig up a motor quickly they could go and buy a dynamo and set it to work. But when he began to consider what had to be done he saw that it was not so simple. They had to put on two contact rings to begin with. Dynamos were cut very fine nowadays; makers did not give extra room for fancy fittings. Therefore they had to send it out to be fitted with these things by a maker. Supposing they had done this, how were they going to start it? Being a single-phase motor, it would not start by itself, and they must put down a little Tesla motor, or some other, to start it. And if they did that they might as well use the Tesla motor a little larger and run their factory from it. He would like to point out that single and multiphase alternate-current motors were on the market and were very good. The only reason that the impression prevailed in England that they were not to be had, that they were not reliable, and only experimental, was that they placed too much credit on what appeared in the electrical papers. He was afraid the papers were treating them rather badly in this respect. It was the fashion amongst them to cry down multiphase and alternate-current work. He could quite sympathise with the editors; it was an unfortunate thing that they had to take up new subjects and study them in order to write intelligently about them. The ordinary alternating current was bad enough, but when you came to three phases it was really too bad. But they should not cry down these things; let them state what the facts were. He had tested such a motor made by the Oerlikon Company, with the following results: the machine gave on the brake 862 watts, and it ran at a speed of 1,800. The frequency varied from 60 to 67; the commercial efficiency was 60 per cent.; the power factor was 74 per cent.; and at starting the current to produce a torque equal to that at the full output of 1¼ H.P. was 2½ times the normal working current. It was rather inconvenient to have such a large current at starting, but by a very ingenious arrangement, now used all over the Continent, the mains did not feel this large current. There was an auto-transformer with a switch handle, which, at the expense of pressure, gave the extra current which went into the motors and it worked beautifully. The weight of that machine was under 1cwt. per horse-power. There seemed to him to be very strong reasons against the adoption of low frequencies as regards motors, and perhaps not so great, but still sufficient, reasons as regards the transformers; one very strong reason was the cost of the alternator. He had studied the design of Prof. Forbes's alternator very carefully, and he might say at once that he was very pleased to be able to agree with him that it was about the best machine that could be made for the job.

Prof. SILVANUS THOMPSON said that the Paper bristled with points, but he would confine his remarks to one or two. In the first place some rules concerning parallel working were given, or rather some remarks were made about the knowledge, or want of knowledge, upon that which constituted the successful design of machines for working in parallel. Prof. Forbes said: "The rules which govern the construction of machines which shall work well in parallel are not very clearly understood. The only fact which has been perfectly established in practice is that the lower the frequency the more efficient and sure is the parallel working." He, too, felt disposed to dispute this point. He would not dwell upon it—he simply disputed it; it had not yet been established; it might be true, but it had not been established. But he did venture to think that this was not the only fact bearing upon the question of the construction or the design of machines for parallel running. In the first place they knew perfectly well that machines would not run well in parallel if they had weak field magnets, if they had armatures that, with the output that the machine was designed for, would perturb or interfere with the magnetism of the field in any serious way. Further, they knew that they did not get easy working between two alternators of distinctly different types. In this case, if the two alternators were so designed, whether in the placing of their coils, or the shape of their pole-pieces, or the relative positions of coil and pole-pieces, so that the curves of their induction were widely different, one giving a form nearly like a sine curve, and the other giving a curve like a saw-tooth curve, they would not run in parallel. These were points that really were known, and bore largely on the question of design. Further, he would like to point out that they sometimes spoke of the self-induction in the armature, and of the reaction of the armature, as though they were the same sort of thing. There was no doubt whatever that an armature which had no iron in it, or in close proximity to it, would have less self-induction and armature reaction than an armature that had much iron in it, and that iron in close proximity to the coils. But they might have an armature which had much self-induction without necessarily very much armature reaction. It depended upon how the iron was disposed near the armature coils with respect to the approach to the polar parts, and the thing which was disastrous in the design of an alternator for these purposes was the putting of iron into the armature in such a way that the iron acted violently on the magnetism, and pulled it about so that the field became an unsteady one. All this, of course, was contained in those wonderful equations on the action of alternate-current machines which Dr. Hopkinson published about 1884. He (Prof. Thompson) was perfectly well aware that the whole theory of alternate working and parallel running could be dug up from those equations. But it was more to the point if they inquired what was the physical action which went on and made it easy or difficult for two machines to run in parallel when they were placed on the same circuit; and the physical effect was really easy to follow out if described by means of a diagram. If they took one of the ordinary types of alternator, say, for example, the Westinghouse (see

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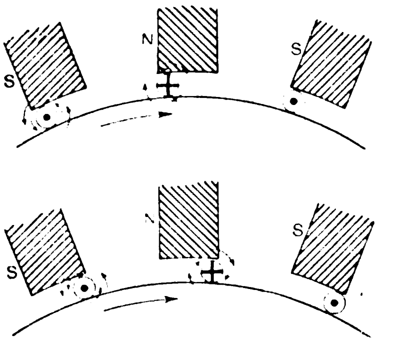
diagram). Suppose the armature core to be rotating right-endedly, and they had the wires on the outside, the tendency would be to generate currents which would come toward them as the wire was passing the S pole, and to go away from them as the wire was passing the N pole. That was to



say, the electromotive forces, everything being supposed to be symmetrical, would be at their maxima in those coils, and would die away to nothing exactly half-way between the poles. Suppose they had two such machines, exactly alike in phase with one another. Their electromotive forces were at a maximum at that particular instant, and if there was no lag in the current, no self-induction, they would have the currents also at a maximum at that particular point. Now, suppose they had those two machines coupled together in parallel, the electromotive forces were equal if other things were equal, and there was no tendency for one machine to send a current through the other one either way. Now suppose one was a little behind and the other a little ahead, then the electromotive forces would not necessarily be equal. The consequence would be that the current produced by the two through one another, they would have a load thrown on the leading machine tending to bring it back, and a load tending to bring up the lagging machine. But now suppose that the current in the wires was capable, by reason of the disposition of the iron or anything else, of producing considerable reaction. Now for the receding current, the tendency was to exercise a magnetising force around it which would strengthen the field in front of it, and weaken it behind. As a matter of fact, the question of strengthening the field in front of it, or weakening the field behind it, strengthening the field as a whole, depended upon whether the strengthening or weakening was a maximum when the coil was in front of the pole of the alternator or not. If the maximum was reached when the wire was behind the middle position it considerably strengthened the field, but if the maximum occurred when the wire was in front of the middle position it would weaken the field. The one that was ahead of the other would weaken its field, while the other one would strengthen its field. These two reactions, the one of strengthening, the other of weakening, precisely tended to defeat the tendency of the two machines to get back into parallel; that was say, the back armature reaction would of itself tend to prevent the synchronism to parallel.

*Mr. J. SWINBURNE said the first thing that struck him on reading the Paper was not a purely electrical question, but a commercial one, and that was, what was this power going to cost? What was it going to be sold at, who wanted it, and what were they going to do with it? The cost of the power was not given in the Paper. In time it must become public property, and he could not be asking Prof. Forbes any secret, because villages and Cities were being built and factories started, and he hardly imagined the 'cute Yankee was ready to build villages and start factories without knowing what the power was going to cost. This was rather a curious question, and a rather surprising one when they went into it. In most industries the power used was quite a small proportion of the cost of running a factory, whatever it might be. In others, of course, it was a very large proportion. But in such cases, for instance, as flour milling, the cost of power was really a very small proportion, and it would hardly pay to remove a flour mill to a place where power could be had cheap from a place where labour was cheap. In other cases, such as tearing up wood pulp, of course the cost of power was a much more serious matter. But in dealing with very large power plants it generally came out, unless the load factor was very good indeed, that the cost of coal was not such a serious item as they might expect. Some time ago he worked out a scheme for transmitting power from the Midlands to London, and he found it was very largely a matter of interest, for he found that the interest upon capital was so enormous when compared with the cost of coal that the cost of coal was hardly a factor to be considered at all. There was also another important question in connection with this. They wanted to know who was going to use the power. The problem was entirely different according to whether they wanted to supply small users who required one-tenth of a horse-power, or to run printing machines in a district like Fetter-lane, with 2 or 3 H.P., or to drive aluminium works, where they would want hundreds or thousands of horse-power. The difficulty with medium powers was to start the motors. That did not come in with large powers; it was a small detail then. Referring to the extra output from a double current, there was something in that undoubtedly, and as a matter of interest he would like to mention that the question of the transmission of power for long distances by means of double alternating current was really before electrical engineers as early as 1887. He had nothing to do with it himself, so he had all the more pleasure in mentioning that at Messrs. Crompton's they had an inquiry for a large power transmission in Australia, and they discussed a method and decided that it should be alternating. Mr. R. B. Rogers, then his (Mr. Swinburne's) assistant, suggested that the right way to do it was by double current, winding the armature all over with wire. In fairness to Mr. Tesla and others he must say that he did not think Mr. Rogers realised that this double-current plant would be self-starting, but he quite realised other advantages. But the extra output, which was one of the features mentioned by Mr. Rogers, was a little illusory when they dealt with very large machines. The next thing he ought to remark was the very high infrequency which Prof. Forbes used, an infrequency of 0·04 sec. per period. He would like to add to what Mr. Mordey and others had said about transformers. Everybody who had done much practical designing would wish to protest against the large amount of general statement in the Paper, "all other things being equal," and so on. The whole gist of the matter was in the "all other things being equal." In making a radical alteration such as that the whole comparison turned on the "other things." He protested also against the introduction into a scientific Paper of "well-known facts." Whenever an author said a thing was a well-known fact he was sure to be wrong. As to the flickering of lights, one rather important point ought to be threshed out. Helmholtz was the first, he believed, to investigate the frequency which worried the eye; whether Helmholtz quoted or investigated he was not sure. Helmholtz was concerned with the frequency that worried the ear, and went on from that to the frequency that worried the eye, which he found to be a frequency of 25. It must be borne in mind that the frequency of the flickering in the lamp was always double the frequency of the current, so that would mean, according to Helmholtz, that the eye would stand an alternate-current frequency of 12½. It was very curious that Helmholtz's and Forbes's results did not agree. Prof. Forbes observed a flickering at a frequency of 48, or a frequency in the lamp of 96, whereas Helmholtz said the point of limit was 25, so that there was a very large discrepancy between the observations of electrical engineers and the observations of Helmholtz. As to capacity, Prof. Forbes took a great deal of trouble to eliminate capacity from his system. He (Mr. Swinburne) could not help thinking he was wrong there. As soon as Prof. Forbes had in all those triple and double-current motors he would find he had a whole lot of consuming devices on his circuit to take up lagging current. Capacity in the mains was very much like putting a redressed circuit round the field-magnets. Mr. Crompton and he went into the question of frequency some years ago, and they advocated about the same frequency as Prof. Forbes—about 20. But on looking into the matter they found they were wrong. In the first place, the transformers came out outrageous. In the second place, a point which Prof. Forbes had not mentioned, there was the heating of the field-magnets. If they were going to use very low frequency their pole-pieces would be very broad; the peripheral angle covered was large, and if the pole-pieces were not laminated they would get very hot. If they were laminated in the direction of movement they got over the difficulty of heating due to the Foucault currents in it, but they did not get over the difficulty of the enormous hysteresis loss, and he was not sure that this was not going to be a serious difficulty.

*Mr. S. F. WALKER said with reference to the winking of incandescent lamps, if they used thick filaments they could make the frequency as little as they pleased. He would like to know what the cost of the culvert which Prof. Forbes described was going to be. It appeared to him that town distribution would have to come to that. At present they buried their cables, and they could not be certain what was going to happen to them. Sooner or later faults would be generated; experience in connection with telegraph lines would bear that out. Therefore, he felt confident that sooner or later subways would have to be made for town work, and the conductors would have to be carried so that a man could walk upright and examine them. Of course, the subways might be used for a good many other things. The only question was one of cost, and it was important to know what that would be. The revolving parts in Prof. Forbes's dynamos were very heavy, and the speed seemed to him to be high. He had followed the designs for the bearings and so on very carefully. They could provide for the speed, for the centrifugal force, and the twisting strain on the spindle, which was a most important matter, but there was a big difficulty when they came to provide a steel spindle which was very large, as it would have to be to stand the enormous twisting strain; they could never be quite certain what they got inside. He believed he was correct in saying that, in this country, at any rate, all machines which had such heavy moving masses as this revolved at a very much lower speed, something like one-tenth.

The meeting then adjourned until December 14th.

Thursday, December 14th.

On the discussion upon Prof. Forbes's Paper being resumed,

*Mr. FERRANTI said it was well known that dynamo contractors and designers from all the world over had submitted plans to the Niagara Company. It seemed to him that it would be very hard to design a dynamo which was not in every way the best from the knowledge which the gentlemen of the Cataract Construction Company had had put before them. There were, however, several important features in which the dynamo proposed was novel. One of them was the method of insulating the coils. He had not heard of any other public proposition except that of Prof. Forbes for doing it in that way. It might be interesting to know that in the provisional specification of a patent he (Mr. Ferranti) had abandoned, occurred a passage describing a very similar arrangement. He let that drop, and he thought wisely so. He had had the pleasure lately, even since the last discussion, as well as before the Paper was read, of going round some of the works on the Continent, much as Prof. Forbes and the other engineers of the Cataract Construction had done. Although he thoroughly disagreed with the general design of the machine, he recognised some details of value in it, but these were embodied in the designs sent in by Mr. C. E. L. Brown, of Baden, perhaps the man who had done most towards high-pressure work and long-distance transmission. With regard to the cooling of the bearings, it was a very

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general practice amongst English and Continental engineers to circulate water continually in the jacket round the bearing, which of course was preferable to throwing water on from a hose according to marine practice, but in this case he should say it would be very effective if water were always left on. There should surely be enough water at Niagara to make this possible. He considered the exciting a large plant like that in series was anything but the best arrangement; he believed the old parallel method of exciting had many points in its favour. The question of transforming up was in practice a very awkward one. It led to many objectionable results, and was especially bad where it was combined with other dynamos working direct on the circuit at high pressure. He believed it was contemplated to make those dynamos of higher pressure than 20,000 volts; then, he supposed, the old ones would have to be re-wound, remodelled, or worked on this objectionable plan. There was, he thought, a very great difference, which might not appear at first sight, between designing dynamos and building them; in fact, a thing which one made one's ordinary daily business, was very different from getting together a collection of all the information which was available in the world, and, then, without any previous knowledge of dynamo design, and especially building, and more especially running, to design a machine which was hoped to fulfil great expectations. With regard to the next point, that of the construction of the line and the voltage to be used, as he understood it, it was proposed to use an electromotive force of 20,000 volts on the assumption that, as at Deptford, there had been used an electromotive force of 10,000 volts; 10,000 volts with one pole to earth, so the safety would be equally great with 20,000 volts and both poles insulated. He thought this was a great fallacy. If they had two cables, both insulated from earth and charged in this way, it was exceedingly unstable and dangerous. If they adopted the safest method of conveying electricity, namely, by concentric cables, then the outer conductor took the same potential as that of the earth. If the two cables were separate they were liable by any accident which might occur in practice to have one put to earth. Then they would have a reversal of strains, the whole theory of 20,000 volts being as easy as 10,000 being upset, and they would have conditions which they had not provided for. Taking this pressure of 20,000 volts, the question was how to insulate it. He read in the paper that a subway had been partly built to carry the cables. The first impression upon his mind, and also the last after carefully considering it, was that that subway would be a very hot place; 10,000 volts was quite alarming enough when it got out of control; 20,000 with big horse-power at the back would, he thought, be worse. He thought it was quite possible if any fault did occur in the subway it would cause a very serious state of affairs in the whole of that subway, or, at any rate, through a considerable portion of it, and it would probably lead to the complete breakdown of the system. Next they had the question of periodicity. He could not agree with the periodicity of 16⅔ per second, or even with a periodicity of 25. He was sure there must be a considerable amount of lighting to be done. Why should this lighting be sacrificed? Was there going to be a proportionate gain in the general working of the system by using such a low periodicity? He did not think there would be. He believed the system adopted by Ganz at Buda-Pesth was a more satisfactory one to work at, somewhere about 40. It certainly rendered both arc and incandescent lighting possible, and was somewhere about the happy medium. With regard to the higher periodicity which they had heard spoken of in connection with this Paper, there were enormous difficulties in working with it. It had been spoken of as though it really was not an important thing; but there were very serious effects. In the first place, the capacity effects were much worse where they had to deal with capacity at this high periodicity, and what was much worse than that again was the magnetic retardation due to the field excited round the conductors. This would be alluded to fully in a Paper shortly to be read, and he would not further touch upon it, except to say that it was a very grave difficulty. He ventured, however, to say that so high a periodicity as 100, or even 86, as at Deptford, would be fatal to an economical working of the system. They came now to a most interesting question—how was electricity to be transmitted to a very great distance, by what method was it going to be done? Was it going to be done by alternating currents or by continuous current? He must say he did not see the faintest chance of its being done with continuous with the present knowledge; but, at the same time, he saw very grave difficulties in the way of doing it by alternating currents.

There was one side of the question which he thought was much more important to the Institution than the periodicity, or the electromotive, or the design of the dynamo. It was the general principle upon which the Cataract Construction Company had obtained its information. They proceeded in an exceedingly clever way. They formed a Commission, asked the greatest scientists of the day to join them, got a room at the City and Guilds Institute at South Kensington, and gave the Commission power to offer prizes, very small ones, and used other means, in fact any means, by which they could draw and collect information. He had had the pleasure of meeting some of the people who had sent in specifications. He himself did not send any. Various schemes were sent in. There were those great scientists, men they would not think of questioning, to give the thing perfect legality, and everybody thought it was a good thing. The information was not sent in by amateurs, but by people who had to make their living by building dynamos or some such articles. One firm spent at least £1,000 in doing it, and they might take it that that money did not represent the whole cost nor the value of the brains of those able men who had been engaged in working out a scheme. Nothing sufficiently satisfactory having been obtained, what was the next step? The engineers of the Company were sent round to the different works on the Continent to gain information, the Company knowing full well all the time that that information was not going to be used to the benefit of those who gave it, or be adequately recompensed. It was upon the information so obtained that the designs and schemes which had been put before the Institution had been got out; it was upon the work of the world, the electrical world, unrecompensed, that the undertaking would be carried out at Niagara. He did not blame Prof. Forbes, but it had been beautifully worked out by the Company, and nearly everybody had fallen into the trap.

*Mr. ALEXANDER SIEMENS said it was only right to the Commission who asked for the tenders that he should put the matter from a different point of view from that represented by Mr. Ferranti. He had not the conditions upon which the tenders were given. He (Mr. Siemens) had the pleasure at the time of speaking to the President of the Commission, who explained to him that the conditions were to be, that the different competitors were to send in detailed designs, and if successful, superintend the construction of the machinery in America for a commission of 2½ per cent. or 5 per cent., he forgot which. Under those conditions they competed, but did not send detailed designs, and as a matter of course, was excluded from the prizes. But he was perfectly certain that nobody who read the conditions under which they tendered could say that it was not from the beginning the intention to construct the whole of the machinery in America. He did not think any question ought to arise about being able to send a current of 20,000 volts through underground cables. He, for one, would be perfectly ready to supply cables that would carry 20,000 volts. Such cables were in daily use at the Frankfurt Exhibition having been supplied by his firm for connecting the transformers in the machinery hall to those in the Maine annexe; the normal working pressure was 20,000 volts, the cables having previously been tested to 40,000 volts. Another point which had been insisted upon was that it was quite out of the question to think that a continuous current could serve for such a transmission. Well he was not so sure about that. Their own project for the Niagara transmission was for continuous current, using machines and motors in series. He was not sure that the Cataract Construction Company would not be converted to the continuous current before they had done.

*Mr. S. EVERSHED said one speaker had spoken of the effect when large solid conductors were used; but Prof. Forbes did not say he was going to used large solid conductors, and he (Mr. Evershed) did not doubt that he would not do so. He showed in his diagram of the subway something which might be taken to be laminated strip conductors, so that the skin effect elaborately discussed by Lord Kelvin would not have any prejudicial effect. But there was one effect which would come in, and it was of vastly more importance, and that was the induction between the conductors, whether solid or laminated. It was easy to work out what the back electromotive force of induction would be for any pair of conductors run at any given distance apart, and he had worked out a few cases, taking the conductors to be 6in. apart, or 12in., or 3ft. He also took the density as 333 amperes per square inch, which he understood the author proposed to use. He found that there was one great argument for using as low a frequency as possible, namely, the enormous inductive drop in the lines if run at the 100 periods of Mr. Mordey. If they had mains of 3 sq. in. in section, as Prof. Forbes would have, and placed those mains 6in. apart, if they ran at 100 periods they would have an inductive E.M.F. of 880 volts per mile. Running at 25 periods this was reduced to 192 volts, while the resistance drop was 27 volts. On that ground alone Prof. Forbes appeared to him to have an unanswerable argument in favour of low frequency in that particular case. The only other point he desired to refer to was the question of coupling in parallel. He wanted, if possible, to get Prof. Forbes to tell them distinctly what were the uses of an artificial load in coupling machines in parallel.

*Mr. CROMPTON said there had been an important omission in the discussion. The question which was of real interest to them was, What would be the cost of power to the users in Buffalo or in the more distant towns? How would it compete with the cost of power produced in those towns? That was the point which would interest him most. He should think many engineers like himself had had such schemes on a smaller scale brought before them, and in the large proportion of cases they were reluctantly obliged to abandon them because the interest on the cost of the plant was so great as to overwhelm the advantages of using water power. He had been forestalled in many of the remarks he would have made by Mr. Ferranti. The barefaced attempt to pick the brains of the world and then to utilise the information gained for the benefit of the American manufacturers was a thing to be admired. He was sorry to say that similar attempts were often made in this country; he spoke feelingly. There were many who had spent their blood and treasure in the perfecting of the mechanical details and the other details of electrical machinery, and who could not get any reward for their labours simply because no system of patent laws could cover every little detail of design. The regular modern habit was for the last comer to pick the brains of the world, so they must not blame the Americans. who were only doing on a large scale what had been done so often before on a small one. With regard to the culvert he would not like to be in that culvert when 20,000 volts were going on. If an arc started at one end of that culvert it would go right up to the other end, the whole eighteen miles, in a very short time. Prof. Forbes was going to use porcelain insulators, and he would ask him if he had made experiments to know what the insulating power of porcelain was. What was good enough for electric telegraphs was not good enough for underground work, and failures had been made by those who without sufficient trial had adopted the material used for aerial insulators for underground work. They had made great improvements, and had now got a material that carried 200 volts satisfactorily; whether they would ever get a material which would carry 20,000 volts was beyond him at present. Oil insulators were supposed to be a great remedy, but he thought there were many there who would agree with him after a long trial that they were entirely useless. He did not think continuous currents had been condemned on sufficient evidence. It was useless for people to

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get up in that room and say there were no difficulties in the matter of "parallelising" alternators. Grave difficulties did exist, and although Prof. Forbes might minimise them, and probably would, by his low frequency, he would find he had not then got over the great problems that would arise. He did not agree with Mr. Ferranti that 40 periods were good enough to produce good electric lighting. He had seen many of Ganz's stations at 42, and the arc lighting was disgraceful.

Mr. WEEKS asked Prof. Forbes whether his circuits were equally divided on either side, with the lead on one side and the return on the other. Prof. FORBES declined to answer this question.

*Mr. MAVOR said it would be interesting if Prof. Forbes would describe the method proposed for ventilating and drying the tunnel. This was a matter of the greatest importance, as constant atmospheric conditions in such a subway were most difficult to maintain. It was notable that the most severe criticism of the scheme for carrying high-tension currents along bare conductors in a culvert came from the principal exponent of the similar method of conducting low-tension currents. The author has said in his Paper that Mr. Tesla has clearly demonstrated the rapid deterioration of solid insulations with currents of high frequency, but many of these effects are also present with currents of low frequency at an equally high voltage.

Major-Gen. WEBBER said they ought all to feel the greatest sympathy with Prof. Forbes in connection with this Paper from one point of view. He had brought before them a Paper referring to work not yet carried out, and in criticising the account he had been good enough to favour them with they should remember that it was inevitable that modifications would have to be made in carrying out that work.

*Mr. KAPP gave an abstract of a communication from Mr. C. E. L. Brown. Mr. Brown advocated a higher frequency than Prof. Forbes, and with regard to running in parallel said he had been unable to detect any difference between low frequencies such as 15 and up to 100. It was astonishing that even at the present day so much was still said of the difficulty of running alternators, single or multiphase, in parallel. He had run machines of very different types in parallel under the most different conditions, and had never found the slightest difficulty; indeed, he had come to the conclusion that the coupling of alternators in parallel was as easy as, if not easier than, that of direct machines. To adopt the two-phase system using four wires seemed to him a good arrangement, and judging from his own experience none but good results could be obtained. It certainly seemed remarkable, considering the number of designs sent in, many of which were extremely good, that Prof. Forbes should have decided upon about the worst arrangement possible for his machine. He could not imagine a more inconvenient arrangement than the magnetic wheel revolving outside the armature, so that it was impossible to get at the machine while in motion, whilst losing entirely the ventilating effect of the revolving wheel for the cooling down of the armature.

*Prof. FORBES said he had to congratulate them on the fact that that evening's discussion had somewhat redeemed the character of the Institution. Those who had really studied this problem to some extent, who knew what the difficulties were, and where the pitfalls were, must have felt that some of the gentlemen who took part in the discussion on the first night had not even begun to grasp the character of the problem before them. He himself had felt nothing but sorrow for the position of that Institution in having such speeches made on a matter of so much importance. That evening there had been more appreciation shown of the difficulties of the work and of its character generally, and the discussion had been carried on with less show of ignorance. In the discordant views expressed by the various speakers he saw a reflection of the train of reasoning which had been going on in his mind during the years he had devoted to the subject, and he saw the beginning of the workings of the minds of those who would have arrived at different conclusions if they had had longer to think about the matter. He was astonished at the manner in which the question of low frequency had been received. He did not claim for himself one atom of credit for having, after most careful consideration, arrived at the conclusion that the lower the frequency they got in the design of their dynamo the better would it be for the working; but now, after the remarks that had been made, he began to look upon himself almost as if he were the discoverer of low frequency. Before going on to discuss the different speeches he wished to say a few words on a subject which Mr. Ferranti had brought forward, and which had also been alluded to in the technical press. It had been said that the International Commission was a farce, and that those who prepared schemes had been treated unfairly. Mr. Siemens had in a great measure answered this, and he would not delay them by referring to that part of the subject. But it had been said that it was determined to give to the men who furnished the plans which should be adopted the superintendence of the work. He held in his hands a report which he submitted at the time, in which he said that alternating current was to be used, that it was to be of two phases, that 2,000 volts was to be used for the local work, that step-up transformers were to be used to carry it to Buffalo, that the motors were to be synchronising motors, Tesla motors with two phases, and motors with laminated fields and commutators. The International Commission had been absolutely loyal to their compact in giving him the superintendence of this work. The only serious mistake which he made in that report was to recommend the adoption of the Mordey alternators. They knew now that they were not of the right frequency, and that in certain other points they would not suit their purpose. If the discussion had been barren in certain parts, they had at least heard from Dr. Fleming of the methods used at Deptford to overcome electrical resonance, and that was an important point. The endorsement which Dr. Fleming had given to his views he considered to be of great value, and showed that he had given some attention to the subject. When he said that the lines should never be suddenly connected to, or disconnected from, the machine, he said something which other speakers probably considered might be regarded as an axiom. But although it might be the practice in this country, it was absolutely the contrary to the practice in America. Accustomed as Mr. Mordey was to deal only with comparatively small electric-lighting plants, he did not realise what their scheme was to be, and especially he did not realise that theirs was to be a power-distributing plant, and that the electric lighting that was to be done was utterly insignificant compared with the rest of the work. Mr. Mordey's opinion that he (Prof. Forbes) had thrown down the gauntlet to electric-lighting men showed that he did not realise the nature of the problem; his reference to transformers of small horse-power as being applicable to their case also showed it; his willingness to condemn the artificial load on the ground of expense also showed it. With regard to parallel working, Mr. Mordey argued, if 100 periods succeeded, why go down to 25? He (Prof. Forbes) had shown twenty reasons for going down below that. It was true 100 periods would allow of the machines working in parallel without getting out of step. But they wanted more than that; they wanted them to run in step without waste current passing from one to the other, and without breakdown. He did not consider that 100 periods would succeed so well as Mr. Mordey would lead them to believe. Mr. Mordey knew quite well that while his alternator worked nicely in parallel it did not work perfectly; he knew his machine had broken down at times. They at Niagara could not afford to experience such breakdowns as he had met with in his comparatively small machines. Mr. Mordey's alternator did not work well enough for their purpose. He said before deciding whether to adopt it or not tests must be made with high resistance between the dynamos in parallel. Mr. Mordey put in a group of Sunbeam lamps in series. The lamps went up and down with a periodicity of a few seconds. From the moment of those experiments he (Prof. Forbes) felt that the machines were not suitable for their purpose. Mr. Mordey thought artificial loads would introduce greater dangers. He had been utterly unable to see what those dangers were. All he claimed for the artificial load was that it was a help to keep the system from breakdown. They could not afford to have breakdowns. He looked to every possible safeguard that could be devised, even though the expense were something greater. In this case there was no additional expense, because the artificial load when not being used for that purpose was useful for other purposes. Mr. Mordey's remarks about skin resistance would be accurate if they could subdivide the 36 square inches required for the conductors of the first 15,000 H.P. used at 2,000 volts. But they could not get space for the enormous conductors unless they massed them together, and at high frequencies the skin effect would come in. Mr. Mordey's remarks on transformers caused him the most regret, for they showed him how far he was from grasping the problem. He did not appear to realise the work that must be done by consulting engineers. An engineer was very little likely to advise such a scheme until he had every detail worked out to a very large extent. Foreseeing difficulties with manufacturers, he set to work to design transformers of low frequencies for every kind of work for which they wanted them. Designing transformers for special cases and for larger sizes than usual was somewhat laborious work, but the results were quite certain when they knew the quality of iron used. Efficiency was so high as to be of almost no account at all when dealing with the large sizes which they required for their work. With regard to the question of the electromotive force of the dynamos, he really hardly understood Mr. Mordey, who wanted them to use 500 volts. If Mr. Mordey would estimate the section of copper for 50,000 H.P. or so, he would see the difficulties to be met with. That copper section would be about 400 sq. in. He had no doubt Mr. Mordey had never realised that until that moment. He could quite understand that with Mr. Mordey's type of machine it would not do to go above 2,000 volts. But he was surprised that Mr. Mordey was not able to realise these two facts: first, that with a 5,000 H.P. the space taken up by insulation was quite immaterial, and in the second place that if you shirked the difficulty of insulating to 20,000 in the fixed armature of the dynamo you would have to face it when you came to the fixed transformer. Mr. Mordey's remarks on lighting were quite beside the mark. Theirs was not a lighting station. Mr. Kapp had dealt with the relative efficiency of single, alternating, two-phase and three-phase currents, and quoted Prof. Elihu Thomson's views. Prof. Elihu Thomson had submitted to him the whole of his reasons for his statement, and he examined them most carefully, and found that they owed their error to the common American mistake of estimating the size of the conductor by the amount of drop they were going to allow instead of by Lord Kelvin's law of economical section. Mr. Kapp admitted his (Prof. Forbes') proof that the losses in the field of a multiphase motor were increased 42 per cent. in the case of a particular motor when they doubled the frequency, but he claimed that a machine with twice the number of poles running at the same speed gave $2\frac{1}{2}$ times the power. Had it not been Mr. Kapp who said that he would have taken no notice of it. But in both of them they had the same total number of lines of force rotating with the same velocity round and round the armature, generating the same electromotive force in the armature and the same current. There was no difference whatever in the power developed in those two machines, and the 42 per cent. remained as he (Prof. Forbes) had given it. Mr. Kapp said they could not find space to put rings on to a direct-current motor to convert it into a synchronising motor. He (Prof. Forbes) did that last summer with one of the stock machines supplied by the Westinghouse Company. Mr. Kapp said he did not know how he would start that motor. The motor would only require to be started once in several months, yet he had started it without recourse to Tesla motors. Mr. Kapp said he had objections to low frequencies with motors, but he did not give his reasons. He heartily thanked Mr. Kapp for the way in which he spoke of his (Prof. Forbes') machine; he was exceedingly glad that a man of such eminence in designing as Mr. Kapp had spoken so well of the machine. He need hardly say that if he dreamt that the Cataract Construction Company were acting in any unfair way he should cease to be

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connected with the work. Mr. Ferranti had been good enough to tell them that he had stolen this machine from Mr. C. E. L. Brown. Mr. Brown said it was the worst possible design that could have been devised. He knew it was simply a ridiculous assertion that the design of that machine could be said to be in any sense like that of Mr. Brown: but he was glad to be able so promptly to bring a quotation from Mr. Brown to show that he did not think so. He believed his (Prof. Forbes') machine was the first which had been designed upon a principle which ought always to rule the design of a large machine of a new type of construction where they had not past experience to go upon, and that was that they should reach the most economical efficiency. In this design he had added material until he reached a point at which $60 worth of material did not save 1 H.P. He had found, as the result of experience in trying parallel running with different types and a certain number of different frequencies, that lowering the frequency increased the efficiency, and not only the ease, of parallel working. With regard, further, to Mr. Ferranti's remarks, he denied *in toto* that any person had the right to say that the design of that machine had a plausible resemblance to the design of any machine that was put before the Company. He was seeking to get the best design he possibly could, and in so doing it so happened that he differentiated that machine from any one of those sent in infinitely more than they were differentiated amongst themselves. Mr. Ferranti said he was wrong in saying that 20,000 volts completely insulated was so very good. He (Mr. Ferranti) thought 10,000 volts with one pole to ground was better. He gave as his reason that with the 20,000 volts, if one conductor was put to ground, the whole insulation was reduced to 10,000 volts. Yet he admitted that he had one of his own conductors to ground; suppose the other got put to ground by any means, how many volts insulation would that be reduced to? It might be that by using concentric cables they avoided the chances very much of putting the other one to ground, but there were connections and numbers of other means by which it could be put to ground far more likely when hidden underground than in the subway. They owed some gratitude also to Mr. Evershed for working out the back electromotive force due to the inductive action of the conductors, and for showing them how valuable low frequency was for that reason. Mr. Crompton complained that he had not given the cost. Mr. Crompton might be perfectly sure that when they knew the actual cost down to a penny he would not give him the cost then either. There were some things he could not tell them, but he did not think the Institution had any right to complain of his not having been candid enough. The result of the discussion upon his mind had been, first, astonishment to find that he was a discoverer instead of a plain, straightforward plodder; and in the next place he was impressed by the vast differences of opinion expressed by different members of the Institution. He felt a good deal fortified in all the conclusions he had arrived at by the general result of the criticisms, however opposed to his views they might have appeared to be. It might be premature for him to say so, but he felt now that all those who had entered into the discussion would, with further study of the subject, ultimately arrive at his position. Meanwhile he thanked them heartily for the expression of their opinions; he appreciated their motives, and he appreciated the value of what had been said by some of them. At the same time he could assure them that he had not lost one particle of confidence in the perfect success of the work that was being carried out; in fact, his own opinions had been strongly confirmed by the general result of the discussion.

The PRESIDENT said although the hour was very late he was certain they would not wish to close that meeting and the session without conveying to Prof. Forbes their deep thanks to him for having brought that subject before them, and for having elicited such an important discussion. They had evidence before them that night of Prof. Forbes's enthusiasm and his nervousness, or rather his suppressed anger every now and then had kept him from that fluent defence of his position of which they were more familiar. He was quite certain that if anyone of them had worked for years on a tremendous undertaking like that of Niagara, and had been as severely handled as Prof. Forbes had been, they would not have remained as cool as he had.

LEGAL INTELLIGENCE.

The Medical Battery Company (Limited).

C. B. Harness, Managing Director of the Medical Battery Company, J. M. M'Cully, C. B. Hollier, and Dudley Towers, again surrendered before Mr. Hannay at Marlborough-street Police Court, on Wednesday, to their bail to answer to the charges of having conspired together to obtain money by false pretences from divers persons with intent to defraud.

Dr. HERBERT F. WATERHOUSE, M.D., of Wimpole-street, assistant-surgeon at Charing Cross Hospital and lecturer on operative surgery, said that on April 25th last he was at Brighton, and remembered receiving a telegram, in consequence of which he went to Chingford. He there examined Mr. Ball (who was called last week as a witness). He found him in a very exhausted condition, and he appeared to be in extreme pain. The man was suffering from strangulated hernia, and an immediate operation was necessary. He operated upon him. Mr. Ball complained that he had been roughly treated and put to extreme pain at the Medical Battery Company. There was distinct external evidence of great violence having been used. He judged that Mr. Ball had been suffering from hernia for some months or years. The ordinary way to ascertain whether hernia was reducible was by gentle manipulation. In the condition in which he found Mr. Ball a truss would have been inapplicable, and nothing but the operation could have saved his life.

HORACE GEORGE TURNEY, resident assistant-physician at St. Thomas's Hospital, deposed that about March, 1892, he remembered Mr. Burbage going to see him. He examined him, but did not find him to be suffering from any definite disease or spinal complaint. He had a very high opinion of Mr. Stanley Boyd and Mr. Critchett. He had heard of Matthews, the instrument maker, of Oxford-street, as being a manufacturer of repute.

In reply to Mr. Avory, Dr. TURNEY said he recognised Dr. Lewis Jones as an authority on medical electricity, but he would not yield his own opinion on the subject to him. He wished it to be understood that in making that assertion he did not wish in any way to disparage the position of Dr. Lewis Jones.

Mr. TERRELL: I wish here to state, Sir, that I think it would be advantageous in the interests of justice if Towers were discharged. The evidence against him is not very strong.

Mr. Hannay then discharged Towers, whose real name is Sellman.

ROBERT WILLIAM SELLMAN, professionally known as Dudley Towers, was then called as a witness for the prosecution.

Dr. HENRY LEWIS JONES recalled, was then cross-examined by Mr. AVORY. He said that he had held his appointment at St. Bartholomew's Hospital for nearly two years and a half. The electrical department at that hospital was established about seven years before he went there. There were five or six other hospitals in London which had special departments for electrical treatment. As a fact, up to the present time the medical uses of electricity had been very much neglected by medical men. He would not say that many medical men now disputed the therapeutic effects of electricity. There might be a few who did so. He adhered to the statement made in the Preface of his book on medical electricity as to the neglect of electricity as a curative agent. Two years ago, when he wrote the preface, he believed the medical profession had assumed a contemptuous attitude towards the subject. When he obtained his appointment at St. Bartholomew's he had a competitor for the office named Dr. Arthur Harries. He was aware that Dr. Harries had investigated and reported upon the appliances and belts at the Medical Battery Company's premises. He knew that about March, 1893, an invitation was sent to the members of the Royal Society to visit the premises. He was not aware that the Medical Battery Company offered to pay the expenses of a commission to inquire into the utility of their appliances. The Royal College of Physicians and the Royal College of Surgeons were both invited to visit the Medical Battery Company with the view of an inquiry being made into the utility of the appliances. The Zander Institute existed in London before its appliances were purchased by the Medical Battery Company. He thought the Zander method might be useful. At one time he looked upon Dr. Tibbetts as an authority upon electro-therapeutics. He thought he referred to him in the book he wrote as his being an authority. He agreed that the application of electricity, by statical machines and otherwise, was of great use in the treatment of disease. The statical chair alone was of some use in cases of debility, but not of very much use. He had found that the positive-charge mode of treatment was rather disappointing in its results. In the case of the connected electropathic belt there was a minute electric current. In his opinion the current passed partly over the surface of the skin and partly through the tissues of the body. In evidence in a certain case Lord Kelvin did admit that a certain portion of the current would pass through the body. He (the witness) felt certain that minute currents could not influence the body in any way.

The examination of Sellman was here resumed, and the case was again adjourned till 12 o'clock on Thursday.

THURSDAY, DECEMBER 21ST.

On the hearing of this case being resumed, the cross-examination of Dr. Lewis Jones, superintendent of the electrical department at St. Bartholomew's Hospital, was resumed by Mr. Avory.

The WITNESS said that he had heard of a work by Dr. Beard and Dr. Rockwell, but he should not consider it a first-rate authority. He did not take up the position of Dr. Turney, and say that because it was American it was not an authority. He agreed that the acceptance of the view that electricity was a tonic had wrought a revolution in electro-therapeutics. He did not think that in certain diseases, both medical and surgical, it was of advantage to allow the current, galvanic or faradic, to run for several hours all day or all night. He did not consider that currents sufficiently gentle might be passed through the body for hours, if not for days, consecutively without injury, but with benefit. He was aware that some authorities held a different opinion.

At the conclusion of Dr. Lewis Jones's cross-examination the further hearing of the case was adjourned.

Printing, Telegraph, &c., Company of the Agence Havas v. Grist.

This was an action before Mr. Justice Wills, on Saturday last, to recover a sum of money alleged to be due as calls upon shares taken by the defendant on an underwriting agreement. In the absence of the defendant judgment was given for the plaintiffs for £392 and costs.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—The coupons on this Company's Second Issue Five per Cent. Debentures, due on the 31st instant, will be paid on, and after the 30th instant, at Parr's Banking Company and the Alliance Bank (Limited), Bartholomew-lane, E.C. Coupons must be left three clear days for examination.

PACIFIC AND EUROPEAN TELEGRAPH COMPANY (LIMITED).—The coupons on this Company's Four per Cent. Guaranteed Debentures, due on the 31st instant, will be paid, on and after the 30th instant, at Parr's Banking Company and the Alliance Bank (Limited), Bartholomew-lane, E.C. Coupons must be left three clear days for examination.

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CORRESPONDENCE.

MOTIVE POWER AND GEARING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I venture to point out an ambiguity which has crept into the articles by Mr. E. Tremlett Carter on this subject, now appearing in your paper.

In No. 811, p. 111, paragraph "Energy," he makes the statement that "when a force is exerted it must be exerted against another force equally great arising from the external or internal resistance of the body against which the force is exerted." Now, if the resistance be equal to the acting force, balance will occur. The acting force cannot overcome the resistance through any length whatever, and, therefore, no work can be done.

A similar assertion is made in No. 812, p. 135, paragraph "Effort and Resistance," where the following is stated:— "The total effort at any point in the engine is exactly, and always, equal to the total resistance at that point." Here, again, balance must ensue, and the engine cannot work. Work can only be done when one force overcomes another through a distance. If the forces are equal, one cannot overcome the other, and no work can be done.—Yours, &c.,

HORACE J. BRYDON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondent, Mr. Horace J. Brydon, has fallen foul of my statements about Newton's Third Law of Motion. If he will carefully study Newton's "Principia," or any reliable treatise on the principles of mechanics, he will find that "Action and Reaction are equal and opposite; and to every Action there must be an equal and opposite Reaction." This is universally true, whether of bodies at rest, in uniform motion, or positively or negatively accelerated. Stated in algebraic form the law becomes

$$E = f + m\,a = R,$$

where E is the effort, f is the external resistance, m the mass particle which receives the acceleration a, and R is the *total* resistance. Mr. Brydon objects to the sign of equality, and would substitute the sign of "is greater than." His statement that "if the forces are equal, one cannot overcome the other and no work can be done," is simply untrue, and opposed to the facts of dynamics. Where young students mostly stumble in their attempts to grapple with the law of effort and resistance, is in not seeing that acceleration and the rate of change of acceleration are totally different things; and that while acceleration must always be finite, the rate of change of acceleration *must* be infinite for every instantaneous finite change of force which may occur. In other words, the very instant a change of force occurs there will be such a change of acceleration as will make the above equation continuously true, and there can be no transition period or state of motion in which it will be, even for an instant, not true.—Yours, &c.,

E. TREMLETT CARTER.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

TENDERS INVITED.—The Corporation of Huddersfied are prepared to receive tenders for wiring, and for the supply of electric light fittings for the Corporation's model lodging-house. Plans and specifications can be had of Mr. A. B. Mountain, the Borough electrical engineer, St. Andrew's-road, Huddersfield, and tenders must be sent in to Mr. Mountain by Saturday, January 6th. Further particulars will be found in our advertisement columns.

——— The Wolverhampton Corporation require tenders for the supply of a complete travelling crane for the electric light station. Tenders must be in before noon on January 2nd.

——— The Wolverhampton Corporation invite tenders for the erection of an electric lighting station in Commercial-road, Wolverhampton. Tenders must be left at the office of the Town Clerk before 5 p.m. on January 1st.

TENDERS INVITED.—The Barnsley Arcade Company (Limited) invite tenders for lighting the Barnsley Arcade and adjoining property by electricity. Particulars can be obtained of Messrs. Wade and Turner, 10, Pitt-street, Barnsley.

——— Mr. J. Townsend, of Wren's Hotel, Briggate, Leeds, requires tenders for fixing the various fittings requisite for the electric lighting of the inside and outside of Wren's Hotel.

TENDERS ACCEPTED.—The tender of Messrs. S. J. Waring and Sons, for the supply of engine, dynamo and electric wiring on the training ship "Conway," has been accepted for £395.

APPOINTMENT.—Mr. Austin Shea, formerly of the Indian Public Works Department, has been appointed Chief Electrical Engineer to the Royal Siamese Public Works Department, and will shortly proceed to Bangkok.

PRESENTATION.—Last week Mr. William Hey, who has recently resigned the position of foreman in the dynamo factory of Messrs. W. T. Goolden and Co., was presented by his *confrères* with a marble timepiece and set of bronze figures, as a token of esteem. The presentation was made by Mr. H. W. Ravenshaw. Mr. Hey returns to Halifax.

AGENCY.—Messrs. Henry Rogers, Sons and Co., of London and Birmingham, have been appointed sole agents for the United Kingdom of the Fonderie et Tréfilerie de Bronze Phosphoreux d'Anderlecht (Montefiore Phosphor-Bronze Works), manufacturers of phosphor-copper, phosphor-bronze, and phosphor wire.

BANKRUPTCY.—Creditors of John Herbert Hale, lately trading at 25, St. Stephen-street, Bristol, as an india-rubber merchant and electrician, must send in their claims to Mr. T. W. Munden, 4, Queen Anne-buildings, Bristol, by January 3, 1894.

——— A receiving order has been issued in the estate of James Cranshaw, trading at 8, St. Mary's Parsonage, Manchester, as an electrical engineer, &c.

RAILWAY EXTENSION.—The extension of the Great Western Railway to Brent and Kingsbridge has been completed, and the line is to be worked on the most approved methods for a single line. The Electric Train Staff system having been adopted, the telephone has been provided between Brent and Avonwick, Carr Bridge, Loddiswell and Kingsbridge, and at several places electric semaphore instruments are provided, showing when a train is approaching, and from which direction it is coming.

MESSRS. CONNOLLY BROTHERS.—This firm have now completed the equipment of their new works at Blackley, Manchester. The works cover more than an acre and a-half, and have been specially adapted for the manufacture of insulating materials and insulated wires and cables. Messrs. Connolly notify that they are starting without any incumbrances in the way of obsolete stock and machinery, and will therefore be able to supply their specialities, in the manufacture of which they have had much experience, with all the latest improvements. Price lists are now ready, and can be obtained on application.

HAZELL'S ANNUAL.—The ninth annual issue of this useful publication has been published by Messrs. Hazell, Watson and Viney. It contains, in addition to an immense amount of general information, special memoirs on subjects of interest to the electrical profession. The book consists of nearly 700 pages, and, from amongst the large number of encyclopædias, directories and similar books published at this season of the year, can be very cordially recommended. Well printed, crammed full of information, "Hazell's Annual" is a marvel of cheapness at the published price of 3s. 6d. Seven maps are included in the 1894 edition.

ABERYSTWITH.—Permission has been granted by the Cardigan County Council to the Bourne and Grant Electricity Supply Company to lay electric lighting mains along the main road from Capel Bangor to Aberystwith, and it is anticipated that before the next summer season the greater part of the town will be lighted by electricity.

AUCKLAND (N.Z.).—The Harbour Board is discussing a project for lighting the Port by Electricity.

AYR.—The Lighting Committee of the Town Council are promised by Mr. Christie a report on the possibility of obtaining water power for electric lighting of the Burgh.

BOLTON.—At the last meeting of the Town Council the proceedings of the Electricity Sub-Committee were approved, including the acceptance of Messrs. Siemens Brothers and Co.'s tender for an enlarged main and of a tender from Messrs. J. and E. Wood for the extension of the foundation rails for the crane at the central station. Mr. Rider, the Council's Electrical Engineer, presented his report as to the progress made at the works, and stated that the only contract now to be let is that for the transformer pits.

BRISTOL.—During the past week the electric light has been burning nightly in the whole of the streets comprised in the area of installation prescribed by the Provisional Order. Gas has not been

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dispensed with because it usually happens that there are faults to be corrected during the first few weeks after the light has been switched on. In Bristol, however, these have been comparatively few, and the installation is generally regarded as a success. With reference to private lighting considerable further progress has been made during the week. By Sunday next electricity will be used for lighting at St. John's Church, in the city.

BRIXTON.—Electric-avenue, a thoroughfare in the south of London, which the Fyfe-Main Company have specially taken under their care, is being brilliantly illuminated during the present week. The installation consists of 60 Fyfe-Main 2,000-c.p. arcs and 1,200 fairy lamps interspersed amongst the trees in the avenue. Between the columns, which run the entire length of the colonnade, baskets of foliage are placed, lighted by incandescent lamps.

BURTON-ON-TRENT.—The new schoolrooms in connection with the George-street Free Methodist Chapel have recently been completed, and are to be fitted for the electric light. The Assembly Hall will seat 600 persons. The work has been carried out by Messrs. T. Low and Sons from designs by Messrs. Durward, Brown and Gordon.

'BUS LIGHTING.—Some difficulty it appears continues to be experienced by the London General Omnibus Company in lighting their 'busses by electricity. It has been found that the extreme wear and tear caused to the batteries by the constant starting and stopping of the 'busses is so considerable that it will be necessary to rearrange these before the system of lighting can be considered perfect.——Mr. J. G. B. Elliot, secretary of the Omnibus and Tramcar Electric Lighting Company (Limited), writes to state that the batteries supplied by his Company to their conveyances will last more than forty hours without recharging.

CAMBRIDGE.—The Town Council, at their last meeting, resumed the discussion on the report of the Electric Lighting Committee, which recommended that the Cambridge Electric Supply Company be permitted to make certain exceptions to a constant supply (see *The Electrician* of November 17th). After some discussion the matter was again referred back to the Electric Lighting Committee.

CARDIFF.—The Lighting and Electrical Committee of the Town Council held a meeting on Tuesday, at which tenders were received and accepted for 250 lamp columns, lamps, and lamp-holders. It was decided to erect about 40 additional lamps in various parts of the town.

CHELMSFORD.—The re-introduction of the electric light into Chelmsford is certainly not to be effected without considerable discussion. The Town Council last week again considered the matter, the first stumbling block being the question of overhead wires. One member of the Council stated that it was more than likely that, if the Council insisted upon the wires being placed underground, the Chelmsford Electric Lighting Company would be compelled to withdraw their offer. It was ultimately decided to leave the question of underground and overhead wires for the decision of the Board of Trade. The Electric Lighting Company have offered to renew for five years their contract for the public lighting of the town upon the same terms as at present. The present contract expires in 1895, and the Lighting Committee's recommendation that this offer be accepted was approved. With regard to the Provisional Order, it was ultimately decided that the further discussion of the subject should be deferred until the next meeting.

CITY OF LONDON.—The Clerk to the Commissioners of Sewers, at the last meeting of that body, read a letter from the City of London Electric Lighting Company on the subject of the telephone tubes in the electric lighting trenches, and also a letter from the Exchange Telegraph Company asking that, in the event of permission being granted for the use of the pipes laid down by the City of London Electric Lighting Company, the Exchange Company might be included in the licences so as to use the tubes for telegraphs and telephones. The City of London Electric Lighting Company, in their letter, asked that no further delay should take place in regard to the Commissioners giving their consent to the use of the tubes. With regard to the proposed charge of £8 per annum for telephones in the City, the Company thought such a charge was not compatible with the outlay of capital, and pointed out that the reduction of charge to 3,000 telephone subscribers would mean that the proposed cheapening of the electric light to private consumers, who now numbered 25,000, could not be carried out. Mr. Gordon moved that the matter be referred to the Streets Committee, and remarked that there might be some modification in the terms made by the Commissioners, and that the charge for the telephone service should not exceed £10 per annum. The Streets Committee will, therefore, consider the matter

CORK.—The following is the reply of the Corporation to the objections raised by the Board of Trade Inspector to the scheme of the City Tramways Company, as approved by the Corporation:—"(1.) The Corporation is satisfied the branch tram through Marlborough-street will be perfectly safe for the contemplated traffic, and unless this branch be sanctioned, tramway No. 2 (to the Bandon and Passage Railway terminus) will be useless; and the inhabitants of Marlborough-street unanimously petitioned in favour of the tramway being laid through the street. (2.) The pressure of 500 volts as the potential of the electrical current be allowed in propelling the tramcars is set down as a maximum, and no regulations were stated to have been made on the subject by the Board of Trade; that a like maximum potential has been allowed in other towns. But the Corporation will assent to whatever potential may be decided upon within that maximum."

COUNTRY HOUSE LIGHTING.—Messrs. A. A. Campbell Swinton and Co. have recently completed the extensive installation of the electric light at "Chesters," Northumberland, the residence of Mr. N. G. Clayton, of Newcastle. In the house, stables, and offices, 500 incandescent lamps are fitted, and the fixtures are of simple but chaste design throughout. The same firm have in hand the electric lighting of Betteshanger Park, near Dover, for Lord Northbourne.——"Larches," the residence of Mr. J. H. Green, has recently been fitted with the electric light by the London and Lancashire Electric and General Engineering Company. The plant consists of a 3-H.P. Crossley gas engine, a shunt-wound dynamo and Epstein cells. Mr. Albion T. Snell was consulting engineer for the work.

ELECTRIC LIGHT IN HYDE PARK.—At a recent meeting of the St. George's Vestry, the recommendation that the offer of the Westminster Electric Supply Corporation (Limited), to lay, at their own expense, an electric light main across the park to the conveniences by Marble Arch, was accepted; but the Vestry would not pledge themselves as to the minimum of current to be consumed.

FLEETWOOD.—The Improvement Commissioners have considered the tenders received for lighting the town, and the Electric Lighting Committee have recommended that the tender of the Brush Company be accepted. It is contemplated that the complete installation will cost about £11,000. The firms tendering consisted of Siemens Brothers and Co., London; Greenwood and Batley, Leeds; C. A. Parsons and Co., Newcastle; Andrews and Preece, Bradford; and the Brush Company, London. The tenders ranged from £6,500 to £8,700. The question of appointing a consulting engineer in connection with the tenders was raised, and the Committee think the superintendence of the works should be placed in the hands of a competent resident working electrical engineer, who shall have charge of the works during construction and take entire charge of the station and the lighting department generally. It is also recommended that a travelling crane be provided in the station, and that motive-power be provided by means of Producer gas plant; 16-c.p. incandescents are to be used for the ordinary street lighting, and in a few selected places 32-c.p. lamps. The Committee, in recommending the report, state that they are very satisfied with the Brush Company's tender, and that they look forward to a considerable saving in various ways outside the question of actual cost of lighting.

HAMPSTEAD.—In connection with the electric lighting scheme a question has arisen as to the position occupied by the architect. Mr. W. H. Preece, who is advising the Vestry on the whole question, has, according to Mr. Farmer, a member, claimed that Mr. Ardron, the architect, is his assistant, and subject to his instructions. This appears to have concerned Mr. Farmer, who has written to the Vestry, and whose letter has been referred to the Electric Lighting Committee.

HEATON.—Complaint is made that the residents of Heaton (Yorks) are charged by the Shipley Gas Company 3s. 4d. per thousand for gas as against 2s. 3d. paid by the consumers of the Bradford Corporation close by. As no satisfactory reduction can apparently be obtained from the Gas Company, many of the principal residents are agitating for a supply of electric current. A circular has been sent round for signature to the principal consumers.

HEREFORD.—A number of the shops in the high town are to be lighted electrically early in the new year.

KILLARNEY.—For some time past there has been a squabble here as to who shall and shall not supply the electric light. This little difficulty has been overcome by a division of the order between Mr. Leahy (representing the Electric Light Company) and Mr. Santry (for the Gas Company).

LLANDRINDOD.—Messrs. Andrews and Preece have presented a report to the Local Board setting out particulars of two schemes for lighting the district electrically, one for 1,000 8-c.p. lamps, the other for 2,000, the former at a cost of £3,000 and an annual upkeep charge of £450, the latter for about £4,000, with an up-keep of from £500 to £600 a year. A suggestion was made from another quarter that the Board should utilise the water power from the river Ithon. The clerk was directed to obtain further information, which will be placed before the next meeting of the Board.

MILL AND WORKS LIGHTING.—The Lark Roller Flour Mills at Mildenhall are now lighted electrically, the work having been carried out by Messrs. W. J. Crampton and Company.——The whole of the extensive premises of the Uskside Engineering Works have been fitted with the electric light, which it is anticipated will prove

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cheaper than gas, in addition to offering greater convenience in the departments where overtime is found to be necessary. The London and Lancashire Electric and General Engineering Company have recently completed the over-haul of the mains, engines and machinery at the Bulbourne Works of the Grand Junction Canal Company. Extensive alterations and additions to the plant have been made, including a complete system of electric lighting for the whole of the works, necessitating the provision of extra boiler power. A Davey-Paxman Lancashire-type boiler has been supplied, coupled to one of the Lancashire and London Company's new overtype shunt-wound dynamos. The wiring for the installation is on the new watertight system, devised by Mr. C. N. Russell, the Company's engineer.

NORWICH.—The Town Council have decided to light the Council Chamber and the Committee Room at the Guildhall, together with the Municipal and Sanitary Offices, by electricity, and the City Committee have been authorised to obtain a contract for the installation.

PLATTSBURG (N.S.W.).—The Co-operative Colliery at this place has been equipped with complete electrical apparatus, not only for the pumping plant, but for the signalling apparatus and the lighting of the workings. The Crompton Electrical Supply Company, of Sydney, have supplied and fixed the whole of the machinery.

RICHMOND.—The Town Council resumed the adjourned discussion of the Electric Lighting Committee's report at their last meeting. A resolution that the electric light should be extended to a number of principal streets and roads in the district, and that a contract should be entered into with Messrs. Latimer Clark, Muirhead and Co. for that purpose was discussed; but an amendment that the discussion be postponed till the next meeting of the Council was ultimately adopted by a majority of one vote.

SHIP LIGHTING.—The White Star Line have recently added to their fleet the "Gothic," which has been built by Messrs. Harland and Wolff, of Belfast, and is, with the exception of the "Great Eastern," the largest vessel that has ever entered the Port of London. Her registered tonnage is 7,730 tons, she is 490ft. in length and 55ft. in breadth. She is specially built for the New Zealand frozen mutton trade, with passenger capacity of 110 first class and 130 steerage. The ship is lighted throughout by electricity.

SPANISH INTERNATIONAL EXHIBITION.—An exhibition is to be held at Madrid from May 1st to October 31, 1894, and will be divided into fourteen sections, one being devoted to electricity. Owing to the high price of gas the electric light finds considerable favour in Spanish towns.

STAFFORD.—A Local Government Board enquiry has been held at the Guildhall in connection with the Town Council's application for sanction to borrow £20,000 for electric lighting purposes. Colonel Ducat held the inquiry, and will submit his report in due course.

STIRLING.—Mr. Arnot, electrical engineer to the Glasgow Corporation, has agreed to prepare a report for the guidance of the Stirling Town Council in connection with the application for a Provisional Order by the Caledonian Electric Supply Company.

STOKE-ON-TRENT.—In reference to our "Note" of last week respecting the completion of the extensive installation of the electric light at Stoke Station and the North Stafford Hotel, we understand that the whole of the plant for lighting the station, goods yards, and warehouses has been supplied and erected by the Gülcher Company, and consists of 30 arcs, 10 incandescents, and two direct-driven sets of engines and dynamos, with the necessary boilers. It is expected that the lighting will be completed before Christmas.

TUNBRIDGE WELLS.—The Electric Lighting Committee of the Town Council have recommended (and the Council have adopted the recommendation) that Mr. W. H. Preece be instructed to prepare plans and specifications for the new buildings, machinery, and central station for the town lighting scheme.

WEYBRIDGE.—At the last meeting of the Lighting Inspectors it was decided to accept the offer of the Weybridge Electric Supply Company for the renewal of the lighting contract, subject to the wires being laid under ground.

WOKING.—The Local Board recently considered offers made by the Local Gas Company and the Woking Electric Light Company for lighting the Station Ward. The offer of the Electric Light Company to supply the necessary lamps and fittings for £314. 10s., and for £264 per annum for maintenance, current, lighting, repairs, and renewals, was, after some discussion, accepted. Comparing the systems of the two companies, the result is largely in favour of the offer of the Electric Light Company.

YARMOUTH.—The Local Government Board have sanctioned a loan of £15,000 for carrying out the electric lighting scheme, and have also approved of the site selected for the central station. Mr. Preece has been instructed to prepare the necessary specifications, and the Borough Surveyor's plans have been approved.

COMPANIES' MEETINGS.

Woodhouse and Rawson United (Limited).

The first meeting of the creditors of this Company was held by order of the Court, at Cannon Street Hotel, on Thursday. Mr. C. J. Stewart (Official Receiver and Provisional Liquidator) presided.

The CHAIRMAN said the Official Receiver's observations had been necessarily delayed by reason of the statement of affairs having only been submitted by the Directors on November 30th. The books were in a very imperfect condition, not having been written up for three months, and at the present time there was £28,000 still unaccounted for, but it was stated to represent the differences between the balances of the inter-office accounts of the Company. The Directors had been called upon to furnish further explanations of that deficiency, and until that was done he could not say that he was satisfied that they had a thoroughly correct statement of affairs before them. It was estimated by the Directors that there would be a surplus on the assets of £29,636, but that was qualified by the fact that three of them state "that as regards the values of the plant, stock, and certain of the securities, they are not personally competent to form an opinion, and have accepted the values placed upon them by persons at present engaged in the Company's business, who are in a position to be well informed on the subject," while the manager (Mr. Stutchbury) said, "the valuations placed upon the shares and debentures held by the Company in other companies, the stock-in-trade at the head office and various branches, and the goodwill and patents are considerably over-estimated. He considered that the valuations of the debts appearing due to the Company are also over-estimated." He understood from the receiver for the debenture-holders that in his opinion it is extremely doubtful whether the debenture-holders themselves would receive 20s. in the £. He would give them an instance of how the assets appeared at all events, to be of a doubtful character. The value of the Company's Founders' shares and debentures in the Epstein Electric Accumulator Company stood in the books at £34,150, but for the purpose of the statement of affairs that had been reduced by the Directors to £17,000, so that practically 50 per cent. had been written off. There was a book debt due to Woodhouse and Rawson United from the Epstein Company of £12,978, making a total of £40,000 to be recovered from the Epstein asset. According to the original prospectus, Woodhouse and Rawson United Company appeared to have been formed for the purpose of amalgamating several industrial enterprises engaged in electric lighting, and as far as he could see there was nothing to lead any person to suppose that anything besides industrial business was to be undertaken. It was true that in the Memorandum of Association there was power given to the Company to promote any other companies for the purpose of acquiring property and holding shares and so on, but as far as he could see the objects of the Company as stated in the prospectus were to carry on an industrial business. The gross income of the Company for the first year, ending June 30, 1890, amounted to £109,597, of which £88,000 was obtained from other than industrial enterprises. Therefore, the only gross profit which could be allocated to industrial enterprises was £21,000, the expenditure on account of which was £34,000, leaving a loss on the first year's working of this branch of the business of £13,246. Up to the present time the Official Receiver had not had the opportunity of going into the affairs of Woodhouse and Rawson (Limited), whose business Woodhouse and Rawson United took over, but he had very grave doubts as to whether the profits stated to be earned by the former Company were profits at all of the industrial concern. If that were so the £75,000 paid as goodwill to Woodhouse and Rawson (Limited) ought not to have been paid. Adopting the same principle as for the first year, the second year showed a loss on the industrial business of £43,000, and the third year, 1892, a loss of £129,000. As far as he could see, that which had kept the Company afloat and given the shareholders 15 per cent. for two years was the promotion of other companies. The Official Receiver was of opinion that further inquiry was desirable, and he proposed to apply for the public examination of certain officials of the Company in order to test the declaration. The business before them on that occasion was to decide whether they desired to appoint a liquidator other than the Official Receiver, and a committee of inspection. In conclusion he stated that the directors had been invited to attend that meeting, and perhaps they might like to address the creditors.

Mr. F. L. RAWSON said that as Managing Director of the Company he was responsible to a large extent for its transactions. What the creditors had mainly to consider was, first, whether there existed a good business; and, secondly, whether it was possible by reconstruction to get in their debts. With regard to their interest in the Epstein Company, he said that that Company's patents had cost the inventor and the firm who had acquired some of the foreign patents more than £50,000. The only way in which they could judge of their present value was to show what the cost of them had been, and what the actual prospects were. Before they went into liquidation they were in negotiation with one of the principal firms in this country for the sale of their interest in the Epstein Company for £20,000. Of course, if the thing were disposed of at break-up prices they would get but little for it. The Epstein Company to-day had £4,000 of orders, which they were executing at a good profit, and he had a letter from a first-class firm expressing their willingness to take up the manufacture, the accumulators giving them a large share of the profits, subject to their engineer's report being satisfactory. In the face of these facts he did not think the small price the Directors had put upon that asset was too much. He informed the

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Directors he did not expect to make a sufficient profit to pay 15 per cent. out of the industrial business during the first three years of the Company's existence. It was always the intention of the Board to build up a big industrial business, and more than one member of the Board threatened to resign unless that was attempted. If the Company were reconstructed he did not see the slightest difficulty in making over £25,000 a year from the business. In order, however, that any scheme for reconstruction might be successful, it would be necessary for the debenture holders to wait. He thought they could be paid off in three years, receiving in the meanwhile 6 per cent. per annum. The Ordinary and Preference shareholders would have to find a certain amount of capital, about 4 per cent. and 2 per cent. respectively. The Five and a-Half per Cent. Debenture Stock holders would, no doubt, only get a comparatively small amount if the Company were broken up, and it was a question whether they should not find a small amount of capital. The assets would remain under the control of the debenture holders, and the creditors and shareholders would not be able to touch them until the debenture holders were paid. His opinion was that the Ordinary creditors should get securities in the new Company for at least 50 per cent., and he thought (and in this he differed from the other Directors) that they should receive the other 50 per cent. of their debt back out of any balance of profit after the shareholders had been paid a 10 per cent. dividend. He had between £40,000 and £50,000; but he should not draw a penny on any of his shares in the new Company until the creditors were paid in full. In his opinion it would be advisable to appoint a committee to assist in the preparation of a reconstruction scheme and he hoped that would be done.

Mr. POPE, Q.C., said he had stuck to the concern in person and by his pocket as long as there was any concern to stick to. As a Director he must take all the blame that attached to him as such, but he was also a large shareholder and creditor, and he should lose, probably, as much as most of those present. His opinion was that whether there was a surplus or not depended upon whether the creditors were patient or not.

Mr. LESLIE (receiver for the debenture holders), in reply to a shareholder, said his firm had prepared the statement of affairs, but they could not vouch for the accuracy of the figures it contained on account of the way in which the books and accounts had been kept.

Mr. BOND then moved: "*That no application be made to the Court for the appointment of a Liquidator other than the Official Receiver.*"

Mr. TILLSLEY seconded, and it was agreed to unanimously.

Mr. Dobson (Reuter's Telegraph Company), Mr. Hampton, Mr. Bond, Mr. C. H. Cox, and Mr. Ellenor were then appointed a committee to act with four shareholders to be appointed at the meeting of contributories for the purposes suggested by the Chairman.

A meeting of the contributories was subsequently held at the same place. Mr. Stewart again presided, and made a similar statement to that put before the creditors.

Dr. DUNCAN said the only chance the shareholders had of getting back anything was by making the promoters, directors, and managing director disgorge and refund the money they had obtained from the shareholders, and which they then squandered by paying dividends out of capital, and in other ways. The only person who would consider their interests in a *bonâ fide* manner and press their claims was the Official Receiver, and he moved his appointment as liquidator.

Mr. WARD seconded.

The CHAIRMAN said he would do what he could for the shareholders, but their prospects did not look very rosy at present.

The formal resolution, that no application be made to the Court to appoint a liquidator other than the Official Receiver, was then carried.

Mr. F. L. RAWSON denied that he had made a huge nest-egg out of the concern for himself, but stated that he had lost his all in it. Since the Company had gone into liquidation he had worked without remuneration to assist the Official Receiver, who he was glad to see appointed liquidator. He felt sure that the examinations which would follow from Mr. Stewart's appointment would result in clearing his character in such a way as could not otherwise be done.

Mr. ABRAHAM said what they now had to inquire into was whether the proceedings of the Directors had not been *ultra vires.* He considered that Mr. Pope had all along behaved in a manly way, and he deplored his connection with the Company.

Mr. POPE, Q.C., said it was impossible in a meeting of that kind for the Directors to enter into any defence they might have. He was sorry that Dr. Duncan had forgotten that an angry man was generally an unjust man, and before he talked about Directors disgorging he should have satisfied himself that they had put anything into their pockets to disgorge.

Mr. ABRAHAM denied that he had said anything against the personal honour of Lord Aberdare.

After further discussion, Dr. Squire, Mr. Pilling, Dr. Duncan, Sir Jas. Lawrence and Mr. Bond were appointed to act with the committee elected at the creditors' meeting. It was stated that there was some doubt whether Mr. Bond had consented to serve on the creditors' committee.

The following is an abstract of the summary of the statement of affairs of this Company at May 17, 1893, the date of the winding-up order, and the Official Receiver's observations thereon:—

After alluding to the proceedings in Court, before the winding-up order was made, the Official Receiver states that the business of the Company has been divided into two branches:—

(*a*) Electrical and general engineering and contracting, and dealing in electric goods.

(*b*) Dealing in patents, &c., in which connection the Company has been identified with the promotion of various other companies, which are referred to hereafter.

The Company's offices, branches, &c., are next set out, and these are followed by a recapitulation of the various Companies which Woodhouse and Rawson United (Limited) was established to amalgamate, which it is unnecessary here to set out. This is followed by a tabulated list of the persons who have constituted the Directorate of the Company from its formation, the date of their appointment, and the date of resignation. The table also gives the present share holding of these Directors, and the Directors' fees received. Sir Rawson W. Rawson, who joined the Board on August 5, 1889, received nearly £1,500 in Directors' fees, and has a holding of 70 Ordinary shares. Mr. F. L. Rawson received £932 Directors' fees, and claims to hold nearly 1,600 Ordinary shares and 4,350 Preference shares. The total amount of the present holdings of Directors is given by Mr. Stewart, the Official Receiver, as £4,500 in all.

The Official Receiver has examined the profit and loss account of Woodhouse and Rawson (Limited), on which a profit of £21,440 is represented to have been made for the year ending June 30, 1888, and discovers that a large portion of the profit arose by reason of the assumed value of various interests in other companies. So doubtful was the real profit that the auditors prepared a special report, the concluding paragraph of which is as follows:—"The accounts are in accordance with the books of the Company, but it is obviously impossible for us to be responsible for the net profit, having regard to the nature of the assets and the Company's interest in many trading concerns not yet fully developed, and without Stock Exchange quotations of their shares."

A balance-sheet of Woodhouse and Rawson (Limited), as at June 30, 1889, and a profit and loss account for the year ending that date, were duly prepared, the latter showing an apparent profit of £78,222. 3s. 6d.; the auditors do not appear to have been instructed to examine it until May of the succeeding year; their report is dated June 26, 1890, and the Official Receiver gathers therefrom that very grave doubts existed in their minds as to the reality of the profits, having regard to the sources (similar to those of the previous year) from which such profits were represented to be drawn.

The Official Receiver has not seen the accounts in the liquidation of Woodhouse and Rawson (Limited), which commenced in September, 1889, and, consequently, has at present no means of informing himself precisely to what extent the said profits have been realised; but he believes it is the fact that a large portion of them was illusory, and it may be necessary hereafter to apply for an inspection of the said accounts; in this connection Mr F. L. Rawson states that, although certain of the items treated as profit were not subsequently realised, the liquidators, on the other hand, received considerably more for their interest in the Elmore Companies than was taken credit for.

All the businesses taken over by Woodhouse and Rawson United (Limited) are stated by Mr. F. L. Rawson to have been profitable prior to the amalgamation, with the exception of the Woodhouse and Rawson Electric Manufacturing Company and the Woodhouse and Rawson Electric Contract and Maintenance Company.

A further tabular statement sets out the terms on which the various businesses taken over were acquired. £192,000 was paid for Woodhouse and Rawson (Limited), of which £93,278 was in cash; £15,000 for the Woodhouse and Rawson Electric Supply Company (Limited), (£2,500 in cash); £32,000 for the Woodhouse and Rawson Electric Manufacturing Company (Limited), (£9,000 cash); £6,000 for the Woodhouse and Rawson Electric Contract and Maintenance Company (Limited), (no cash); and £24,000 for C. L. Baker and Company (£5,000 cash), representing a total of £269,000, of which £109,778 was cash, £54,722 in Debentures, £42,820 in Ordinary shares, and £49,680 in Preference shares. The properties taken over were duly valued, and (including about 78 patents) £345,230 was the sum arrived at as the value of the various businesses, including £97,000 for goodwill, which amount appears to have been simply agreed.

The nominal capital of the United Company was originally £350,000, and was increased on February 2, 1891, to £550,000, divided into 50,000 Preference and 60,000 Ordinary shares of £5 each. The first prospectus, dated July 15th, 1889, states that "15,700 Ordinary and Preference shares have been applied for by the Directors and their friends, and will be allotted in full at par." The Official Receiver has been unable to verify this statement, except as regards about 12,000 shares, from the Company's records.

In November, 1889, the Directors issued a second prospectus, offering for subscription 10,000 Ordinary and 10,000 Preference shares at a premium of 5s. per share; also 400 debentures of £100 at a premium of £2 per debenture, being the unissued balance of the capital of the Company. This prospectus states that "The wisdom of the amalgamation is shown by the fact that already more business of a profitable character has been offered than the capital issued enables the Company to entertain, thus justifying the correctness of the view formed in fixing the amount of the Company's capital on its formation, and the Directors entertain with confidence the realisation of the prospects held out in the original prospectus."

In January, 1890, another prospectus was issued, offering for subscription 3,684 Ordinary and 6,866 Preference shares, at a premium of 5s. per share, and 289 debentures of £100 each, at a premium of £2 per debenture. This document states that "the prospectus, announcing the formation of the Company, was issued on July 15th last, since which time it has been exceedingly successful, and an interim dividend has just been paid for the period ending December 31, 1889, at the rate of 15 per cent. per annum on the Ordinary shares and 8 per cent. on the Preference shares in respect of profits realised since the formation of the Company. The prospects for the second half-year promise to be equally satisfactory, besides allowing for the carrying of a substantial portion of the profits to the reserve fund."

No further prospectus appears to have been issued until February, 1891, when, the nominal capital having been meanwhile increased, the Directors placed a further invitation before the public to subscribe for 20 000 Ordinary shares of £5 each, on which also it was stated that there was

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"no present intention to call up more than £2. 10s. per share," 10,000 Preference shares of £5 each, and £100,000 Five and a-Half per Cent. Debenture Stock, redeemable in ten years at £105, or at an earlier date (but at the same premium), with the consent of two-thirds of the holders of the stock. This prospectus states that "the objects of the issue are to provide capital for the constantly increasing business of the Company, and to carry out various additional proposals, including a contract for the lighting of a portion of the City of Paris, and further to enable the Directors to pay off the balance of the £75,000 deposited [as a guarantee fund] with the Company, which they can now do on advantageous terms." The Company paid only one half-year's dividend after the issue of this prospectus.

On November 30, 1891, yet another prospectus was issued, with a view of obtaining subscriptions for 10,000 Ordinary and 13,000 Preference shares of £5 each, and £50,000 Five and a-Half per Cent. Debenture Stock. With regard to the Ordinary shares, it is again stated "that there is no present intention of calling up more than £2. 10s. per share." Representations are again made in this document as to the flourishing state of the Company's business. These various prospectuses are stated to have been drafted by Mr. F. L. Rawson, and settled by the Board of Directors; in addition to the issue of the prospectuses to the public, subscriptions for shares, &c., were invited by means of advertisements in the leading newspapers. When new shares were issued the subscribers were made to pay up to the same point as original shareholders.

The Official Receiver's document sets out the further businesses which were acquired by the Woodhouse and Rawson United Company, including Jensen's Bell business, for which £2,050 in cash was paid; Thorne's Tachometer Patent, price £450 cash and £500 Preference shares; Mr. Jacob Bohn's instrument business, price £1,000, £929. 10s. in cash and £70. 10s. still owing; Messrs. King, Masterman and Terry's business at Union Foundry, Kidsgrove, for which £36,600 was paid, £5,000 in cash, £25,000 in Six per Cent. Debentures, and a further cash payment of £6,500 to clear a mortgage on the works; and, finally, Sargeant's Electric and Steam Launch Works, for which £1,000 in cash was paid. The two latter undertakings were acquired on a report by the Woodhouse and Rawson Company's then Manager, Mr. George North.

This statement is followed by a summary of the printed balance-sheets and profit and loss accounts prepared by the Company from the date of formation to July, 1892. The Official Receiver points out that in the accounts to June, 1890, in the items "Salaries, &c," amounting to a total of £25,269, includes a sum of £13,775, with which Mr. F. L. Rawson was credited, being a commission of 25 per cent. which he was allowed in terms of his agreement with the Company in respect of surplus profits that remained after the payment of 15 per cent. dividend to the Ordinary shareholders. No portion of this amount was received by him in cash.

At the same date a profit of £37,235 was claimed for the promotion of the International Okonite Company (Limited), which the Official Receiver regards as a very doubtful item, seeing that the Woodhouse and Rawson United Company immediately afterwards subscribed for shares and debentures in the Okonite Company for a very large amount, and at the date of the winding-up order held securities to the amount of £33,721. 10s (estimated to produce £22,057). On this occasion an Employé pension fund was formed, to which the Company contributed £1,000. Having regard to the facts above mentioned, the Official Receiver points out that it must be matter for further consideration whether the Directors were justified in treating certain of these profits as earned and divisible; whether Mr. F. L. Rawson was entitled to be credited with the above sum of £13,775; and whether the whole facts of the case were fully before the shareholders when they consented to part with the Guarantee Fund previously mentioned. It is pointed out that the International Okonite Company was only registered in June, 1890, and that therefore its prospects could only have been conjectured when the large sum of £37,235 was included as a profit in the balance-sheet to June 30, 1890.

In the balance-sheet to July 31, 1891, the Dividend Guarantee Fund disappears. This alteration was effected at a meeting of shareholders held in January, when it was represented that the company had attained to such a flourishing state that the retention in this fund was not further necessary. "Sundry investments" set out in this balance-sheet amount to £119,338. 15s., consisting largely of Elmore, Okonite, Epstein, and Phœnix Trust Shares, and the profits of the company for the year include a sum of £14,975 appreciation on shares in the Phœnix Trust Company, £35,145 treated as profit on the promotion of the Epstein Accumulator Company, £2,000 for services rendered in the promotion of the Ward Electric Car Company, £1,112 assumed profit on the holding of the Company in the Sociedad Española, and £2,640 an assumed profit in respect of certain assets acquired by the taking over of the Kidsgrove Foundry; £500 was added on this occasion to the Employés pension fund. The accounts for this year will form the subject of further inquiry as to whether the Directors were justified in declaring dividends out of profits, which could only be "estimated" and were to a large degree unrealised. Nothwithstanding the alleged prosperity of the Company during this period, the Directors found it necessary to borrow largely at 6, 6½, and 7 per cent. interest, and immediately after the date of the balance-sheet, and between the period of the annual general meeting in the following November, further large sums had to be borrowed at 6 and 7½ per cent. interest. In November, 1891, money had to be borrowed and in some cases at very high rates of interest. The dividend of 8 per cent. on this occasion was the last dividend the Company paid.

In the accounts to July, 1892, "Special losses" are set out at £69,531, which includes £14,473 by the Edison-Swan Lamp action, £17,784 loss at the Kidsgrove Works, and £37,274 loss on trading, &c. In December, 1892, the auditors of the Company issued a circular to the shareholders, in which they state that the books of the Company had not been balanced, owing to the fact that the Directors had not employed a sufficiently competent book-keeper. Owing to the manner in which the books were kept it was impossible for the auditors to complete the audit, and they state that a large number of the vouchers were missing, and that of the "investments" of the Company at that date amounting to £109,413 10s., 34,150 shares in the Epstein Accumulator Company were held by the Chairman (Sir W. W. Rawson), and the Managing Director (Mr. F. L. Rawson) as security for undertakings given by them on behalf of the Woodhouse and Rawson United Company in respect of contracts, rent, &c. The total loss for the year to July 31, 1892, appears to have been £122,198, even supposing that the securities and the sundry debtors realised the amount taken credit for, and that the stock goods in transit and expenditure on contracts in hand (amounting to £123,120) realised their full value. The actual nett loss for this year amounted to £129,765.

These accounts were received with great dissatisfaction by the shareholders, and at a meeting on December 22, 1892, a consultative committee was appointed to investigate the Company's affairs, and have since reported very unfavourably thereon. The Official Receiver proceeds to point out that the energies of the Directors were chiefly devoted to the promotion of companies, and that it is open to question whether they were justified in so engaging themselves, having regard to the fact that the first prospectus only contemplated the carrying on of an industrial business; and as regards the payment of dividends, it is possible that some claim may rest upon the Directors for reimbursement.

The statement of affairs of the Company prepared by the which follows was filed on November 30, 1893. No reasons which the Official Receiver thinks adequate, have been assigned for the delay which has taken place in submitting this statement. The statement shows liabilities as regards creditors of £14,713. 9s. 2d., and assets estimated to produce £44,349 17s. 5d., or an estimated surplus, after meeting the liabilities of the Company (subject to cost of liquidation) of £29,636. 8s. 3d. There is no unpaid capital liable to be called up. As regards contributories there is a total deficiency (again subject to cost of liquidation) of £477,957. 16s. 2d. There are 1,303 creditors, 1,300 debtors, and 1,683 shareholders.

The Official Receiver states that Mr. F. L. Rawson's transactions with the Company have been somewhat extensive and varied, and Mr. Stewart is not disposed, on the evidence before him at present, to accept as owing to Mr. Rawson the sum of £117. 0s. 6d. as the balance on the various accounts. A full investigation, the Official Receiver states, will probably disclose Mr. Rawson as a debtor of the Company.

The Official Receiver's report concludes with a careful statement of the total liabilities and assets of the Company, and is followed by the views of the Directors and other officials as to the present value of the assets. It will be observed that the assets are so valued as to make the Company appear solvent as regards creditors and leaves an apparent surplus for shareholders, but the Receiver for the debenture holders, who is now conducting the business, does not concur in this, and believes that it is doubtful whether the assets would realise sufficient to pay off all the claims of the debenture holders. In conclusion, the Official Receiver states that the books of account appear to have been kept in a very imperfect manner, and do not exhibit with sufficient clearness the past operations or present position of the Company, and that when the Receiver and Manager went into possession in March, 1893, the books were discovered to have been unposted from the previous December, and therefore the accuracy of all the Official Receiver's figures cannot at present be verified. There are a number of matters into which the Official Receiver proposes to make further inquiry, and it is intended to apply for a public examination of certain of the Company's officials.

Elmore's French Patent Copper Depositing Company (Limited).

A meeting was held on Wednesday at the Holborn Restaurant of the debenture holders and secured creditors of this Company, to consider a scheme of arrangement between the Company and its creditors. Mr. C. J. Stewart, the Official Receiver and provisional liquidator, presided. It was explained that the object of the scheme was, first, to satisfy the claims of the debenture holders and creditors of the Company; and, secondly, to resuscitate the Company, so that the reversion of assets might belong to the shareholders. If the scheme were adopted, those present must distinctly understand that it was not a scheme recommended by the Official Receiver. The scheme was adopted with one dissentient.

A meeting of the unsecured creditors was afterwards held, the Official Receiver again presiding, and on the motion of Mr. John Heal, seconded by Mr. Shurmer, it was decided to approve the scheme, subject to the sanction of the Court.

The shareholders of the Company subsequently held a meeting, under the chairmanship of the Official Receiver, and after some discussion the scheme was approved, subject to the sanction of the Court.

Swan United Electric Light Company (Limited).

The annual general meeting of the shareholders of this Company was held at the Westminster Palace Hotel on Wednesday, Mr. J. S. Forbes presiding.

The SECRETARY (Mr. H. Charles Gover) having read the notice calling the meeting, the report and accounts were taken as read.

The CHAIRMAN said: I will begin by dealing with the balance-sheet and profit and loss account, because, in view of a possible contingency, it has had to be made up rather in the nature of a final balance of our affairs to September 30th. I have an apology to make. The meeting is called three weeks later than it was last year, for a reason which, I think, when you know it, you will regard as satisfactory. We promised at the last meeting that measures should be taken with a view of combining the

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remnant of our business with the bulk of our investment in the Edison and Swan Company. The necessity of the running out of the patents, and the altered condition of things likely to arise when we are out of the baleful influence of protection, and are in the open air of free dealing, make it desirable that our affairs should be as compact as possible, and be managed as economically as possible. I think that all those reasons are well understood by the shareholders of both Companies, and during the interval the negotiations have proceeded between the Company and the Edison and Swan Company, and have now reached that stage at which, as far as we are concerned, our responsibility will end and that of the proprietors will begin. Briefly, What is the price which the Edison and Swan Company are to pay to the Swan shareholders for the remnant of their business not already included in the Edison and Swan Company? We thought the better plan was that two gentlemen interested in the Swan Company and two gentlemen interested in the Edison and Swan Company should have the necessary preliminary discussions, and should, if possible, arrive at some basis of agreement. That has been done. The matter is a good deal complicated by the relative position of the fully-paid shares and the partially-paid shares in the Swan Company, and therefore we asked Mr. Swan, who represents for the most part a holding in fully-paid shares, and Mr. Quilter, who represents more especially the partly-paid shares, to see what would be a fair method of dealing with the cake when you have got it to cut. Then, of course, we had to ascertain how big the cake was and the ingredients of which it would be composed, and whether it would be palatable. That involved another process. Sir John Lubbock, although not a Director of the Edison and Swan Company, was originally intimately connected with it, and was good enough, in conjunction with the Earl of Lichfield, a Director, to consider the question from the point of view of the purchasers. After rather prolonged negotiations a basis has been arrived at as regards not only what the Edison and Swan Company are prepared to give for this residuum, but how far the purchase price was to be divided between the fully-paid shares and those partially paid. It is rather too complicated to go into details, but it was not so easy to arrive at a conclusion; and the conclusion arrived at seems to be as equitable as is possible in a case where the factors are partly existing and partly problematical. Briefly, it is this: The Edison and Swan Company, in which we are interested to the extent of 60 per cent., agree to give £100,000 in the shape of a 4½ per cent. debenture stock, of course forming a first charge over their whole income. You yourselves, by that process, will put over your own heads £60,000 of 4½ per cent. debenture stock, and your partners in the Edison and Swan Company—who hold 40 per cent. of the interest—the original Edison Company, will put £40,000 over their heads. But dealing with the bargain it is to be remembered that £100,000 of debenture stock, of a first charge, as far as that amount goes, as against future risks and contingencies, is extremely safe-guarded compared with the rest of the capital, because, as you know, a debenture is a mortgage of the property, and the interest is cumulative, and assuming anything should arise to raise an issue between the two classes of capital it is quite clear that the one has a great advantage in respect to its priority, both for principal and interest over the other. As I shall have to present this matter, if it is approved, to the shareholders of both Companies, I have examined it, and being conversant with the difficulties of dealing with a positive factor in conjunction with a factor more or less impalpable and uncertain, I have arrived at the conclusion that it will be a very good bargain for both sides. First of all it will unite the two concerns, and secondly it will strengthen our hands as against the severe competition to which we are probably about to be subjected both in England and abroad, and it will effect certain economies which will be extremely advantageous to the united body. I will now proceed to the profit and loss account in order that I may explain how it is that it differs in some senses from preceding forms, and I will go to the credit side of the account first. The sales, less commissions and allowances, stand at £10,346, transfer fees and interest £646, the dividend on shares in the French Company £878, and the dividends on shares in the Edison and Swan Company £24,826. Now, I want you to observe the two next items: proportion of further dividends accruing to September 30, 1893, on the above shares, estimated at £6,000. That is brought in because the theory of this amalgamation is that it is to apply as from October 1st of this year. This Company, with its liabilities and income, &c., would be merged as from October 1st last into the accounts of the Edison and Swan Company, and that made it important to bring into the account an item which had not appeared before. We are creditors upon the Edison and Swan Company from June 30th to September 30th for dividend, and when the accounts are published of the other Company we shall find, I suppose, that that proportion of further dividends is an asset of this Company. Treating this as what I call a winding-up balance, it was necessary to bring that £6,000 into the accounts in order that there might be no asset when fusion took place, if it does take place, belonging to us which should not be kept by us and not form part of the assets to be transferred on the amalgamation taking place. The next item is "dividends received and due on shares in the National Telephone Company (Limited)." We had a considerable amount invested in Consols paying a very miserable rate of interest, and we thought it wise, when the price of those Consols reached a figure which got us out without a loss, to sell out and put the money into some undertaking which at all events would pay some reasonable dividend. The opportunity offered at that time to take shares which were about to be issued by the National Telephone Company, and as Mr. Quilter and myself both knew something of the position of that Company, we persuaded our colleagues to put the money into that as an investment which will return a reasonable dividend. It has paid 5 per cent. For the £25,000 invested in that Company, we have got 5 per cent. instead of 2¾ per cent. That will account for the item of transfer fees and interest showing a diminution, as against the corresponding figure in the previous year, when it was £1,168. You have to add those two together, and the result of the operation is shown, if you do that, to be £1,700 instead of £1,168. I do not think I need dwell more on this side of the profit and loss account, except to bring you down to the item of "balance of suspense accounts — law costs." Unfortunately, ever since the initiation of the lamp business, we have been more or less in litigation—patent fights, &c., and solicitors have a very bad habit of not sending in accounts to date, so there is always a running account. The thing was very complicated from the fact that the Edison and Swan Company and the Swan Company in much of this litigation were partners, and it has only been recently, upon a final account being delivered from the solicitors of these law costs, extending over several years, both in this country and Germany, and the proper attribution of the amount to the two Companies, that we have been able to state the accounts properly as between them; and the agreeable position in which we found ourselves was this—that in our former accounts, as presented from year to year, the aggregation of over payments amounted to £2,300, part of which was revenue and part capital, and, therefore, we have credited the profit and loss account with a balance of £800 over paid by us in former years from revenue. If you carry your eye down the balance-sheet you will see that the costs represented by patent rights, &c., £328,563, have been diminished by £1,500, the amount over estimated for legal charges paid out of capital. We have now, therefore, our account clear of that item, and it amounts to this—that in the aggregate sums paid by the two Companies we have debited ourselves with £2,300 more than was fairly attributable to us, and we have now got that money back. With regard to the item of stock on September 30th last, it represents the value of the stock of lamps, platinum, and other apparatus in store at the end of our year. If you carry your eye up to the top of the debit side of the profit and loss account you will find that we began the year with a stock amounting to £14,654. It is quite certain that in this lamp business stock in hand must always form a very serious item in the balance-sheet, and one which may well be the subject of a good deal of anxiety. I have had to explain before that, having a large business in lamps, it cannot be carried on without an enormous number of various types of lamps in stock, and the number of different types and depots, agencies, &c., that we have to maintain involves a very large amount of money locked up. I suppose that would be one of the difficulties of a small manufacturer. This £8,507 only represents the stock we have at Kalk, in Germany, where our business is now confined exclusively to Germany. By agreement with the French Company we are precluded from selling lamps in any other part of Europe than Germany, and it takes £8,500 of stock in lamps to keep our customers going, who from day to day want this or that type of article. In Great Britain it is, of course, a much larger amount. It is proportioned, in fact, to the amount of lamps sold in the course of a year, and the proportion sold in Germany is very much smaller than that sold in Great Britain. However, it is satisfactory to see that during the year to September 30th we have been able to work the stock down from £14,654 to £8,507. That has been done partly by disposing of it and partly by writing down the value of it in the books as carried over. A certain amount must therefore be written off for depreciation. I think I can present the accounts now as being in a most wholesome shape, and as showing if we do go into partnership with the Edison and Swan Company what we reserve for ourselves in the nature of profits already accrued but not yet announced in the accounts of the Edison and Swan Company. The purchases, the salaries, the wages, and expenses at the factory are all set out, and the balance is then given of £28,877. That balance is made up largely, as you see, of the contribution by way of dividend on the shares held by this Company in the Edison and Swan Company. That dividend shows a falling off of £12,200, as compared with the preceding year. I am afraid complications arise from people having their money in two pockets. They forget the relations between one pocket and another. During the last few years the Edison and Swan Company paid on the face of the accounts very large dividends, but these were made up of two elements—the 7 per cent. to which the A shares were entitled out of the profits of the particular year, and the payment in respect of that 7 per cent. during the years when it was not earned; and as long as those accumulations of between £130,000 and £140,000 were being paid off, it meant a very large dividend on the face of the accounts. Last year, for the first time, we were enabled to wipe out the balance standing to the debit of that arrear, and to carry over a considerable sum which had to be distributed between the Edison and Swan A and B shareholders; but the dividend, under those circumstances, distributed was 10 per cent., and in comparison with the dividend in the preceding year, shows £12,000 less than in 1892, when the item of unredeemed arrears was so considerably greater. Now, going to the balance sheet itself, the share capital stands exactly as it did. The item of sundry creditors is £2,943. That item last year was £5,000, and now we have managed to pay cash and reduce it to about £3,000 in round figures. The balance from previous account is £6,825, and the balance on September 30th last, brought down from the profit and loss account, is £28,877, making together £35,702, available. We paid a dividend for the six months ended March, 1893, at the rate of 5 per cent. per annum, which absorbed £9,376, and what we propose to pay to-day is enough to bring up the dividend to 7½ per cent. for the year. That will take £18,013 and leave £8,312 to carry forward. We have suggested that because the £6,000 proportion of further dividend accrued to September 30th last on our Edison and Swan shares, although pretty safe, is not yet in our pockets. It will not be ours until the accounts of the Edison and Swan Company are made up. That is why we feel that we should carry forward now £8,312, instead of £6,824, as we did last time. On the other side of the balance-sheet there is the value of what our capital is invested in:—Cost of patent rights, represented by shares in Edison and Swan United Electric Light Company (Limited), with £208,478 paid; shares in La Compagnie Générale des Lampes Incandescentes with £30,489. 8s. 3d. paid; patents held by the Company for Germany, &c., as per last balance-sheet, £328,563. That is reduced by the £1,500 that I have mentioned overpaid on account of law

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charges. That brings the item down to £327,063. In order to impound that £6,000 accrued dividend on our Edison and Swan shares to which I have referred, and keep it in our pocket instead of having to transfer it in the event of this arrangement coming off, we show it in the balance-sheet. Then there is the outlay on factory, plant, &c., £1,570; and sundry debtors figure for £33,772. That is very satisfactory when you look at the item on the other side of the balance-sheet of sundry creditors, which stands in round figures at £3,000. That shows a surplus of debtors, all good, over creditors of £30,000. That is explained by the fact that we cannot afford to let our money lie idle, and we are obliged to invest it. We have invested £20,000 on Stock Exchange loans, and instead of getting 1 per cent. or 1½ per cent., we get 2 per cent. or 2½ per cent. We have also lent the Edison Company £10,000, and those two sums mop up the £30,000. With regard to our investment of £25,000 in the Third Preference shares of the National Telephone Company, those shares now stand at a modest premium, but, although fully aware of the danger of prophesying, if it turns out wrong, I have no hesitation in saying that these shares are worth a great deal more than their present premium. Cash on deposit and in hand brings me down to the final entry. If you had before you the balance-sheet of the preceding year you would have seen that we have got rid of £29,000 of Consols and £5,000 of Prussian Consols. We got out of the Prussian Consols at a profit, and out of the other Consols at about their cost price, and the money is now in your pockets, partly in the shape of cash, and substantially in the shape of this investment in the National Telephone Company. I will now conclude by moving—

"*That the report and accounts for the year ended September 30, 1893, be received and adopted.*"

The DEPUTY-CHAIRMAN (Mr. Quilter, M.P.) seconded the motion.

Col. STROUD stated that in the two Companies the assets shown for patent rights amounted to £700,000. Those patent rights, however, as he understood, ceased to have any effect on November 11th, and did not represent a farthing of value. In their own case the proportion roughly was about £300,000. Would it not be better, as that asset was practically not worth a penny, as he understood it, to expunge it, and show only any real assets that they possessed?

The CHAIRMAN: The two sets of accounts show a discrepancy. The capital of the Swan Company was shown in the balance-sheet as £375,000, and the capital of the Edison and Swan Company was shown in their balance-sheet at about £350,000. Of the £350,000 standing in the balance-sheet of the Swan United Company, as shown on the credit side of the balance-sheet, they had £208,000 in shares of the Edison and Swan Company, and £30,500 in shares of the French Company.

Col. STROUD said that there were other assets that were valuable, but he considered that it would be better to expunge those assets that were simply in the air and to show only assets that were real and substantial.

The CHAIRMAN said that if the agreement in question were carried out the whole of the capital of the Swan United Company, now shown in the balance-sheet, £375,000 would disappear. The capital of the amalgamated undertaking would stand at £350,000, *plus* the £100,000 to be paid to the Swan Company as mentioned. The amalgamated capital would, therefore, not be £700,000, but £450,000. What this Company had got now was the amount of capital invested in the whole business, including some other advantages, the £30,000 odd in the French Company, and the fact that they would be enabled on the expiration of the agreement with the French Company at the end of next year to remove the restriction for selling lamps all over Europe. By that agreement their sale of lamps was now confined to Germany. He was not able to say at present that it would be the case, but he thought it was quite on the cards that their partners of the French Company would see that it would be advantageous for them to remove the restriction in question. With regard to the Edison and Swan Company, they were not free to export lamps from Great Britain.

Col. STROUD asked whether the Edison and Swan Company's patent held good or whether any one could infringe it.

The CHAIRMAN stated that the lamp patents were gone, and for the £450,000 which he had mentioned they would have their lamp business not only in Great Britain but in all Europe and the world, because, the two Companies being together, the bar of exportation would be removed. The question was, was the £450,000 a sum that was likely to be covered?

Col. STROUD said that, with all deference, he thought not.

The CHAIRMAN said that the Directors thought it would be, but he was not going to give any pledge on the point. They had often said that the whole policy of the Company was built up on the vital fact that the protected period would end at a given date, and therefore their business was first of all to exercise the opportunity of protection to turn out the most efficient article. They had a monopoly of all the scientific information that came up during those years. They had had that advantage, they possessed the best factory in the world, and they had not limited themselves to the lamp business.

Col. STROUD stated that the Germans were at the present time importing lamps which he could buy at a shilling. He had made inquiries on the subject, and he heard that the Edison and Swan lamp was so superior at the present time that the vendors did not like to quote any other lamp.

The CHAIRMAN stated that they were perfectly well aware of the quality of other lamps that had been produced, because they had bought and tested them. He had not yet discovered that they made lamps in Germany cheaper than we could, although it was perfectly true that they had advantages in Germany which we had not here. They had been playing off their factory in Germany against their factory in London, and they found that the result in London was rather more satisfactory than it was in Germany. The matter turned on quantities. With regard to the quality of the lamp, Mr. Edison had a great name, and they had under their arrangement the opportunity of obliging their customer with any lamp—the Edison or the Swan. Any customer of theirs could have an Edison lamp made in New York at the same price as he had a Swan lamp made for in London; and the Edison lamp had disappeared, although, possibly, it would come back again. With regard to German lamps, he had no doubt that a great many of them would be sold in England at a very low price. The large stocks held in Germany could not be held without depreciation; and, as a matter of fact, they knew that all the refuse stock in Germany had been bought by speculators, and would be sold here as first-class lamps. When it was a question of an efficient lamp, he certainly thought they could hold their own against their German friends. What they hoped to do was to make up for the diminished profit on the limited quantity of lamps they had made during the protected period by the manufacture of an enormously increased number of lamps, which, though sold at a lower price per lamp, would make up for the difference in the profit. They had found as they went along that the lamp was not the only element to consider; there was the installation business—the holders, the switches, the fittings, and things of that sort, in connection with which they had some extremely valuable patents, which had several years to run. They had licensed many of the leading firms of manufacturers, who paid the Company a royalty. Their profit in future years would not depend exclusively on the lamp. They had reduced the price of the lamp to a nominal 1s. 9d. They gave a trade discount of 12½ per cent., according to quantity; and to large consumers—those who took 5,000, 10,000, or 20,000 lamps, the net price was only 1s. 5d. Concurrently with the enormous expansion now going on in electric lighting, their speculation was that *qua* the lamp, they would multiply the production enormously, and *qua* the other things, they had a business which, in the nature of it, must also be profitable.

Mr. F. W. REYNOLDS said he desired to confirm the remarks made by the Chairman. It appeared to him that when they offered an Edison lamp or a Swan lamp they would be able to command a much higher price. They had had 14 years' experience, and the benefit of Mr. Swan's constant experiments; and he (the speaker) had no doubt that Mr. Swan's name would insure the continuance of the business. He desired to know how they would stand in regard to the liability of 30s. a share on their shares if the proposed amalgamation was carried out.

The CHAIRMAN said that there would be, under the arrangement, a wiping-out of capital; but this was of no consequence, because they would retain their profit-earning power, and whether the capital was more or less, the amount available for dividend would be the same. With regard to the liability of 30s. a share upon the Swan shares, it represented a great deal more than the £2 a share on the shares in the Edison and Swan Company, and to the extent of the difference they would escape this liability. He did not see himself, however, that in either one or other case there was any immediate fear of new capital being required. In answer to a question of Col. Stroud, the Chairman added that the competition, prospective and potent, up to the present time since the termination of the protected period was not at all appreciable. He believed they were quite safe in the transition period. He afterwards called attention to a circular regarding the proposed amalgamation which had been issued by Mr. Quilter and Mr. Swan to the fully-paid shareholders, and stated that up to the present, out of 19,750 shares, assents to the scheme had been received from holders of 14,896; the holders of 4,854 had not responded. On the scheme being carried through application would be made to the Stock Exchange for a quotation. He would present the plan in due course to a meeting of an aggregate body of the shareholders.

The resolution was then put to the meeting, and carried unanimously.

The CHAIRMAN afterwards proposed the following resolution:—

"*That in addition to the £9,376. 15s. 9d. already distributed in respect of the six months ended March 31, 1893, a further sum of £18,012. 19s. be divided, free of income-tax, to be distributed in accordance with the provisions of Clause 77 of the Articles of Association, making a total distribution for the year of £27,389. 14s. 9d., being at the rate of 10 per cent. for the half-year, and making 7½ per cent. for the year ended September 30, 1893.*"

Mr. QUILTER seconded the motion.

The CHAIRMAN put the resolution, which was carried, and he stated that the warrants would be received by them on the 23rd inst.

Mr. Quilter and Major S. Flood Page were re-elected as Directors, and Messrs. Welton, Jones and Co. as auditors.

A vote of thanks to the Chairman and Directors terminated the proceedings.

The report above referred to is as follows:—

The profit and loss account for the year shows a credit balance of £28,877. 9s. 6d., which, together with £6,824. 17s. 9d. brought forward from the last account, leaves disposable the sum of £35,702. 7s. 3d. An interim dividend in respect to the first half of the year, amounting to £9,376. 15s. 9d., has already been paid. The Board proposes that a further sum of £18,012. 19s. be divided (free of income-tax), and that £8,312. 12s. 6d. be carried forward. This is equivalent to 7½ per cent. per annum on the partly-paid, and of rather less than 7½ per cent. upon the fully-paid, shares. The shareholders are reminded that Messrs. Quilter and Swan were deputed to meet Sir John Lubbock and the Earl of Lichfield, acting for the Edison and Swan United Company, with a view of suggesting a basis on which an amalgamation with this Company could be effected. The basis having been generally agreed upon, it became necessary to ascertain in the first instance whether the fully paid-up shareholders of this Company are prepared to accept the terms. Messrs. Quilter and Swan have now by circular addressed each fully-paid shareholder with a view of ascertaining whether they approve of the amalgamation of the companies on the arranged basis. As soon as this has been ascertained the matter will be brought before the partly-paid shareholders, and, if approved, a general meeting will be called to give effect thereto.

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The Exploration Company (Limited).

The annual meeting of this Company took place on Tuesday at the Cannon-street Hotel, under the presidency of Sir Horace B. T. Farquhar, Bart.

The CHAIRMAN, in proposing the adoption of the report, said: Gentlemen, the reason why a long interval has occurred since our last meeting is that we hoped and wished to announce to you that the issue of the Central London Railway had been made. But that was found impossible, in the first place, because the approval by the Commissioners of Sewers of the City of London of the plans for a central city station and public subways at the Bank was only obtained in June, and, secondly, because since then financial conditions in London have been so distinctly unfavourable that it has been deemed prudent to defer this issue. You will have seen that we recommend the payment of about £12,000 in dividends. If you endorse our recommendation, the Exploration Company will then have distributed altogether £67,600 in dividends on a paid-up capital of £30,000. The first business mentioned in the report is the Central London Railway, the most important enterprise with which the Exploration Company has hitherto been connected, and one which we trust to bring to a successful termination. The line meets with a great want of the people of London, and from all the close study to which we have subjected it, we are confident that it will be enormously patronised. A heavy traffic is waiting for it, and the working by electricity should be cheap — cheaper than by steam. These two factors make us feel assured that this line will be a large and lasting dividend-earner. We have, in fact, the very highest opinion of its earning capacity. Whenever, in great cities, means of quick transit have been afforded directly on the established lines of traffic—and not at some distance from them—the financial results have been brilliant. The engineers state from actual experience that the construction will not take long; the streets will not be opened up nor the traffic stopped. The authorised capital is £2.850,000 in shares, and £950,000 in debentures, which, we believe, will be ample for all purposes. We consider it of mutual advantage to have obtained of the City authorities the approval of our plans for dealing with the central part of London, between the Royal Exchange, the Bank of England, and the Mansion House. The vehicular traffic at that well-known centre has, as you know, to be stopped constantly. The City authorities have to face the daily problem of regulating the overgrown traffic—an ever-increasing difficulty. The proposed subways will it is hoped, remedy this congestion; they will be made and maintained by the railway company, but open to the public. This arrangement will be of material benefit to the City, while, on the other hand, the right of the railway company to construct its principal City station under that most desirable place is confirmed. and the station becomes accessible from all sides. The Chairman afterwards referred with satisfaction to the important interest which the Company had in deep-level mining in South Africa.

Mr. F. A. LUCAS seconded the motion, which was adopted, and the dividends recommended were afterwards approved

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The Telegraph in South Africa.

The Duke of Abercorn presided over the third annual meeting of the British South Africa Company, which was held on Tuesday at the Cannon-street Hotel.

In their report the Directors said:—"The amount expended in telegraph construction during the year is £392. 7s. 3d., making the total cost of the Company's line to March 31st, 1893, £93,201. 1s. 2d. The whole line from Mafeking to Salisbury, 819 miles in length, is working well; but it has been found necessary to renew a large number of the wooden poles in the Nuanetsi-Salisbury section owing to the ravages of the white ant. The increase in the cost of maintenance from £2,137. 15s. 1d. last year to £4,242. 16s. 2d. this year is largely due to this cause. It is expected that the expenses of the Company's telegraph service will be reduced next year, as arrangements have recently been made with the Postmaster-General of the Cape Colony for the management and superintendence of the line. He now controls the telegraph clerks and undertakes all technical management, while the expenditure remains under the control of the Company's Managing Director in South Africa. This arrangement is a satisfactory one for the Company. It will be remembered that Mr. Rhodes, at the general meeting last year, brought forward his scheme for a transcontinental telegraph. Since that date, with the support and authority of this Company, a Company, called "The African Transcontinental Telegraph Company, Limited," has been formed, and sufficient material has been shipped (and is now in Africa) to extend the telegraph system from Salisbury to Zomba in Nyasaland. The British South Africa Company cannot fail to benefit largely by this extension. Although erected by an independent company the new line will not only increase the traffic over the Chartered Company's own line, but will connect the latter Company's field of operations North and South of the Zambesi.

The CHAIRMAN, in the course of his remarks in moving the adoption of the report—which was agreed to—said: Mr. Rhodes, in his speech last year, fully explained his views respecting a transcontinental telegraph. A Company has since been incorporated under the title of the African Transcontinental Telegraph Company (Limited), with the cordial support and authority of your Directors. We have not, however, thought it expedient on behalf of the Company to subscribe for shares or render any purely financial assistance. You all individually have had an opportunity of subscribing for shares, as have the shareholders in other companies with which Mr. Rhodes is associated.

NEW COMPANIES, STATUTORY RETURNS, &c.

ACME AND IMMISCH ELECTRIC WORKS (LIMITED).—This Company was registered on December 16, 1893, with a nominal capital of £25,000, divided into 20,000 Ordinary and 5,000 Preference shares of £1 each, to acquire the undertakings, businesses, and assets of the Acme Works, of Chalk Farm, London, N.W., and of the General Electric Power and Traction Company (Limited), of Kentish Town, London, N.W., with a view to such acquisition to enter into and to carry into effect the following agreements:—(1) Dated August 15, 1893, between Francis Teague and Russell Aitken of the first part, John A. Iliffe of the second part, and James Renwick (on behalf of the new Company) of the third part; (2) with the General Electric Power and Traction Company (Limited); and (3) with the Electric Construction Company (Limited), to generate, accumulate, distribute, and supply electricity for the purposes of light, heat, motive power, or otherwise, and to carry on the business of electrical and mechanical engineers, electricians, and manufacturers of and dealers in machinery, stores, appliances, and apparatus of every description applicable for or in connection with the supply or use of electricity. The subscribers are:—

Sir Henry C. Mance, C.I.E.	10	Pref. Shares.
Moritz Immisch	10	„
William Bullock	10	„
James Gray	10	„
Emile Garcke	10	„
Thomas Smith	10	„
James Renwick	10	„

The first Directors are to be appointed by the signatories above.

NEW PANULCILLO (LIMITED).—This Company was registered on December 16th, with a capital of £50,000, in £1 shares, to enter into and carry into effect an agreement, dated December 15, 1893, and made between the Panulcillo Copper Company (Limited) and Sir John Pender, G.C.M.G., M.P., Francis J. Johnston and Frank W. Bond (the liquidators of the said Company), and George Mountier (for this Company), whereby this Company purchases the copper mines and smelting works, situate at Panu'cillo, in the Province of Coquimbo, Chili, and to carry on the business of raising, crushing, smelting, washing, reducing, amalgamating, working and winning ores, metals, minerals, &c. The number of Directors is not to be less than three nor more than seven. The first are:—Sir John Pender, Francis J. Johnston, J. Denison Pender and R. S. Archbold.

"LIGHTNING" (LIMITED).—The annual return of this Company, made up to December 8th, has been filed. The nominal capital is £3,000, divided into 2,400 Ordinary and 600 Founders' shares of £1 each. All of these have been taken up, and 300 Founders' shares have been issued as fully paid. Upon 1,815 Ordinary and 226 Founders' shares the full amount has been called, and upon the remaining 585 Ordinary and 74 Founders' shares a call of 5s. per share has been made. The calls paid amount to £2,205. 15s.

MATHER AND PLATT (LIMITED).—The annual return of this Company made up to November 4th has been filed, when 15,000 out of a total of 20,000 £10 shares were taken up. Upon these shares a call of £9 per share has been made, resulting in the payment of £135,000.

NATIONAL COMPANY FOR THE DISTRIBUTION OF ELECTRICITY BY SECONDARY GENERATORS (LIMITED).—The annual return of this Company made up to November 1st has been filed. The nominal capital is £500,000 divided into 3,000 Preferred and 47,000 Ordinary shares of £10 each; 2,669 Preferred and 20,000 Ordinary have been taken up and allotted, of which 1,000 of the former class and all of the latter have been issued as fully paid. Upon the remaining 1,669 Preference shares a call of £10 per share has been made, resulting in the payment of £17,690.

CITY NOTES, &c.

AFRICAN DIRECT TELEGRAPH COMPANY (LIMITED).—The coupons of this Company's Four per Cent. Mortgage Debentures, to bearer, due on January 1st, will be paid on and after that date at Parr's Banking Company and the Alliance Bank (Limited), Bartholomew-lane, London, E.C. Warrants for interest on the registered debentures will be sent out on the 30th inst.

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ended December 17th were £905, as against £918 for the corresponding period of last year, being a decrease of £13. The total receipts for the half-year amount to £20,037, as against £19,894 for the corresponding period of 1892, an increase of £143.

DEATH OF MR. W. W. DUNCAN.—Mr. William Wallace Duncan, whose name is well known in connection with "Duncan's Tramway Manual," died in London, last week, after a long illness.

LIVERPOOL OVERHEAD RAILWAY COMPANY.—Notice is given that the first call of £2 per share on the second issue of Preference shares in this Company is payable on January 9th next.

GREAT NORTHERN TELEGRAPH COMPANY.—The coupons falling due on this Company's shares on January 1st will be paid at the office of Messrs. C. J. Hambro and Sons, 70, Old Broad-street, E.C., where lists may be obtained. Coupons must be left three clear days for examination.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the week ending December 15th (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £3,215.

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WEST COAST OF AMERICA TELEGRAPH COMPANY.—This Company announce that the coupons due on December 31st on the Company's debentures will be paid by Messrs. Barclay and Co., bankers, London, E.C., and that coupons should be left two clear days for examination.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the two weeks ended December 15th were £2,692, as compared with £2,510 for the corresponding period of last year. The receipts for August estimated at £3,587, realised £3,608.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price, Dec. 13.		Price Wednesday, Dec. 20.		Rate per Cent. Yielded. £ s. d.	Dividend Due	Business Done During Week Ending Dec. 20. Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	12/6	Anglo-American	42	44	42	44	6 5 0	Jan., Apr., July, Oct.	..	..
£2,932,680	Stock	25/0	Do. Preferred	81	82	80½	81½	6 15 0	" "	81¾	80½
£2,932,680	Stock	5/0	Do. Deferred	7½	8	7¼	7¾	..	..	7¾	—
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	101	104	101	104	3 16 11	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine xd	11¾	12¼	11¾	12¼	5 6 1	Mar., June, Oct., Dec.	12 1/16	12
£18,700	£100	5%	Do. 5 per Cent. Bonds	101	104	101	104	4 16 2	January and July ..	..	—
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	108	112	108	112	4 9 3	June and December	—	—
10,000,000	$100	7%	Commercial Cable Capital Stock xd	140	150	140	150	4 13 4	Jan , Apr , July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11½	12½	11½	12½	6 8 0	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October..	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	..	..
60,710	20	8/6	Direct United States Cable, 1877	11⅜	11⅝	11⅜	11⅝	6 0 2	Jan., Apr., July, Oct.	11⅝	11½
400,000	10	2/6	Eastern	15	15¼	15	15¼	4 5 3	" "	15¼	15
70,000	10	6%	Do. 6 per Cent. Preference	15½	16½	15¾	16¼	3 13 10	" "	15 11/16	..
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	—	..
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	108	111	108	111	4 10 1	February & August	..	..
250,000	10	2/6	Eastern Extension	15½	15¾	15½	15¾	4 8 11	Jan., Apr., July, Oct.	15¾	..
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	114	117	114	117	3 8 5	February & August	117	..
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103	106	103	106	4 14 4	January and July ..	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	103	106	103	106	4 14 4	" "	..	—
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103	106	103	106	3 15 6	February & August	..	—
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	106%	109%	103%	109%	3 13 5	May and November	..	..
180,227	10	1/6	Globe Telegraph and Trust	8⅝	8⅞	8½	8¾	5 2 10	Jan., Apr., July, Oct.	8¾	8 9/16
180,042	10	6%	Do. 6 per Cent. Preference	15⅜	15⅝	15⅜	15⅝	3 18 1	" "	15⅝	15½
150,000	10	5/0	Great Northern	20	20½	20	20½	4 3 0	Jan., April, and July	20½	..
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 14 4	March & September	..	..
17,000	25	12/6	Indo-European	40	43	40	43	5 16 3	May and November	..	—
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	3 6 8	" "	..	—
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	105	108	5 11 1	March & September	..	—
£100,000	£100	4%	Pacific European Telegh. 4% Guar. Debs. "Red" 1942	102	105	102	105	3 16 2	..	..	..
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October..	..	..
3,381	£100 Cert.	35 0	Submarine Cables Trust 6 per Cent.	113	118	114	119	5 0 10	" "	118	116
15,609	10	5/0	West African Telegraph	5½	6½	5½	6½	7 13 10	January and July ..	..	..
£249,900	100	5%	Do. 5 per Cent. Debentures	98	101	98	101	4 19 0	March & September	..	..
30,000	10	2/0	West Coast of America	2	3	2	3	..	January and July ..	2⅝	2 9/16
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	103	99	103	7 15 4	June and December	..	..
88,321	10	1/0	West India and Panama	1	1½	1	1½	..	..	—	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10½	9¾	10½	5 17 1	May and November	9⅞	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	108	111	108	111	4 10 1	June and December	110	..
64,242	15	4/6	Western and Brazilian	6	6½	6	6½	3 9 4	May and November	..	..
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5¼	5¾	5¼	5¾	..	..	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¼	1¾	1¼	1¾	..	..	—	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	103	106	103	106	5 13 2	February & August	—	..
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	103	106	103	106	5 13 2	" "	..	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	105	102	106	5 13 2	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	—	..	
224,850	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	1/8	1/16	3/16	..	May and November	..	—
220,000	£1	4·76d.	Oriental Telephone and Electric (11s. paid)	¼	..	¼	..	6 7 9	Yearly	..	—
484,597	5	2/6	National xd	4¼	5	4⅜	4⅞	5 2 7	June and December	4 13/16	4 11/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref. xd	14	15	13½	14½	4 2 9	" "	..	..
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid) xd	13¼	14½	13	14	4 5 9	" "	..	—
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref. xd	5¼	5½	5⅛	5⅜	4 13 0	..	5 5/16	..
925,017	£100	4½%	Do. Deb. Stk. 4½%	113	115	113	115	3 18 3	January and July ..	114½	113½
58,000	5	1/0	United River Plate	2	2½	2	2½	..	January and July ..	..	..
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	..	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11½	11¾	11½	11¾	—	—	11½	..
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	10¾	13¼	12¾	13½	..	—	13 3/16	13
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	—	..	—
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	—	—
8,322	£5	..	House to House Electric	..		..		—	—	—	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		..	..	—	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July ..	—	—
30,000	£5	1/9	Liverpool Electric Supply (£3 10s. paid)	4¼	4¾	4¼	4¾	..	—	—	—
15,000	£5	2/6	Do. (fully paid)	6¼	6¾	6¼	6¼	..	—	..	—
111,000	5	..	London Electric Supply	¾	1	¾	¾	.	..	..	—
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	7¾	8¼	7¾	8¼	2 8 5	..	8 1/16	—
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	103	106	103	106	4 14 4	June and December	..	—
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	—	—	..	..
19,980	£5	9½%	St. James' and Pall Mall	5¼	6¼	5¼	6	..	—	5⅞	5½
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	7¾	8¼	4 4 10	—	8¼	—
59,900	5	1/6	Westminster Electric Supply (fully paid)	5	5½	5	5½	3 3 8	—	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	2/1	Brush Electrical Engineering	2⅝	2⅞	2⅝	2⅞	6 5 8	—	2¾	2⅝
90,000	2	6%	Do. 6 per Cent. Preference Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	—	2¼	2⅜
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	105	107	105	107	4 4 1	March & September	..	..
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	4	4½	4	4½	..	January and July ..	..	..
12,139	5	..	Edison and Swan United	—		—		—	—	..	—
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	—	..	..
49,900	10	12/0	Electric Construction	..		½	1	..	—	1⅛	..
91,195	2	10/0	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜	—	—	—	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	—	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21½	22½	21½	22½	5 11 1	February & August	22¼	22 1/16
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	..	—	—
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	—	—
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/0	4/0	3/0	4/0	..	..	—	..
78,949	5	1/9	Swan United (£3. 10s. paid)	2	2½	2¼	2¾	..	May and November	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	36	38	36	38	4 9 1	March and July....	37	36½
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	104	107	105	108	4 12 7	January and July ..	106½	..
37,514	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		—	—	—	—
41,098	£5	..	Do. Preference (fully paid)	..		..		—	—	—	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	3%	City and South London Railway	28	33	28	33	2 5 5	May and November	..	—
37,500	£10	—	Liverpool Overhead Railway	5½	5½	5	5½	—	—	—	—

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THE ELECTRICIAN:

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NOTES.

In our last issue we published some data relating to the working of the Cologne municipal central station, and called attention to them in an editorial note, thinking, with Mr. Crompton, that they were "interesting as showing the best figures that have as yet been obtained in Germany." Mr. Crompton, however, in a letter which will be found in our Correspondence columns this week, is evidently inclined to think that we wished to draw invidious comparisons, and award the palm for good engineering and careful central station management to the Germans. The English figures quoted were merely made use of so as to give an idea of the relative total costs of generation per unit in London and in Cologne, and we are glad to find that whilst Cologne beats London, Bradford and Liverpool redress the balance.

There are, however, two completely different aspects to this burning question of coal consumed per unit delivered and total cost of generating a kilowatt-hour. The shareholder of a company or a potential rival concern merely looks at the difference between the selling price and the total cost of manufacture; the one with a view to dividends, the other with a view to cutting-in; in neither case is the relative importance of the various items that go to make up the total cost of supreme importance; the shareholder, indeed, does not care one jot how it comes about that a commodity is manufactured at threepence and a fraction, so long as its selling price leaves a sufficient margin of profit. On the other hand, if anyone is bold enough to set out on the task of appraising the engineering and management of a number of central stations running under a variety of conditions, numerous factors have to be taken into account before even a convenient approximation of the truth can be arrived at. For instance, Mr. Crompton states that coal at Cologne is about 11s. 6d. per ton, and that 11·8lb. are used per unit, whilst at Kensington the figures are respectively 20s. 6d. and 5·8; but until we know the calorific values of the two fuels, it would be somewhat premature to argue that fuel at Cologne was really cheap, or to imply that the large consumption was due either to the inherent defects of the system adopted, or of the plant employed, or to the lack of experience and care of the *personnel*.

The discussion on action and reaction which appears in our Correspondence columns arises out of an ancient paradox. Paradoxes might form an interesting study from the point of view of pitfalls in science, into which generation after generation of students stumble. We are inclined to doubt that the tendency of different minds thus to trip at the same spot is due to some mental defect, but rather that something is wrong with our method of teaching, of definition, or of nomenclature. As regards teaching, a distinction has too artificially been kept between statics and dynamics. In statics we are told that two equal and opposite forces balance one another, there is no motion, and there is therefore equilibrium. By a false process of reasoning it appears that whenever there are two equal and opposite forces there can be no motion, and further, that if there be motion, it must be due to a superfluous force. This paradox sometimes takes the form of a horse and cart connected by traces. It is argued that the forward pull of the horse on the trace must be greater than the backward pull of the cart on the trace, else there would be no motion. If this were the case, spring balances placed at the ends of the traces would show different forces, and we presume that advocates of this view would admit that the difference between the forces—that is, the resultant force—multiplied by the distance over which the cart moved in a second, would give the amount of work done by the horse. Or, as Prof. V. Boys put it at a recent meeting of the Physical Society—if a chain were used the stresses would differ on different links. As a matter of fact, the horse pulls the cart with precisely the same force that the cart pulls back on the horse. No work is expended in doing this. The whole of the force exerted by the horse, multiplied by the distance traversed in unit time, assuming the velocity to be constant, gives the work done on friction or against gravity.

Local conditions being so widely different, it would be useless to compare the American Institute of Electrical Engineers with the English Institution of Electrical Engineers, but the last number of the "Transactions" of the former body gives an analysis of the result of election of its members which is perhaps worth noting in connection with our leading article of last week. Five applications for transfer were reconsidered, three were approved, and two were disapproved. Twenty-six new applications for transfer were considered, of these thirteen were "laid over for further consideration," ten were approved, and five were disapproved. The names of candidates are printed in the "Transactions," 'endorsed" by three members each, "one month in advance of action by Council," so that if any objection be raised to

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proposed candidates members will have one month to file that objection to the secretary.

The three examples which we have selected for publication from Prof. E. L. Nichols's paper, and which will be found in another column, serve to indicate the wide field of usefulness of a wire heated by an electric current as a laboratory instrument, especially when combined with an apparatus for measuring temperature by means of electrical resistance. Both the readiness with which the temperature may be evenly distributed and gradually varied or adjusted at will, and the high degree of exactness in calibration, render these methods of considerable value in research work. In regard to the method adopted in the first-named experiment, we may remark that the temperature measurements being only relative, there was no need to assume any difference between the temperature of the coil and that of the substance which it enshrouded. But in more exact work, a thermometer might be inserted in the mass of the substance under test. Uniform temperature along the length of the test bar would require that the heating wire should be wound to an accurately constant pitch, and that the ends of the heating coil should project some distance beyond the ends of the test bar. This latter should also be arranged horizontally, and the irregular effects of convection currents should be prevented by suitable screens.

The Bimetallic Dynamo Company.—A company with this title and a capital of £10,000 has been formed in Paris to work the Reignier-Parrot patents.

Blackpool.—The Blackpool Tramway is being temporarily worked by horses. Mr. T. Parker and Mr. Holroyd Smith have both been engaged to inspect the line and plant, and to report thereon to the Town Council.

Governing Arrangements of Engines.—A special course of three lectures on this subject will be given at Finsbury Technical College by Mr. R. G. Blaine, Assoc.M.Inst.C.E., on Thursday evenings, from 7.30 to 8.30, commencing Thursday, January 18th.

Licensed Wiremen.—The New York Board of Fire Underwriters have, says the *Electrical Engineer* of New York, passed a resolution asking Governor Flower to have a law passed requiring persons desiring to do electric light wiring to pass an examination and to get a licence just as engineers have to.

Telephoning on Railways.—There are several instances in the United States where the telephone has superseded the telegraph in railway work. The latest case is in Indiana, where the Elkhart and Western Railway Company has erected a telephone line between Elkhart and Mishawaka in place of the telegraph.

The Anglo-American Telegraph Company and the Compagnie du Télégraphe de Paris à New York.—The action brought by the Anglo-American Telegraph Company against the Compagnie du Télégraphe de Paris à New York, which has been for so long before the Courts, was down for hearing before the Cour d'Appel de la Seine on Wednesday last.

Explosion at Glasgow.—Between 11 and 12 o'clock last Wednesday night an explosion occurred at the corner of Renfield and St. Vincent-streets, Glasgow. The accident is said to be due to a spark from one of the street cables igniting some gas which had escaped from a street pipe. The explosion resulted in two manholes being blown out. No one was injured.

The Telephone in Scotland.—The subscribers in the Scottish district of the National Telephone Company now amount to 10,167, being an increase of 1,143 over last year. The mileage of the Company in the district is 14,800, being an increase of 1,500 miles. The total number of conversations passing through the Company's system in Scotland is 29,000,000 in the year, being an increase of 11,000,000.

Massage and Electrical Resistance.—A singular property of massage is noticed by Dr. A. S. Eccles, who has discovered, says the *Electrical Review* of New York, that it indisputably decreases in a marked degree the resistance of the skin to the passage of electric currents. In this way the number of cells necessary in order to pass a given quantity of current through the skin, in cataphoric and other treatment, can be reduced.

Research Scholarship. — Mr. William Cecil Dampier Whetham, M.A., Fellow of Trinity College, Cambridge, has been elected to the Clerk Maxwell studentship in experimental physics. The student is required to devote himself, under the direction of the Cavendish Professor, to original research in experimental physics within the University. The studentship is tenable for three years, and its annual value is about £190.

Overhead Wires and Fire Escapes.—A somewhat serious fire recently occurred in Eliot-street, Boston, U.S.A., just at a point where there is a very thick network of overhead electric wires. While the firemen were handling one of the aerial ladders it came in contact with the wires, with the result that several of the firemen received severe shocks. This experience has stirred up the fire underwriters and fire commissioners to the point of demanding, for the twentieth time, that all wires shall be placed underground.

The Telephone in Germany.—According to the *Zeitschrift für Electrotechnik* the number of telephone stations in Germany, which was only 1,504 in 1881, had increased at the beginning of this year to 63,558, of which Berlin had no fewer than 17,424, with over 20,400 miles of lines. The inter-urban telephonic service is also increasing very rapidly, and there were at the beginning of the year 310 long-distance telephones, with 14,280 miles of lines, the longest direct line being that between Berlin and Breslau, which is nearly 200 miles.

The St. James and Pall Mall Electric Light Company.—We learn that complaints have been made to the St. James Vestry that scalding water and steam have been turned into the sewer, *presumably* by the St. James and Pall Mall Electric Light Company, and a certificate has been received from ten inhabitants that offensive effluvia are emitted from the chimney shaft of the generating station in Mason's-yard. Whether the Vestry will take any action or not depends upon what report their solicitors may make upon the papers submitted to them.

The Académie des Sciences Prizes.—At the annual general meeting of the Académie des Sciences, on December 18th, the La Caze physiological prize was awarded to M. d'Arsonval for his researches on animal heat and electricity, and the Gaston Planté prize was awarded to M. Blondlot, professor at the Nancy University. M. Blondlot has devoted his time of late to the study of Hertzian oscillations. In the department of electrical research the Gaston Planté prize will be awarded in 1895 for an invention or an important work in the province of electricity.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
Jamaica-Colon	November 25th.	December 26th.
Kotonou-Accra	December 4th.	December 27th.
Cayenne-Paramaribo	October 25th.	—
Cayenne-Vizeu	November 25th.	—
Lagos-Brass	December 4th.	—
San Domingo-Martinique	December 10th.	—
Haiphong-Hongkong	December 11th.	—
Garachico-Santa Cruz de Palma	December 27th.	—

Madrid.—The two large electrical companies in Madrid, which, so far, have kept up the price at 1s. per unit, with very slight changes, have, says *Industries and Iron*, commenced a rate-cutting war, with the view of securing one another's customers. The English Company has offered to a large club, which was consuming by the meter current to the value of £960 per annum, to provide them with better light for a lump sum

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of £600 per annum, without employing any meter. So far both companies, although their charge is heavy, are able to supply current below the cost of gas, and for this reason electric lighting continues to gain ground in Madrid.

A French Trolley Line.—The third electric tramway on the overhead trolley system in France was "inaugurated" on December 17th. The line is three miles long, and runs along the bank of the Gironde from Bordeaux-Bouscat to Vigean, the gradients and curves being remarkably easy throughout. The line is provided with motor-cars carrying 40 passengers and weighing five tons, and with "trailers" carrying 50 passengers. Each motor car is provided with a single-reduction 15-H.P. Thomson-Houston motor, weighing, with gearing, just upon 1 ton. The ordinary speed is 7½ miles an hour. The installation is said to exhibit at one and the same time "the characteristics of American practice and the elegance and good taste of France."

Gas-Retort Carbon.—In the course of a Paper recently read before the German Gas Association, Dr. Hempel drew attention to the high price of large masses of retort graphite, a material useful in many ways nowadays, particularly in making electric light carbons and electrodes. Alluding to the fact that people are now going in on the largest scale for making caustic soda and chlorine by the direct electrolytic decomposition of common salt, and that for that they require large gas-carbon electrodes, which they cannot get, Dr. Hempel asked whether the retorts could not be so shaped as to yield graphite at once in large workable plates or slabs, and suggested that it ought to be easy to get thick copper or iron conductors embedded in the retort itself.

The Matabeles and the Telephone.—In describing the visit to England of Babjaan and Umsheti, two envoys of King Lobengula, a writer in the *Review of Reviews* relates this interesting incident:—"But the thing which completely astounded them was the telephone. They could conceive—though with difficulty—that it was possible for English witchcraft to make a machine which could talk English, even when those who talked were a mile from each other, but they could not understand the witchcraft which enabled the English to make the telephone speak Matabele. But that it did they could swear. They had been separated, and at the distance of a mile apart Babjaan had talked to Umsheti by means of this magic, and the machine spoke as pure Matabele as if it had been made in Africa."

A Long Telegraph Circuit.—On December 3rd, the President's message was transmitted direct from the New York Bureau of the United Press to San Diego, Cal., *viâ* the Postal, Canadian Pacific, and the Pacific Postal telegraph lines. There were twelve repeaters in the circuit, situated as follows:—Albany, 150 miles; Montreal, 343 miles; Sudbury, Ont., 444 miles; Fort William, Ont., 533 miles; Winnipeg, Man., 426 miles; Swift Current, N.W.T., 511 miles; Donald, B.C., 513 miles; Vancouver, B.C., 458 miles; Portland, Ore., 367 miles; Ashland, Ore., 316 miles; San Francisco, Cal., 402 miles; Los Angeles, Cal., 473 miles. San Diego is about 122 miles south of Los Angeles, which makes the total length of the circuit 5,080 miles. The message consisted of 5,211 words, and the time occupied in transmitting the same was three hours and forty-two minutes.

The Junior Engineering Society.—At the last meeting of this society, held at the Westminster Palace Hotel, Mr. Percy Waldram in the chair, a Paper was read by Mr. S. Cutler, jun., on "Coal Gas Manufacture, and Recent Improvements of the Plant employed therein." Commencing by showing how rapidly the demand for gas had increased since its introduction, the author proceeded to briefly describe the usual processes of gas manufacture, passing on to a detailed account of the recent improvements which had been adopted. The inclined system of retorts to obtain automatic charging and drawing; the latest forms of condensers and purifiers; compressed air, hydraulic, and rope-power machinery for working horizontal retorts; water-seal valves; water gas plant; and other features being dealt with. In conclusion, the cost of manufacture; by-products; the future of gas considered in respect to electricity; and gas employed as a heating agent were touched upon. A discussion followed the reading of the Paper.

Telegraphic Addresses.—In reply to Mr. Henniker Heaton, Mr. A. Morley stated in the House of Commons on Wednesday evening that as telegrams were urgent communications it was the universal rule throughout the Telegraph Union to require that the address should contain all the particulars necessary to insure delivery, so that no delay might be incurred in inquiries or references to directories or other books. Although this was the rule, the Department did take some trouble to deliver telegrams the addresses of which appeared to be defective by accident and not by design; but it would be contrary to the interests of the public that it should allow its officers' time to be spent in procuring the delivery of telegrams which were systematically sent with insufficient addresses. Not only would the telegrams in question be delayed, but telegrams bearing sufficient addresses would also be delayed, and the whole character of the service would be altered for the worse. The case of telegrams was not analogous to that of letters.

Long-Distance Transmission of Power.—At Jalisco, Mexico, a long-distance electric power plant is in operation for street lighting at Quadalajara. The generation station is on the Rio Grande river at a point 17 miles distant, and where there is abundant water power. Three 500-H.P. horizontal turbines have been installed to drive five alternating dynamos, four for arc and one for incandescent lighting. As a safeguard against floods the turbines are placed 16ft. above the bed of the river. A grooved pulley is carried at both ends of the shaft of each turbine and connects by rope transmission with countershafting on the floor above. The rope used is laid in plumbago and tallow and runs at the rate of 6,594ft. per minute. The pressure is increased from 1,000 volts to 5,000 volts by means of a set of 10 transformers, and at the lighting station in Quadalajara it is again reduced in the same manner. Lightning is apt to cause trouble in that locality, so the poles are all of iron and provided with a pointed arrester extended 3ft. above the top of the pole.

The Telephone at the Antipodes.—So rapidly is science extending its conquests, says the *Melbourne Argus*, that many sheep stations, which were formerly only connected by the dreary tramp of the sundowner are now linked together by the telephone. So long as a squatter keeps his telephone on his own property he is quite within his rights; but if his wires cross a public road he renders himself amenable to the law, which forbids a private person to erect a telephone or telegraph, the monopoly being reserved for the Government. The Colonial Postmaster-General does not wish to prohibit telephones under such circumstances, and he has, therefore, had regulations prepared, which have been passed by the Governor in Council, charging a licence fee of £1 per mile per annum for the first four miles, and after that 10s. per mile; the fee, however, in no case to exceed £7 per annum. The height at which the wire must be carried across roads is specified, and it is also provided that in no case shall a fee be charged or accepted for the use of the line.

Electricity and Windmills.—The Netherlands Society for the Promotion of Industry offer a gold medal and £30 for the best Paper on the production of electricity by windmills, its storage, transmission, and utilisation. The following points in particular should be attended to:—1. What is the average energy a common windmill is able to produce per day of 24 hours in combination with an electric accumulator; what would be the installation most suitable to this effect, and what would be the cost of one horse-power hour? 2. Is it possible, from an economical point of view, to apply the new aerial motors on an extensive scale for the accumulation and the utilisation of this energy? If so, what mechanical appliances would be required for this purpose? The project of a supposed application of the system, by which a factory is provided with light and power, is wanted as an illustration. Answers must be sent before July 1, 1894, with the author's name, in a closed envelope, to the general secretary of the Society, F. W. Van Eeden, at Haarlem, Holland.

Obituary.—The death occurred on the 20th inst. of Sir George Berkley, a past-President of the Institution of Civil Engineers, who was made a K.C.M.G. in June last "for services rendered as consulting engineer to the Government of Natal

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and in connection with other colonies."——The death of Mr. Stephen Wilcox, the well-known mechanical engineer, vice-President of the Babcock and Wilcox Company, took place in Brooklyn on the 27th ult., at the age of 63 years. Mr. Wilcox was very well known as a mechanic and engineer, his life having been devoted to mechanical and engineering work. In 1856 Mr. Wilcox devised a boiler which was the prototype of the present inclined water-tube boiler so largely used in generating stations, and since that time has been actively engaged in perfecting and developing that and kindred matters pertaining to steam plants. With Mr. Babcock he organised and built up the New York Safety Steam Power Company, a business which was disposed of by them about ten years ago, when the boiler business became so extensive as to demand all their time. Recently Mr. Wilcox had been making some experiments in the direction of a marine boiler, and was engaged in that work especially at the time of his death.

The Post-Office and the National Telephone Company.—Attention is rightly being called to the curious difference in the attitude of the past and present Postmasters-General on the telephone question. Sir James Fergusson, speaking in March last year, stated that, supposing local authorities were willing to take telephone contracts themselves, he did not see anything contrary to Government policy in such a proposal. A Treasury minute quoted by Sir James Fergusson on that occasion declared that the Government would comply with the reasonable demand of any town or district for telephonic facilities. Notwithstanding this very definite expression of opinion from his predecessor, Mr. Arnold Morley declines to act up to it, and in the case of Glasgow, for instance, has refused the facilities which Sir James Fergusson says the townspeople are perfectly justified in asking for. Attention will be drawn to this anomalous state of things in the House of Commons early next year. Mr. A. C. Morton will set down a motion declaring that the Post Office telephone contract, and all that relates thereto, shall be referred to a select committee of the House, so that the local authorities of the United Kingdom shall have an opportunity of stating their views on the question.

The Supply of Electric Poles in America.—Telegraph and telephone companies in some parts of America, it is said, are becoming not a little alarmed, says the *Electrical Engineer*, of New York, at the rapid depletion of material for poles. Formerly, when poles carried but one or two lines of wire, very small ones could be used, but now nothing less than a pole 32ft. high and 8in. through at the top end is of any good, and the supply is getting very limited. The rapid consumption by telephone lines of small poles and the thousands of new poles cut each year are two important factors that the telegraph people have to face. The only pole worth setting that grows in Maine is a cedar, and these if well set and of good size will last a long time. Some have been in use over forty years. The only trouble with a cedar is its brittleness in frosty weather. The supply of cedar has become so short that of late years a large number of chestnut from Massachusetts have been used. They are costly, but are very handsome and durable. Some idea of the cost of poles can be had when it is stated that the cost of wire and labour is equalled by the cost of the poles alone. A good chestnut 32ft. long is worth from $3 to $4. What will be used for poles in the future is an important question. With such an increased demand for chestnut poles they are likewise being cut off at half their growth, and they, too, will be available but a few years.

Electro-Biological Research.—By the generosity of M. G. Solvay, says *Nature*, two important institutes have been established at Brussels, namely, a University Institute of Physiology, and an institute specially designed for carrying on electro-biological researches. In May last M. Solvay presented the town with a sum of two hundred thousand francs for the erection and equipment of the University building, stipulating only that the University should provide courses in physiological chemistry, and medical physics relating to the connection between physiology and electricity. This condition was laid down with the object of improving the instruction at the University, and developing the spirit of investigation in the minds of students, thus giving them the ability to carry on physiological researches independently in a special laboratory. For students thus trained, and desiring to apply their knowledge to research of a special kind, the Solvay Institute has been established. At the inauguration of this institute, on December 14th, M. Solvay delivered an address on the *rôle* of electricity in the phenomena of life. He remarked that his conviction was that the phenomena of life could probably be explained by the action of physical forces, and that, among these forces, electricity played an important part. It was to obtain evidence on this point, by the observation and study of facts, that M. Solvay was led to found the institute that bears his name.

Engineering at Cambridge.—*The Times* of Christmas Day contained the following letter from Prof. Ewing :—

Sir : Two years ago, on Christmas Day, you were good enough to appeal in a leading article for funds with which to create an engineering laboratory at Cambridge. You pointed out what the University was doing to promote the teaching of engineering, by the establishment—then contemplated and now an accomplished fact—of a tripos in the subject, and by its grant of a site for a laboratory. In the depleted state of the University chest nothing more than these evidences of goodwill could be expected, and you added—" Here, then, is an opportunity for someone willing to connect his name with the supply of a great educational need. A sum of £20,000 is required to put the whole thing upon a sound basis, and in a country containing so many wealthy men it does not seem extravagant to hope that someone may be found willing to imitate the example of the benefactors who in ancient times endowed the colleges." The millionaire whom you invited to come forward did not appear ; but instead of that a subscription list was opened. The Chancellor, the Duke of Devonshire, subscribed £1,000. Thanks to the liberality of resident and non-resident members of the Senate, and also of many prominent engineers and others interested in this new development of the University's work, a sum of close on £5,000 has been raised, and, in addition, a large number of valuable gifts of machinery and instruments have been received. The new tripos has attracted so many students (77 are now in attendance) that the University, recognising the urgency of the case for a laboratory, has strained its resources so far as to supplement the donations by a grant of £1,000. These moneys are at present being spent in building as much of the laboratory as they will pay for, and next term we shall be in occupation of some of the rooms. But a large part of the plan is put off for lack of funds, and, what is of more immediate concern, we cannot provide some very necessary plant and fittings until further subscriptions come in. Those who read, and especially those who responded to the appeal of your article, may be interested to know these particulars of what has been done. The need for help remains, and I do not doubt that there are many old Cambridge men, not yet subscribers, who would give if only they knew how much it is wanted.

The Intrusion of Physical Ideas into the Development of Pure Mathematics.—Writing in the *Physical Review* for September-October on Mr. Oliver Heaviside's recently-published collected papers, Mr. Alexander Macfarlane makes the following pithy remarks about the value of using settled physical ideas in the development of mathematical analysis :—

It will be, perhaps, in the recollection of some readers that Professor Sylvester, a few years since, in the course of his learned paper on Bipotential, poked fun at Professor Maxwell for having, in his investigation of the conjugate properties possessed by complete spherical-surface harmonics, made use of Green's theorem concerning the mutual energy of two electrified systems. He said (in effect, for the quotation is from memory) that one might as well prove the rule of three by the laws of hydrostatics, or something similar to that. In the second edition of his treatise Professor Maxwell made some remarks . . . to the effect that, although name involving physical ideas are given to certain quantities, yet, as the reasoning is purely mathematical, the physicist has a right to assist himself by the physical ideas. Certainly ; but there is much more in it than that. We may, indeed, get rid of the principle of energy, and treat the matter as a question of the properties of quadratic functions : a method which may commend itself to the pure mathematician. But, by the use of the principle of energy, and assisted by the physical ideas involved, we are enabled to go straight to the mark at once and avoid the unnecessary complexities connected with the use of the special functions in question which may be so great as to wholly prevent the recognition of the properties which, through the principle of energy, are necessitated. It seems to me that we may go even further, and hold that mathematical analysis should be based, not on arbitrary laws, but on physical principles. Certain it is that the great developments of analysis have been due to an infusion of physical ideas and principles.

The difficulty, however, seems to be about the value of the line of argument. If one only wishes to arrive at a result, and is not particular as to the strictness of the premises or of the logical sequence of the steps, then the intrusion of physical ideas to get mathematical results is all very well. But if the object is to preserve a well-defined line of argument, which may be easily re-traced, it is putting the cart before the horse to employ concrete generalisations in purely abstract research.

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MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 136.)

Measurements of Work and Power.—Even at this early stage it must be evident to the reader that it will be necessary to employ some method of determining the load, power, and work done by an engine or complete plant, with a view to calculating its efficiency, rateable power capacity, load factor, &c. We will now consider some of the principles of these measurements, taking firstly the measurement of work. Work is considered in two aspects in engineering:—(1) as the consequence of power exerted for any time; (2) as the result of force exerted through any distance. The first is represented in Fig. 2 (see *ante* p. 159), where the horizontal axis measures the interval of time, and the vertical ordinate at any point on the axis of time gives the value of the power at that moment of time. In curve (*c*) the engine is working at a constant rate, so that the work it does is represented by the area of the rectangle O H, H J. In curve (*a*) the rate is never quite constant; but if we consider a very brief interval it may be taken as being approximately constant, the error being reduced in proportion to the length of the interval, so that a thin vertical strip of the curve (*a*) gives the work done in the brief time represented by the base of that strip; therefore the whole area of the curve A, B, C, D, E, F, T, O, A will give the total work done. We may ascertain this area by means of a planimeter, or by drawing the curve on uniformly thick paper, cutting it out and weighing it in a delicate balance against the weight of the square piece of paper on which it was drawn; or by means of Simpson's rule. This rule gives

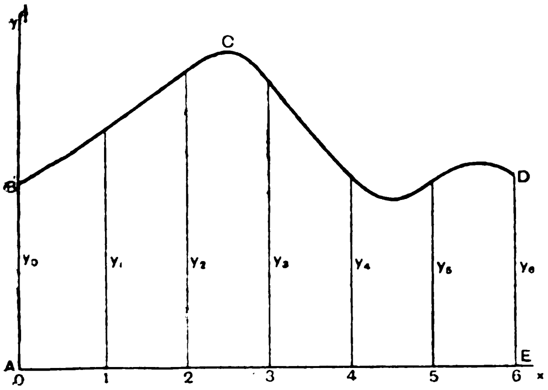

FIG. 3.

a result as nearly accurate as may be desired, according to the number of observations made. In Fig. 3 let it be required to find the area of the curve A, B, C, D, E, A, the ordinates and abscissæ of which are on known scales. Divide the area into n strips by means of $(n+1)$ equi-distant ordinates, as shown; and number these ordinates $y_0, y_1, y_2, \ldots y_n$. Let the total length of the base be x. We now treat each strip as if it were a true trapezoid, in which case the area of the first strip is—

$$a_1 = \frac{x}{n} \cdot \frac{y_0 + y_1}{2},$$

and of the last strip—

$$a_n = \frac{x}{n} \cdot \frac{y_{(n-1)} + y_n}{2}.$$

While the total area is

$$\text{area} = a_1 + a_2 + \ldots a_n = \frac{x}{n}\left(\frac{y_0 + y_1}{2} + \frac{y_1 + y_2}{2} + \ldots \frac{y_{(n-1)} + y_n}{2}\right) = \frac{x}{n}\left(\frac{y_0 + y_n}{2} + y_1 + y_2 + \ldots y_{(n-1)}\right). \quad (30)$$

The error made in treating each strip as a trapezoid is proportionate to the width of the strip and to the rate of curvature. By taking a large number of strips it may be made very small. Where there are points of contrary curvature in the curve the errors due to one set of strips will be more or less cancelled by those due to the other set; as, for example, in the strips between 4 and 5, and 5 and 6, in the first of which the estimated area is too large, and in the second too small. Usually, where the curves are not complicated by numerous and rapid variations, we take n equal to 10. If we apply this rule to Fig. 2 we may obtain the work done by the station or by any one machine; to complete the calculation, it being only necessary to find the number of units of work represented by unit area. This latter may be found by multiplying the number of units of power in the unit length of ordinate (or the scale of power) by the number of units of time in the unit length of abscissa (or the scale of time); the product multiplied by the area gives the work done. An equally simple method of determining the area of a curve which is used in finding the area of the diagram of work done in the cylinder of an engine consists in taking the average of the middle ordinates of all the strips, and multiplying this average by the base of the curve. In Fig. 3, if lines are drawn to represent the mid-ordinates of the strips (which may be scaled off), the average of these is the average

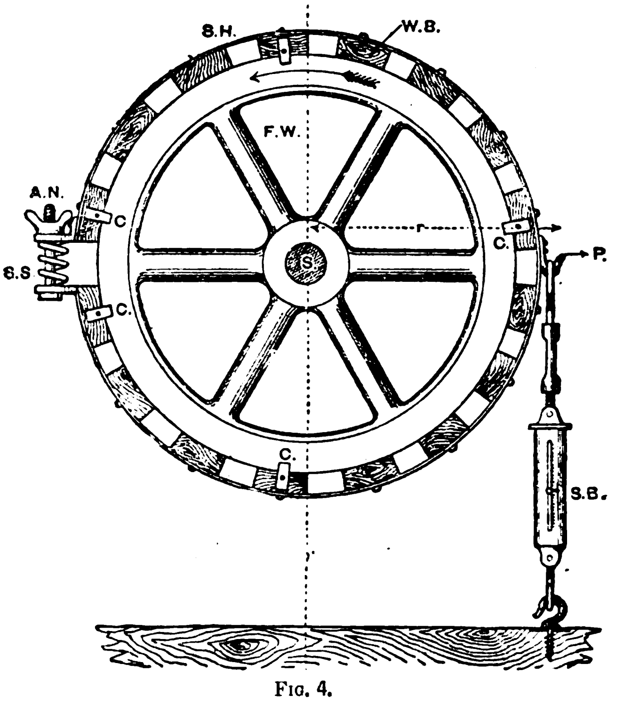

FIG. 4.

of the ordinates within a limit of error which depends on the number of strips taken. By the product of this average into the length of the base the area may be found, and the area, multiplied by the number of units of work in unit area, gives the measure of the work done.

If the axis x in Fig. 3 represents the distance in feet through which a variable force is exerted, the force being everywhere represented by the ordinate y, it is evident that the area is a diagram of work done by that varying force. Such a diagram of work can be automatically drawn on a sheet of paper by a pencil, if the vertical motion of the pencil and its height above a datum line are determined by the force, and if the paper receives a horizontal motion proportional to that with which the force is exerted on the moving body. An instrument for this purpose is called an *indicator*, the diagram obtained by means of it is called an *indicator diagram*, and the measure of the work determined in this way is called the *indicated work*. Indicated horse-power (I.H.P.) is the power based upon measurements of indicated work and speed. It will be convenient to study the indicator in relation to the special engines for which it is designed.

Dynamometry.—For the purpose of measuring the power which is taken from a pulley, or transmitted through a shaft or belt, we have recourse to some form of dynamometer. The derivation of the term dynamometer would seem to indicate that this is an instrument for the measurement of force; but, strictly speaking, it is only indirectly used to indicate force,

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and its direct purpose is to measure work or power. It is most commonly used for the purpose of measuring power, which is then known as brake horse-power, from the fact that dynamometers are frequently used which act as brakes upon the engine. There are two classes of dynamometers, absorption dynamometers, or brakes, and transmission dynamometers. The former measure only the power which they are allowed to absorb and waste, the latter measure the power which passes through them to some machine, and only waste power in proportion to their imperfection of action. Brakes or absorption dynamometers are usually built of blocks or bands of some comparatively soft and rough material, these being pressed against the rim of the pulley where the power is to be measured. A simple form is the Prony brake, which is represented in a modern form in Fig. 4. A number of wooden blocks, WB, are secured to a flexible band or strap, SH, and fitted round the pulley or flywheel, FW, in the manner shown, being held in place by means of a few clamps, C, which prevent the blocks slipping off sideways, but do not prevent the pulley from turning. The blocks first fit the pulley loosely, but can be tightened up as required by means of the adjustable nut, AN, and the spiral spring, SS. At one end of a horizontal diameter of the pulley, and at a radius, r, there is a hook, P, to which a strong spring balance may be attached. This spring balance is shown at SB, and is coupled up through a tightening nut which alters the length of the coupling rod. The engine is set in motion, care having been taken to place the brake so that the motion will be away from the spring balance and will tend to stretch it. Then the blocks are gradually tightened up until the engine is running at its proper speed. Next, the nut is tightened up so as to bring the hook, P, back again to the horizontal level with the centre of the shaft, S, and care is taken to see that the coupling rod of the spring balance is quite vertical. Let the force in pounds on the spring balance be now read; let it be W lbs. At the same time that the reading of W is taken, all adjustments being in order, the speed of the pulley must be noted on a speed counter placed against the shaft, S. Let this be N revolutions per minute. Evidently the force, W, balances, at the radius, r, the frictional resistance of the brake blocks which acts at the radius of the pulley, say R; so that—

$$W : \text{Friction} :: R : r.$$

Now if the force of friction is multiplied by the velocity of the rim, the product is the power expended. Whence,

$$\text{Power expended} = \frac{W.r}{R} \times \frac{2\pi R.N}{60} = \frac{2\pi W.r.N.}{60} \quad . \quad (31)$$

$$\text{And,} \qquad H.P. = \frac{2\pi W.r.N.}{33{,}000} \quad . \; . \; . \; . \; . \; . \; . \; . \quad (32)$$

With such measurements, however, there are innumerable difficulties. In the first place, the measurement is made on an engine which cannot be permitted to do any useful work during the test; in the second place, the engine is often placed under abnormal conditions, differing widely from the conditions of practical running; in the third place, it is difficult to take accurate readings on account of the great heat and vibration produced in the brake. In regard to the first, it may be said that absorption dynamometers must be abandoned if the engine cannot be freed for a time long enough for the test; of the second, it may be said that care should be taken that the internal conditions of the engine, the speed, &c., are identical with those for which the engine is built, and that the brake does not impose conditions on the engine which will differ, either prejudicially or advantageously, from those of ordinary running. A glance at Fig. 4 will show that the brake there shown will supply a force at the point P, which will set up pressures on the engine bearings quite different from those occurring when the same engine is driving a belt. The effort should be made to absolutely imitate the conditions of practice, for then only can reliable results be obtained. As regards the heating and vibration: the first is usually got rid of by a copious stream of soapy water directed between the blocks and the pulley face; and the second is often diminished by means of a dash-pot on the brake strap. Other forms of brake dynamometers are constructed, some of which supply friction by means of a length of leather belt thrown over the pulley face and held in contact with it by means of weights or spring balances.

Transmission dynamometers may be divided into two classes: those which measure power transmitted by means of a belt or set of ropes, and those which measure power in a shaft. Of the first class, we may notice one form which has been used largely in dynamo tests—the Alteneck dynamometer. The general arrangement of this instrument is shown in Fig. 5. Power is being transmitted from the pulley A to the pulley B, through a link leather belt, C, which passes, both at the upper and lower parts, through the dynamometer. The instrument consists of a rectangular framework, D, with idle pulleys pivoted at the four corners, E, F, G, H, and two other idle pulleys, I and M, also pivoted to the frame. In addition, there is a movable pulley, P, attached to a lever which is pivoted at the centre of M. The tight side of the belt tends to lift this pulley, P, while the slack side presses downwards upon it. The motion of the lever is controlled by a dash-pot. Attached to the lever at the centre of P there are two vertical rods, R and Y. The rod, R, terminates at its lower end in a spiral spring, the tension of which is adjusted by the handle, T, and indicated on the scale, Z. The rod, Y, terminates at its upper end in a small lever, pivoted at O. This lever is weighted on its further side, and is provided with a pointer which travels over a scale on which there is a zero mark, m. The instrument having been fixed into position, the handle, T, will next be turned so as to bring the pointer of the top lever to the mark,

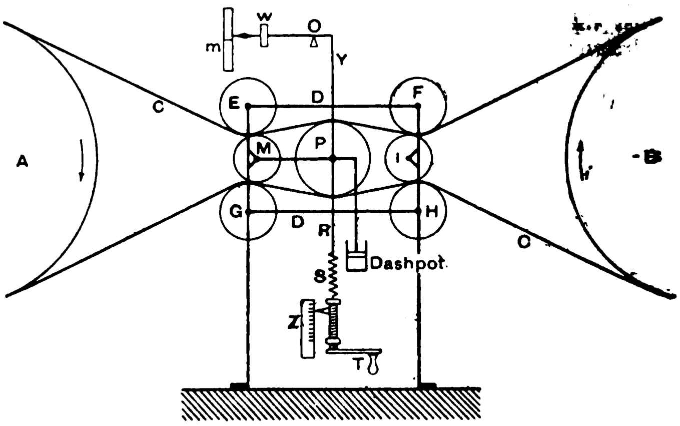

Fig. 5.

m. The reading on the scale, Z, is noted. The engine will now be started, the motion being such as to put the lower part of the belt into greatest tension. Instantly the pointer will fall below the mark, m, on account of the pulley, P, being lifted; but this must now be rectified by turning the handle, T, so as to increase the pull of the spring, S, until the pointer again stands at m. The reading on the scale, Z, is again noted, and the former reading subtracted from it. Simultaneously with these observations, the velocity of the belt must be observed, by measurement of the speed of either of the pulleys, A or B, the diameter of the pulley having previously been accurately measured. Let D be this diameter in feet, N the speed of the pulley in revolutions per minute, W the difference between the two readings on the spring scale, Z, and k a constant which is marked on the instrument. Then,

$$H.P. = \frac{\pi D N W}{33{,}000\,k} \quad . \; . \; . \; . \; . \; . \quad (33)$$

The second class of transmission dynamometer is placed in a gap or break in a line of shafting, and forms a flexible shaft coupling, through which the power is transmitted by torsion and angular motion. These instruments are sometimes provided with recording apparatus, for marking the diagram of torque or the power diagram on a sheet of paper contained within them. They are, however, only applicable to small amounts of power. Further consideration of the dynamometer testing of engines is reserved for treatment in a more complete manner in a later section.

(To be continued.)

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SOME APPLICATIONS OF ELECTRIC HEATING IN PHYSICAL LABORATORY PRACTICE.*

BY EDWARD L. NICHOLS.

It is strange that so little attention has been given by physicists to the advantages of electric heating in calorimetric and other similar work. Prof. Henry Crew † quite recently described "a new method of obtaining a constant temperature" in which a coil of wire is used to heat an air bath with admirable effect. It would seem that devices more or less closely related to the one due to his ingenuity must have occurred to others engaged in laboratory operations; but I recall no published account of such methods. The application of electric heating for temperature control has been in use in the physical laboratory of Cornell University for a considerable time, and it gives me pleasure to confirm Mr. Crew's statements as regards the excellent results which may be obtained by means of it.

It will be seen from what follows that the methods of procedure to be described differ from his chiefly in three particulars: (1) the use of naked wire, whereby the range of temperature attainable is much increased; (2) the absence of the ice bath, it having been found that remarkable constancy of temperature within a heated coil occurred, under almost all ordinary conditions of the surrounding space; (3) the measurement of temperatures by means of a calibrated coil of copper wire.

The method to be described consists in heating the body or apparatus in question by means of a spiral coil of uncovered wire surrounding it. The wire, which may be of German silver, is traversed by strong electric currents, and thus brought to a high temperature. The best material for this purpose is some metal of small temperature coefficient. It should be capable of withstanding high temperatures without melting. The method under consideration has been applied under my direction in a variety of laboratory experiments. I propose to describe several of these briefly for the purpose of illustrating its advantages.

I. The first of these experiments was suggested by a Paper read by Prof. William A. Rogers at the Cleveland meeting of the American Association for the Advancement of Science. He called attention in that Paper to the fact that thermometers when subjected to a fall of temperature frequently indicate apparent discontinuity in the curve of cooling, the mercury column falling stepwise, and in some cases even retracing its course in the tube. This observation having been verified in the case of several thermometers of the best manufacture, it seemed of interest to determine whether the phenomenon might not be due in part to some peculiarity in the law of the contraction of glass. The experiments were made by Mr. Ernest F. Nichols. Rods of glass were mounted upon the bed of a comparator. One end of the rod was fixed, and to the free end a mirror was attached in such a manner that the changes in the length of the rod would produce a motion of rotation. The image of a vertical scale set up at a distance of about three meters was observed by means of a reading telescope. In this way every change in the length of the rod was greatly magnified. The rod was surrounded by an open spiral coil of iron wire reaching from end to end. Sufficient current was sent through the wire to heat it, and this current, which was supplied by a storage battery, was kept constant until the movement of the image of the scale had ceased. The circuit was then broken, and the rod was allowed to cool. A curve of cooling was obtained by noting the movement of the image at frequent intervals until the rod had reached the temperature of the room again. Upon plotting this curve it was found that the discontinuities in the rate of cooling if present in the case of the specimen of glass tested were extremely small. The curves were not perfectly true, but the irregularities were so small as to make it uncertain whether they were not to be ascribed to errors of observation or to imperfections in the apparatus. Rods of aluminium and brass also showed slight irregularities. The outcome of the experiment, therefore, was a negative one; but that it was evident from the curves obtained that the phenomenon noticed in thermometers could not be ascribed altogether to the suspected peculiarity in the law of the cooling of glass. From the point of view of the present Paper, however, the experiment was of considerable interest. It made it evident that this means of heating is an advantageous one in the study of the linear dilation of rods of considerable length.

II. In the same year, 1891, the method was applied to a determination of the coefficient of expansion of a standard meter bar of brass. This experiment was carried on by Mr. Joseph Le Conte. For the purpose of determining the temperature of the bar, the same was wrapped from end to end with several turns of fine silk-covered copper wire. The resistance of this longitudinal coil, the temperature coefficient of which had been previously determined with a good deal of care, was measured by the fall of potential method, using a sensitive galvanometer, a single cell of battery, and a compensated standard made by combining German silver and copper. Thus the temperature of the bar was averaged for its entire length. This bar was mounted upon a comparator, and was surrounded by a coil of large uncovered German silver wire in the manner described in Experiment I. The length of the bar was measured by means of reading microscopes attached to the comparator. The bed of the instrument was protected from the radiation of the coil by means of a layer of asbestos paper. It was found by trial that the rise of temperature of the massive iron bed of the comparator was almost unappreciable, even when the coil was heated to a temperature of 50°C. In this experiment the measurements were taken with the circuit closed, the bar having been brought to the desired constant temperature by long-continued application of the current. It was found that any temperature within wide range could be reached by simple adjustment of the resistance of the circuit through which the heating current flowed, and that no troublesome fluctuations took place. The coefficient of the bar was found to be in close agreement with determinations for this metal by the best known methods. The method of measuring temperature by means of an integrating coil extending over the entire length of the bar was also found to be superior to any procedure involving the use of a mercury thermometer. How very difficult it is to place thermometers so as to obtain true indications of the temperature of a bar in process of being tested is well known to all who have attempted work of this description. The calibration of the coil of copper wire for temperature measurements showed that the temperature indicated by it represented very closely indeed the temperatures of the mass of metal which it surrounded.

III. An experiment illustrating this method of heating, in application to work of another character, is as follows:—It was desired to determine the effect of heating sugar solutions upon the rotation of the plane of polarisation. In the Soleil saccharimeter the tube containing the fluid, the rotational coefficient of which was to be determined, was surrounded by a coil of German silver wire precisely in the method already indicated. It was found possible in this way to bring about temperature changes within the entire range below the boiling point of the solution, and to maintain them during the measurement of the angle of rotation. The entire apparatus consisted simply of a German silver helix surrounding the brass tube of the saccharimeter, in series with suitable resistances, and a galvanometer for the measurement of current. Since the temperature itself could not be readily determined directly at the time of observation, a calibration test was made with the thermometer inserted in the liquid, the temperature being measured as a function of the current flowing through the coil. The relation between temperature and current having been ascertained once for all, it was therefore only necessary to note the readings of the galvanometer in order to find the temperature to which the measurement of the angle of rotation applied.

* Abstract from the *Physical Review*, September-October, 1893.

† Crew, *Philosophical Magazine*, 33 (5), p. 89, 1892.

CONDENSERS FOR ELECTRIC-LIGHT PLANTS.*

A large number of steam engines in electric lighting plants are situated so that an adequate supply of water can easily be had for condensation, but are at the present time non-condensing, labouring under a back pressure of 14·7 pounds due to exhausting against the atmosphere. The value of a vacuum to an engine under normal conditions is at a low estimate equal to 25 per cent. of the power developed by the engine running non-condensing. This means that, by the use of a condenser, the coal consumption can be reduced one-quarter to one-fifth with the same production of light, or the number of lights may be increased a fifth without burning more fuel.

With electric light and power companies, the cost of fuel is the great expense. The cost of the light is dependent primarily upon the cost of the coal, and any increased economy of the boilers or engines, improved belt transmission or dynamo efficiency directly affects the profits in nearly like proportions.

Upon changing an engine from non-condensing to condensing it is found that the boiler pressure in many cases may be lowered 15lb. to 20lb. with nearly as high results. Doing this often lengthens the life of the boilers considerably, and is very desirable to such as have had long service. When steam plants are located near dwellings, the noise of escaping exhaust steam is sometimes found to be annoying. This objectionable feature may be entirely relieved by the application of a condenser. Several engines may be exhausted into one condenser, and a vacuum maintained on all or part of them at a time.

The exhaust pipes from the engines lead to an exhaust trunk to which the condenser is attached. When an engine is stopped, it is shut off from the exhaust trunk by a gate valve in its exhaust

* Abstract from the *Electrical World* of New York.

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pipe. In large plants it is well to divide the engines into groups, and use two or more condensers, putting those engines which have about the same time of running in the same group. At stations where the water supply is distant, inexpensive means can often be devised whereby the water can be reached. An excellent method is to lay a conduit, connecting the water supply with a well in the vicinity of the engines. From this well the water is readily taken by the condenser if the lift is under 20ft. Where the lift is greater, it is practical to lower the condenser by placing it in a pit. A cheap and serviceable conduit can be constructed of sewer pipe laid level, and at such a depth that a flow of water into the well is assured. The quantity of water needed to properly condense the exhaust steam depends, of course, on its temperature. It may be stated that 1¼ to two gallons of water per minute are required fo every horse-power developed by the engine. The use of city water supply for condensation is not recommended, unless the cost is so low as to be merely nominal.

ON COPPER ELECTROLYSIS IN VACUO.*

BY WILLIAM GANNON.

The following research upon the electrolysis of copper sulphate *in vacuo* was commenced nearly two years ago, at the suggestion of Dr. Schuster, and the experiments were made in the Physical Laboratory of the Owens College.

The electrolysis of copper salts is interesting, not only theoretically as affording a verification of Faraday's Law of Electrolytes, but also practically on account of its constant use in the graduation of current-measuring instruments, such as tangent galvanometers and ammeters. It is known that copper sulphate in solution does not conform rigorously to the simple form in which Faraday's law is generally expressed. Gray,† who made a detailed examination of the electrolysis of copper sulphate, found that the weight of the deposit is very variable in neutral solutions for the same current and the same interval of time; and he also showed that, in solutions containing a little free sulphuric acid, this inconstancy was removed, but that the weight was a function of the temperature of the solution and of the current density at the cathode. His results with acid solutions are graphically represented by curves (partly reproduced at the end of this Paper), an inspection of which shows that the deposit is heavier the higher the current density and the lower the temperature. ("Current density" is defined as the ratio of the value of the current in amperes to the total immersed surface of the cathode plate.) A very possible explanation of this anomaly is furnished by the work of Gore‡ and Gray,§ who independently found that copper dissolves to a very appreciable, though variable, amount in solutions of copper sulphate.

The secondary chemical reactions which follow—chiefly the formation of basic salts—complicate the electrolysis. This corrosion of copper plates in the sulphate solution is much diminished if a little free sulphuric acid is present, with the result that the electrolysis of acid solutions yields more consistent results than are obtainable with nearly neutral solutions. Now, Schuster‖ found that the loss in weight of copper plates in a solution of copper sulphate does not occur if the air be removed from the solution. It is, therefore, very probable that it is the oxygen of the air present in the solution that causes this chemical corrosion; and hence it was of interest to examine if any difference could be found between the weights of the deposits of two copper voltameters, one of which would be placed *in vacuo*. Schuster and Crossley¶ showed that the silver deposit is slightly greater *in vacuo* than in air; and the experiments tabulated in this Paper point out, with certain limitations, a similar result.

The results of my experiments may be briefly summarised:—

1. With two copper voltameters containing freshly-made neutral solution of copper sulphate, one of which is under reduced pressure, the copper deposit in the partial vacuum is higher (for the same current, current density, and temperature) than the deposit under the atmospheric pressure; but the percentage difference is not constant.

2. If a little free sulphuric acid be added to the air solution, the percentage difference is more constant and higher than in 1.

3. The addition of acid to both voltameters causes the percentage difference to be constant within experimental errors. The experiments conducted under this condition show that—

i. For current densities above 0·01 ampere per square centimetre of active cathode there is no practical difference between the two deposits.

ii. For current densities below 0·01 ampere per square centimetre the vacuum deposit is very appreciably higher than the air deposit.

iii. A curve drawn representing the deposits obtained *in vacuo* at different current densities is more regular than the air curves, and for densities below 0·01 ampere per square centimetre is approximately a straight line.

* Abstract of a Paper read before the Royal Society.
† *Phil. Mag.*, Vols. XXII. and XXV. (1886-88).
‡ *Nature*, Vol. XXV., p. 473.
§ *Phil. Mag.*, Vol. XXII., p. 400.
‖ See note at end of this paper.
¶ Roy. Soc. *Proc.*, Vol. L., pp. 344—358.

NOTE ON THE ACTION OF COPPER SULPHATE AND SULPURIC ACID ON METALLIC COPPER.*

BY PROF. ARTHUR SCHUSTER, F.R.S.

Mr. Gannon, in the foregoing Paper, refers to some unpublished experiments made by me a few years ago. These experiments were conducted for the purpose of satisfying myself that, as seemed *a priori* probable, the diminution of weight observed when metallic copper is exposed to the action of sulphuric acid or sulphate of copper is due to the presence of free oxygen in the liquid. Copper gauze was taken in order to deal with as large a surface as possible, and rolled up so as to fit into a piece of glass tubing. After the copper had been carefully washed, dried, and ignited in hydrogen, it was immersed in dilute sulphuric acid, the air above the acid was removed as far as possible, and the tube containing the gauze was then sealed hermetically. At the end of a fortnight a few tubes prepared in this way were opened and weighed after being subjected to exactly the same treatment as previous to immersion, that is to say, the copper was washed, dried, and ignited in hydrogen. The diminution in weight observed under these circumstances was insignificant. I cannot, unfortunately, now find the record of the actual weighings, but the quantities involved were about the same as in the next set of experiments. On January 26, 1891, four spirals of copper gauze were placed in a solution containing 20 per cent. of cupric sulphate, 5 or 10 per cent. by weight of sulphuric acid being added to the aqueous solution. The conditions thus approximated to the solutions which are used in the electrolysis of copper. The tubes were exhausted and sealed up: two of them were opened on February 2nd, and the two remaining ones on February 9th; the weighings were taken after drying and ignition in hydrogen. The results are shown in the accompanying table:—

Time of immersion.	Amount of sulphuric acid.	Weight before immersion.	Weight after immersion.
7 days	10 per cent.	17·512	17·510
7 „	5 „	14·357	14·356
14 „	10 „	14·267	14·265
14 „	5 „	18·471	18·468

It will be seen that the diminution in weight is quite insignificant compared to what takes place in the presence of air, and may be due to some remnant of oxygen left. The late Mr. Hoskyns Abrahall, however, suggested that it might also be due to the formation of copper sulphide; and this suggestion was supported by the fact that traces of sulphuretted hydrogen were given up when the copper, after immersion, was heated in hydrogen. The action would be represented by the formula

$$4\,Cu + SO_3 = CuS + 3\,CuO.$$

The above experiments prove that nearly the whole effect which is observed when copper is immersed in a solution of sulphate of copper or sulphuric acid is due to the presence of oxygen in the solution.

Electric Mail Cars in Ottawa.—A contract has been entered into, says the *Electrical Engineer*, of New York, between the Dominion Government and the Ottawa Electric Street Railway Company for the conveyance of the mails between the railway stations and the post office at Ottawa city. This service has hitherto been performed by mail wagons drawn by horses. The electric postal cars were made by the Ottawa Car Manufacturing Company, and equipped with 30-H.P. Westinghouse motors. The cars are 20ft. long, and are mounted on Brill trucks. The distance from the Post Office to the farthest railway station is a mile and a-quarter. The run is usually made in five or six minutes, while under the old system of horses the time occupied was never less than 20 minutes. The Postmaster-General and the Post Office officials are very much pleased with the change, and it is probable that a similar service will be put into operation in the other cities of the Dominion. Three cars are used in the service at Ottawa.

* Abstract of a Paper read before the Royal Society.

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THE PROPOSED PACIFIC CABLE.

During the late tour of Mr. Mackenzie Bowell, the Canadian Minister of Trade and Commerce, through the Australian colonies, a memorandum, drawn up by Mr. Sandford Fleming, and containing definite proposals for the construction of a Pacific cable, was submitted by him to the Australian Governments. Copies of the memorandum have reached this country, and in *The Times* of Monday last there appeared an abstract of it, from which we take the following information. In our issue of May 6, 1892 (Vol. XXIX.) we discussed the various proposals at considerable length, and gave a map showing the proposed routes :—

Mr. Sandford Fleming's views were expressed at the Colonial Conference of 1887. His scheme embraces four alternative proposals for carrying a cable from Vancouver Island to Australia without landing on any territory which is not under British protection. By the first route the cable would run from Vancouver Island to Fanning Island, thence to the Fiji group. From Fiji it would run direct to New Zealand and thence to Australia. The distance by this route is 7,145 nautical miles, and the estimated cost of construction £1,678,000. By the second route the cable would run from Vancouver Island to an unoccupied island known as Necker Island, about 240 miles to the West of the Hawaiian group ; from Necker Island to Fiji, and thence to New Zealand and Australia. The distance by this route is also 7,145 nautical miles. The estimated cost of construction is £1,585,000. By the third route the cable would extend, as in No. 2, from Vancouver Island to Necker Island and thence to one of the eastern islands of the Gilbert group. From the Gilbert group two branches would extend, one to Queensland, touching at the Solomon Islands, one to New Zealand through Viti Levu, the southern island of the Fiji group. The distance by this route is 8,264 nautical miles. The estimated cost £1,825,000. The fourth route is identical with the third, except that it leaves out the branch to New Zealand. The distance is only 6,244 nautical miles, and the estimated expense £1,380,000.

As to the question of cost, Mr. Sandford Fleming proposes to meet it by constructing the cable as the joint property of the colonies concerned, and raising the capital required on their joint guarantee. He proposes to extinguish the subsidy of £32,400 paid by some of the Australian colonies to the Eastern Extension and payable until May, 1899, by purchasing an annuity of the required amount for those years, and thus adds a capital outlay of £145,000 to the sum required for the construction of the cable. If this arrangement be applied to No. 2 route, the capital required will be £1,745,000, and interest at 3 per cent. will bring the annual charge to £52,350. Mr. Standford Fleming's estimates as to working include the salaries of all officials, the cost of two steamers for current repairs, and the highest figure is £60,000. Besides working expenses it is proposed to establish a renewal fund of 2 per cent. on the cost of the cable, or £32,000 a year. The total estimated expense, including interest upon the capital, amounts, therefore, to £144,350 a year.

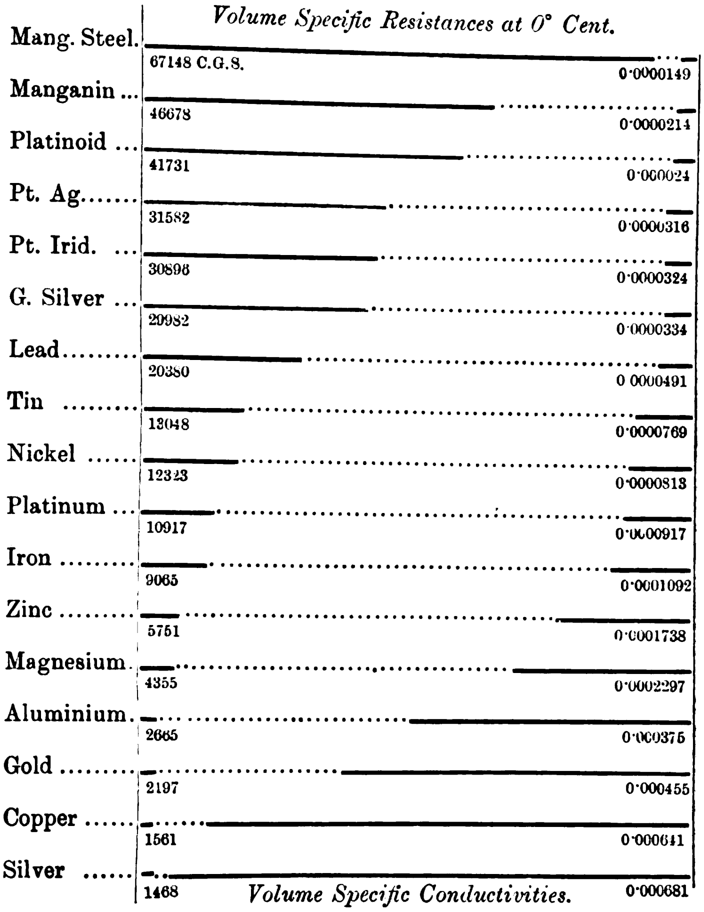
As to income, Mr. Sandford Fleming bases his calculation on the assumption that a Pacific cable may hope, when it is in complete working order, to take at least half of the messages now sent over the lines of the Eastern Extension Company. The number of words transmitted by that Company last year was 1,275,191. Dividing this into equal parts he takes 637,595 words as representing the probable business on which the Pacific cable would begin. But there is the increase of business to be taken into account. The normal increase under the old 9s. 4s. tariff was 14 per cent. per annum. The charge which it is proposed to make over the Pacific cable is 2s. a word. Thus messages would pass by that route from Australia to England for 3s. 3d. a word instead of 4s. 9d., which is the present charge. Putting aside, however, any estimate which might seem to be justified by these considerations, and basing his calculations on the assumption that business may stand still for three years and will afterwards continue only to increase at the normal high tariff rate of 14 per cent., Mr. Sandford Fleming works out the following table of the estimated earnings of the cable :—

Year.	Words per annum.	Earnings at 2s. per word.	Year.	Words per annum.	Earnings at 2s. per word.
1894	637,595	£63,759	1900	1,173,176	£117,318
1895	726,858	72,686	1901	1,262,439	126,244
1896	816,122	81,612	1902	1,351,703	135,170
1897	905,386	90,539	1903	1,440,967	144,097
1898	994,649	99,465	1904	1,530,230	153,023
1899	1,083,913	108,391			

It is scarcely to be supposed that the line would be in working order before 1896, and according to this estimate the business done in 1897 would be £90,539—that is to say, in the first year following the establishment of the line the business done might be expected to cover the whole of the working expenses and to give £30,539 for the renewal fund. After only seven years of working the business done would amount to £144,097, the scheme would be self-supporting, and the contributing Governments would be relieved from any further financial charge.

It is understood that a Conference will shortly be held in Canada for the purpose of discussing the scheme more fully, and if it be found to bear the examination of experts steps will be taken to procure the assent of all the Colonial Governments concerned.

RESISTANCES AND CONDUCTIVITIES OF METALS AND ALLOYS AT 0°C.



The length of the lines in this table is based upon the determinations of volume specific resistances by Profs. Dewar and Fleming. "Volume specific resistance" is defined as the resistance between opposite faces of a centimetre cube of the material in C.G.S. units. These values are marked under the lines, the value for manganese steel being 67148, and for silver 1468. If these numbers are divided by 100,000 the quotient is the resistance in *Ohms* of a wire of the material one metre long and one square millimetre in section. The lengths of the resistance lines of these two metals in the diagram are 67·1 millimetres and 1·5 millimetres respectively. The lengths of the lines representing "volume specific conductivities" are the reciprocals of the corresponding resistances. Wires of different metals, all of the same diameter, and of lengths equal to or multiples of the lengths of these conductivity lines, will all be of the same resistance. With wires of different metals, all of the same length and of the same resistance, the sectional areas must be proportional to the length of the resistance lines.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

TUESDAY, January 2nd.

ROYAL INSTITUTION.

3 p.m. Juvenile Lecture on "Air: Gaseous and Liquid," by Prof. Dewar, F.R.S.

THURSDAY, January 4th.

ROYAL INSTITUTION.

3 p.m. Juvenile Lecture on "Air: Gaseous and Liquid," by Prof. Dewar, F.R.S.

FRIDAY, January 5th.

JUNIOR ENGINEERING SOCIETY.

8 p.m. Meeting at the Westminster Palace Hotel. Lecture on "Boiler Incrustations and Deposits," by Prof. Vivian B. Lewes.

SATURDAY, January 6th.

ROYAL INSTITUTION.

3 p.m. Juvenile Lecture on "Air: Gaseous and Liquid," by Prof. Dewar, F.R.S.

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ELECTRIC SUPPLY METERS.

No part of the material and plant used for the production and distribution of electric light has developed so slowly as the meter. Nearly as much mechanical ingenuity, and skill of a far higher order than has been expended on arc lamps, have been devoted to the design and perfecting of this necessary piece of apparatus. Before even a tolerable meter had been made, the efficiency of dynamos was well into the nineties. Glow lamps of a satisfactory quality had come into common use before any instrument was ready to record the current or the energy consumed by them. The construction of meters is, of course, a branch of mechanical work so different from dynamo building that there was no inducement for the larger manufacturing firms to add a meter department to their works. But it is singular that none of the well-known makers of electrical measuring instruments have successfully placed a meter on the market. Two exceptions are to be found among dynamo builders—the THOMSON-HOUSTON COMPANY and Messrs. FERRANTI and Co. are known for their meters as well as for their dynamos. Many names, such as ARON, FRAGER and SHALLENBERGER, are known to the electrical world only as inventors of meters. The time has not yet come for an exhaustive discussion of this subject, and only two Papers, so far as we remember, have been read, one by Prof. FORBES before the Society of Arts nearly five years ago, and one by Mr. WORDINGHAM before a students' meeting of the Institution of Civil Engineers.

The first meter was, we believe, that of Mr. J. T. SPRAGUE, patented November 22, 1878. This was a coulomb-meter for electro-plating work, and consisted of two copper plates, "supported by spiral springs, or in any other equivalent manner which will permit them to descend and rise according to their relative weights." A reversing commutator, ratchet wheels, and counting train were provided. Less than two years later Mr. EDISON patented almost precisely the same thing, with a balance arm instead of springs; but this was soon abandoned for his simple but unsatisfactory voltameter which lingers yet. The accelerated pendulum meter, one of the first practical instruments, was the invention of Profs. AYRTON and PERRY, who,

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if the Chinese failed to invent it in the year *n* B.C., were as usual the first. Too early, however, for once were the early birds, for the early worm had not arrived. But only a few months before they allowed their patent to drop, Dr. ARON re-invented the pendulum meter, and added the differential train, which had been designed but not patented by the first inventors. The Aron meter, though made with insufficient care at first, served a useful purpose for several years, while other meters were being perfected. The principle of the pendulum meter has been carried to the highest refinement by Mr. EDMONDSON, and both he and the late Mr. RECKENZAUN have obviated the necessity for periodical winding by automatic electrical driving. It remains to be seen whether the additional mechanism, the liability to stop working, and the consumption of energy entailed by this improvement will enable the pendulum meter to keep its place among other competitors. The motor meter has perhaps received more attention than any other, and while the Thomson-Houston, Shallenberger, and Brillié meters have each been evolved on separate lines, the principle adopted by FAURE in February, 1882, has been elaborated by FERRANTI, HOOKHAM, and PERRY, each laying stress on a different point, and each attaining very high merit. The principle first proposed by J. E. H. GORDON—namely, a galvanometer with a snail cam, and an arm actuated by clockwork at intervals to strike the cam, and record the length of all its journeys—has been developed by CAUDRAY, FRAGER, Lord KELVIN, RICHARD, and others. But the complication and delicacy of the mechanism is so great that these meters must present very marked advantages if they are to compete with the simple disc or bell immersed in mercury, or the paddle driven by the mercury itself, rotating through the interaction of a radial current and an axial magnetic field. Apologising for, or defending the complication of, a delicate and complicated machine, a well-known engineer once observed that a watch is both delicate and complicated, but is none the less serviceable.

Most meters aim only at recording coulombs or ampere-hours. The constancy of the volts is assumed. Others measure the whole energy. An instrument with a shunt coil and with no iron core can of course measure the watts, but it is only in exceptional cases that the consumer wants to measure the energy. He generally wants candle-power, is charged for energy, but really buys current. A meter that took the sixth or seventh power of the volts into account would give an approximation to the candle-hours.

The essentials of a meter are accuracy, durability, low cost of maintenance, and low first cost. Accuracy must not only be a matter of laboratory testing, but the meter must stand packing, carriage, and erection. The older Aron meters worked fairly well when once at work, but the constants had, at great inconvenience, to be re-determined after the meters were fixed in place. The relative effect of errors in motor meters on small load before the constant is reached, and of full load errors, the effect of the correction introduced by Mr. EDMONDSON of what may be called the $2ab + b^2$, and the importance of both external and of C^2R temperature errors, might be discussed at great length. They are of vastly greater practical importance than problems about alternate currents in conductors having self-induction and capacity and the like. They bide their time; they will some day receive attention. Durability, of course, can only be estimated after several years' work, though the number of working parts, their speed, and their action, can be considered by inspection of the mechanism. The cost separates itself into two parts, the first cost forming part of the capital expenditure of the company, but one that is certain to earn a steady revenue; and the maintenance, which includes winding up, where clock meters are used, and the consumption of current, where shunt circuits are employed, either for driving the mechanism or for exciting electro-magnets. An elaborate discussion might be started on the price at which the shunt current should be debited in the company's accounts. Is it, for example, part of the current sent out to the consumer and chargeable to the total cost of production, or to "sheer" cost, or merely to cost of fuel? Engineers who will wrangle over the question of charging coal shovels to plant or to consumable stores, neglect this shunt current altogether. It has been pointed out by Mr. SWINBURNE that at 2d. per unit every watt lost in a shunt instrument is equal to the interest on £1 at 7 per cent., and that the saving of 10 watts therefore makes an instrument £10 cheaper. When meters are being sold at £6 or £7 each, this question must be seriously considered. There are in London alone, excluding the City, according to the last Board of Trade accounts, some £45,680 worth of meters. This is no less than one twelfth of the value of the "machinery and plant" at the stations, which amounts to £545,062. It is not fair to the consumers to say—it matters not whether meters cost £5 or £10, the cost is amply covered by rentals, for in many cases, especially in offices, the rental is a very perceptible part of the cost of lighting, and this is brought home to the consumer when he sees the charge in all its simplicity in the bill for the summer quarter. Were meters cheaper, rentals could be reduced without affecting the present rate of profit on capital outlay. Meters, then, form no inconsiderable part of the plant of a supply company, and the accuracy of the meters of course has a direct effect upon the revenue. Nor can the errors of meters be expected to cancel each other out, for a cautious consumer here and there will have his meter tested, especially if he has reason to think that it is erring in favour of the company. But of the meters which err in favour of the consumer less will be heard. We hope that the subject will attract more interest than hitherto. So great ingenuity has been spent on the designs, and such excellent results have been obtained, that the study of the construction of modern meters will amply repay the trouble spent on it.

OBITUARY.

SIR GEORGE ELLIOT.

We regret to announce the death, on Saturday afternoon last, of Sir George Elliot, Bart., well known in the electrical world on account of his early connection with submarine telegraphy.

Sir George Elliot was a typical Englishman. Born at Gateshead in 1815, and beginning life, as he often proudly boasted, at the bottom of a coal-pit, he worked through every stage of the industry with which his name is so widely connected. He early succeeded in creating for himself a fortune, which enabled him to take the place and exercise the influence belonging to energy of character, and shrewd, practical intelligence. In 1849 he acquired the business of Messrs. Kuper and Co., wire-rope makers, from the assignees of the firm, paying off their liabilities in full, and giving a handsome sum to Messrs. Kuper for the reversion. In this business he invited Mr., afterwards Sir, R. A. Glass to become a partner, and that gentleman in 1852 first adapted the principle of wire-covering for submarine cables which, successfully protecting them from the perils of the deep, had its share in the development of submarine cable industry to its present enormous proportions. The story of the laying of the Atlantic cable is well-known. After the failure of the cable which had been successfully laid in 1858, the Company were, from 1858 to 1864, engaged in raising new capital, and scientific men were making improvements in the form of cable and in

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the apparatus for submerging it. Then the Telegraph Construction and Maintenance Company was formed, with Sir John Pender as Chairman, and absorbed the firm of Glass and Elliot and the Gutta Percha Company, and an entirely new cable, much thicker and more costly than the former one, was manufactured. The 2,300 miles, weighing more than 4,000 tons, of which this cable consisted, was shipped in 1865 on board the "Great Eastern," and when over 1,000 miles had been paid out the cable snapped by overstraining, and the end sank to the bottom. A new cable was constructed with a sufficient addition of the 1865 cable to repair the disaster of that year; and in 1866 both this new cable was laid and the lost cable of 1865 recovered and completed. Upon this occasion Mr. Glass received the honour of Knighthood. The firm subsequently became, and is now known as, Elliot and Co., wire rope makers, of Great George-street, Westminster; Cardiff and Durham. Sir George Elliot fought several severe political contests and represented South Durham in Parliament for many years, receiving his Baronetcy from Mr. Disraeli in 1874. At the time of his death he was Chairman of the Telegraph Construction and Maintenance Company and a Director of the Metropolitan Electric Supply Company.

THE HOOKHAM METER.

Since the invention in 1887 of a meter with an armature on a horizontal shaft, the armature being composed of a number of segments or windings, and the field-magnets between which it revolved being furnished with radial grooves to enable it to dipped was on the point of being splashed out of its trough. We only recall these defects in order to make a clear distinction between the present meter and the early instrument which it so little resembles.

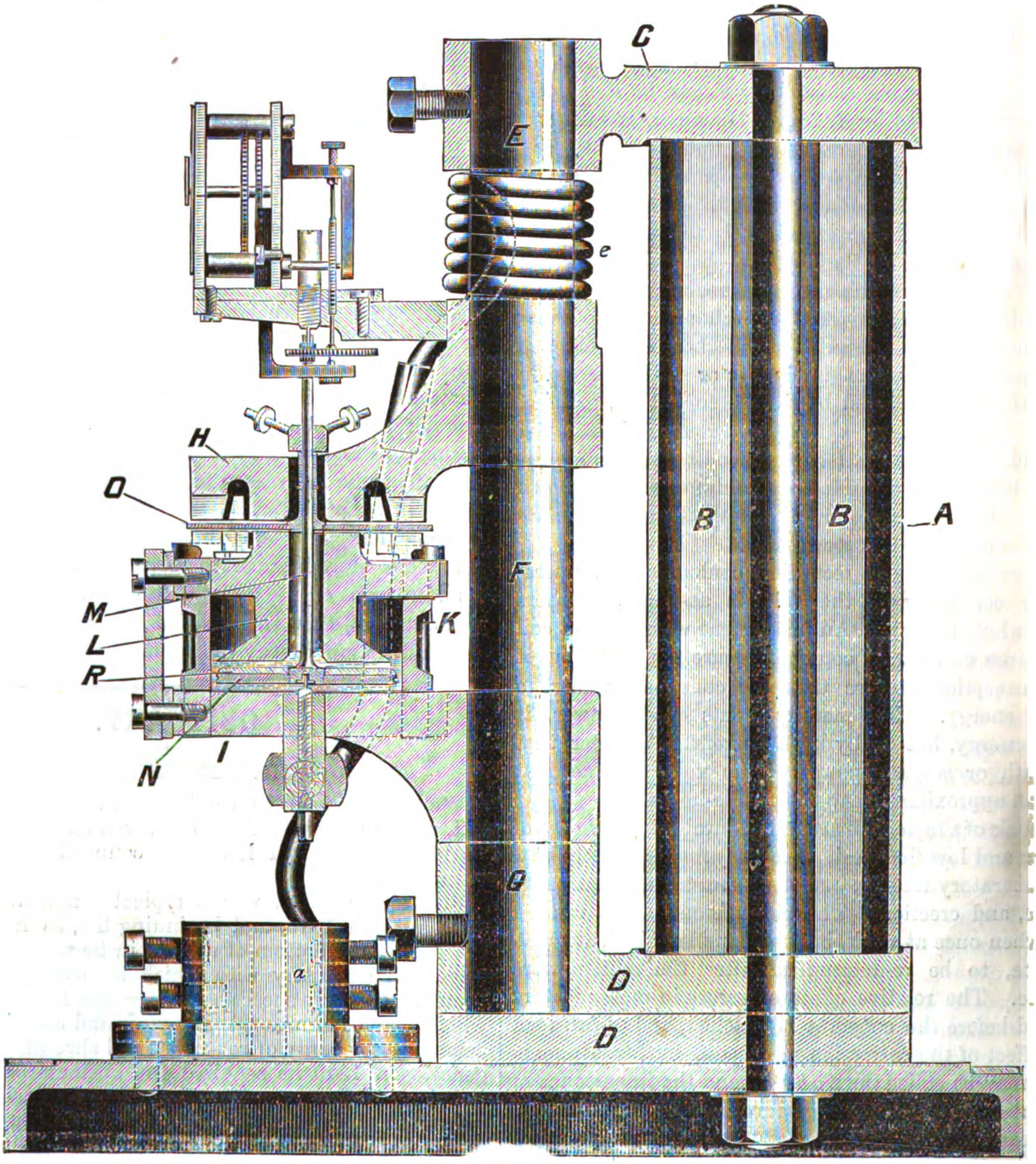

FIG. 1.

act as a magnetic brake, Mr. Hookham has gradually evolved a singularly interesting and valuable instrument. Most meters have been presented to the public in an immature condition, and the early Hookham meter not being an exception, we would call attention to the totally different pattern of the present instrument. The excessive surface friction affected the starting current, and if we remember rightly, at full load, the mercury in which the edge of the armature

The accompanying engravings represent a section and general view of a 50 ampere meter. A brass tube, A, Fig. encloses a number of steel bar magnets, B B. These are firm clamped between the cast-iron caps, C and D. The pilla E F G, is composed of three parts; E and G are wrought ir and the middle part, F, is of brass. Two pole pieces, H and are carried by the parts E and G. The flat upper surface of the pole piece, I, forms the bottom of a mercury cup. A coppe

ring, K, nickel faced on its inner surface, is held against the pole piece, I, by the iron cover, L. This cover is of such a shape that a large recess is afforded, somewhat on the unspillable ink-bottle principle, allowing space for the mercury in case the meter is tilted on one side, or even inverted, and preventing its escape through the central hole This cover spreading out at its foot reduces the magnetic reluctance of the air gap and acts as a pole piece. The armature, N, is a copper disc mounted on a vertical spindle ; it is faced on its

meter of Faure, nothing but the fluid friction of the mercury retarded the armature; but this friction does not follow the same law at high speeds as at low, and is so small that the armature would revolve at an extremely high speed, entailing considerable wear and tear and a longer train of wheels.

As in Mr. Hookham's first meter, a magnetic brake plays an important part, and by separating this brake from the driving part of the instrument special modifications are possible. On the upper part of the spindle, M, a disc, O, is mounted. This

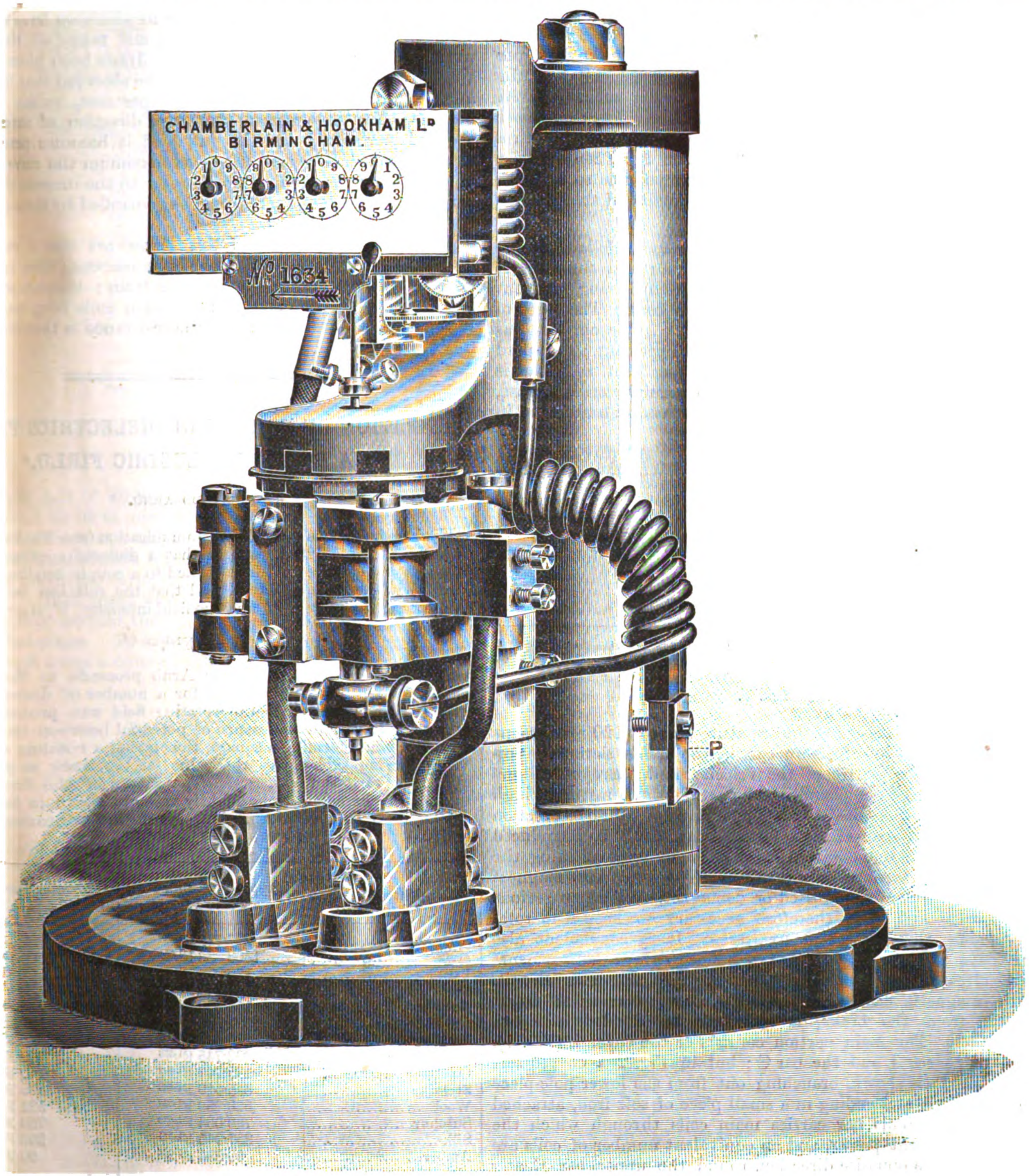

Fig. 2.

upper surface with a disc of vulcanised fibre, R. This acts as a float, and is so adjusted that with the starting current the spindle is almost in equilibrium, tending to rise, and bearing very gently against the upper jewel. The current to be measured enters the disc, N, through the mercury in which it is immersed, and passes radially to the centre, where it is carried off by an insulated conductor. It is clear that the disc will revolve in the strong magnetic field. In the earliest

is made of a special alloy of low but nearly invariable resistance. It runs between the upper part of the iron cover, L, and the pole-piece, H. Each polar surface is cut up by radial grooves as described in the early patent of 1887. The radial slots do not pass through to the centre, but leave a solid cylindrical portion which carries a considerable proportion of the magnetic flux. Radial projections on the lower pole piece (the upper part of the cover, L) embody a very interest-

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ing and ingenious device. It will be seen in the engraving that these projections are notched at their bases, leaving necks or isthmuses. A considerable portion of the induction passes, as we have observed, through the centre, where there are no notches, and where therefore there are no eddy currents or brake force. The rest of the induction has a good magnetic circuit, except at the necks. The iron here becomes nearly saturated. If by any chance the permanent steel magnets become weakened, the torque between the pole-pieces of the driving armature, N, would be reduced; but the retarding force of the brake varies as the square of the induction. If no provision were made, a weakening of the torque by 2 per cent. would be accompanied by a weakening of the brake by 4 per cent. The meter would, therefore, run too fast. But as the necks to which we have referred are nearly saturated, the induction through them would vary very much less than 2 per cent. If perfectly saturated the meter would, indeed, with a 2 per cent. weakening of the magnets, run 2 per cent. slower. By careful experiment it has been found possible so to shape the notches that with any reasonable weakening of the magnets the meter will be practically unaffected.

The value of this arrangement is shown by the following test A few turns of insulated wire were wound round the magnet bars, and a current was passed through them giving sufficient ampere turns to reduce the field by 10 per cent. The speed of the meter was altered only 0·8 per cent. The current was increased until the field was reduced by 15 per cent.; the speed was altered only 1·7 per cent. The 10 per cent. reduction is probably much more than is likely to occur in ordinary use, and we are informed that no such change has been observed in any meters that have been in use.

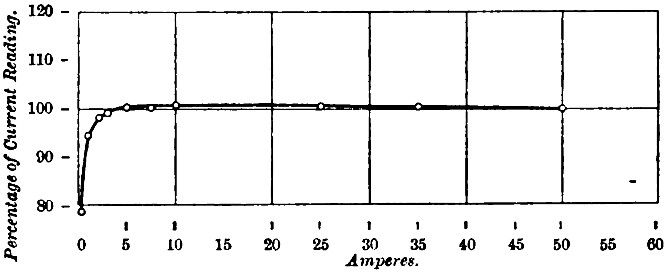

Fig. 3.

The maximum speed of the armature is about 120 revolutions per minute. While for slow speeds, the fluid friction is proportional to the square of the velocity, and therefore follows the law required for controlling the action of the meter, at high speeds this proportionality no longer holds. If no correction were made, an error of 20 to 30 per cent. would be introduced at full load. Compensation is effected by strengthening the field in which the armature revolves. The permanent magnets cannot be further magnetised or demagnetised without serious hysteresis, and it is therefore necessary to keep the total induction through them unaltered. It is convenient also to leave the brake field unaltered, since delicate adjustments are already made in this part of the magnetic circuit. The magnetic circuit of the instrument, tracing it downwards from the brake, is found to be divided into two branches. The main portion consists of the cover L (Fig. 1), the pole-piece I and the bar G; but in Fig. 2 a curved soft iron bar, P, is shown, branching out from the lower pole-piece of the brake, and ending in a small piece of soft iron, attached by a screw. This bar carries main coils through which the working current passes, and an equivalent number of coils are wound in the opposite direction, round the upper bar E at *e* (Fig. 1). This branch of the magnetic circuit is completed across the air-gap between the plate at P (Fig. 2), and the lower part of the main magnetic circuit. The curved bar and its winding is similar in all meters, and is a workshop matter; the piece of iron at the extremity forms a fine adjustment, and is carefully set in position once for all in the testing laboratory.

One more correction remains to be noticed. In all motor meters the pivot friction not only determines the starting current, but is liable to destroy the accuracy of the meter through the lower part of its range. For sensitive starting a very delicate pivot and light thrust is necessary, and it has been argued that such pivots are the weak point of motor meters, for they cannot stand the wear and tear of prolonged work. In the Hookham meter, as we have already observed, the armature spindle floats upwards at very light loads; the upper pivot is fine, and allows easy starting. But as the armature attains speed the mercury below it is flung outwards by centrifugal force, reducing the pressure and pulling the armature down against the flotation of the fibre disc to which we have already alluded. The lower pivot is strong, and takes all the hard work. The accompanying curve (Fig. 3) has been plotted from a test of a 50-ampere meter. It will be observed that it starts low, but with two amperes is only 2 per cent. wrong. At no point is there an error in the other direction of more than about 1 per cent., and at full load it becomes practically exact. If pushed beyond the rated maximum the curve would fall off, the meter running slow, owing to the increase of fluid friction at a greater rate than can be controlled by the magnetic shunt.

The main advantages of this meter are that it requires no winding up; it consumes no shunt current; there is only one moving part besides the counting train; there are no contact makers or commutators; the main coils being used only for a correction are small; and the resistance is therefore low.

DISSIPATION OF ENERGY IN DIELECTRICS PLACED IN A ROTATING ELECTRIC FIELD.*

BY RICCARDO ARNÒ.

Having shown in a preceding communication (see *The Electrician*, Vol. XXXI., June 23rd, p. 201) that a dielectric cylinder placed in a rotating electric field is subjected to a couple tending to make it rotate in the same direction, and that the relation between the energy thus dissipated, W, and the field intensity, F, is given by the empirical formula

$$W = HF^{1.6},$$

where H is a constant, Signor Arnò proceeds in the present Paper to determine this constant for a number of dielectrics. It will be remembered that the rotating field was produced by a harmonically variable difference of potential between two pairs of opposite points forming a square, thus giving a rotating resultant The following table gives the value for the work as performed upon the various dielectrics. The values in the first column assume the exponent to be slightly variable, those in the second assume it to be constant, and represent the approximate value of H:—

Material.	Exponent assumed to be slightly variable.	Exponent assumed to be constant.
Ebonite	$287·718\ F^{1.614}$	$288\ F^{1.6}$
Mica	$1308·888\ F^{1.551}$	$1309\ F^{1.6}$
Paraffin	$120·978\ F^{1.561}$	$121\ F^{1.6}$
Glass	$1388·248\ F^{1.569}$	$1388\ F^{1.6}$
Gumlac	$165·578\ F^{1.579}$	$166\ F^{1.6}$
Gutta-percha	$381·624\ F^{1.557}$	$382\ F^{1.6}$
Sealing wax	$216·383\ F^{1.557}$	$216\ F^{1.6}$
Caoutchouc	$902·745\ F^{1.573}$	$903\ F^{1.6}$
Colophony	$139·747\ F^{1.591}$	$140\ F^{1.6}$
Stearine	$325·619\ F^{1.638}$	$326\ F^{1.6}$
Wool	$520·939\ F^{1.552}$	$521\ F^{1.6}$
Sulphur	$758·064\ F^{1.628}$	$758\ F^{1.6}$
Silk	$257·946\ F^{1.551}$	$258\ F^{1.6}$
Amber	$99·284\ F^{1.633}$	$99\ F^{1.6}$

The dielectrics were moulded in the form of hollow cylinders about 3cm. long, 2·4cm. in diameter, and 1 to 5mm. thick. They were thoroughly dried and then left for some hours in the apparatus itself. The formula found is analogous to that by which Steinmetz represents the work due to magnetic hysteresis, and the results confirm the supposition that the work done in this case is due to electrostatic hysteresis.

* *Rendiconti dei Lincei*, November 12, 1893.

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ELECTRIC LIGHTING AT CHATSWORTH.

A description has been sent to us by Messrs. Drake and Gorham of the generating plant which has recently been put down by them for the supply of some 850 lamps in the private rooms, corridors, and chapel at Chatsworth.

A 15in. pipe was laid, many years back, from a lake on the hills for the supply of the fountains near the house, giving an available fall of 400ft., and as this pipe, upon examination, was found to be in good preservation, it was merely necessary to insert valves at a convenient point for the supply of turbines. The turbines selected were those of the Vortex type, by Messrs. Gilkes, the larger turbines being of 50 H.P. each, and the smaller 25 H.P. The speed of the turbines was arranged to be 1,000 revolutions, so that the dynamo could be coupled direct on the same bed-plate. To avoid the complications due to the supply of current from a dynamo charging accumulators, complications which are owing to the rise of E.M.F. according to their state of charge, the switchboard has been arranged so that the small machine can be employed for charging the accumulators, while the house circuit is run direct from the larger machines, which are connected either singly or in parallel as required. The arrangement also provides for the small machine and the accumulators being worked together in case of emergency for the supply of the house. Precautions are taken in the switchboard to prevent any accident due to the switches being moved in the wrong order. The dynamos were made by Messrs. Siemens Bros. and Co.

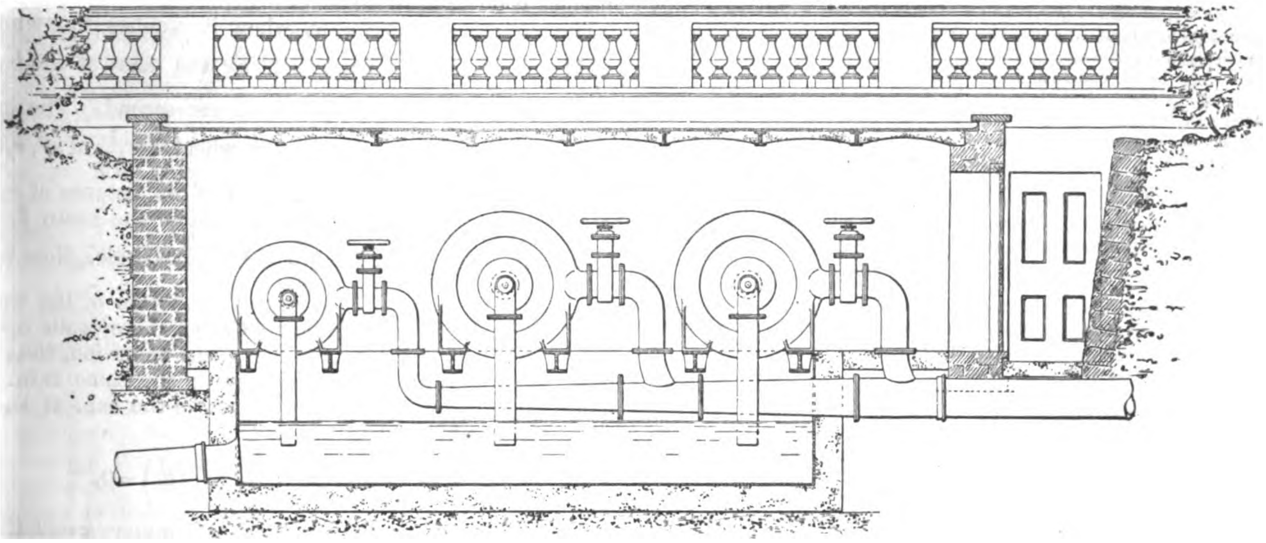

Fig. 1.—Side Elevation of Turbines.

Owing to the high fall available, special precautions had to be taken to prevent any sudden stoppage of the water, which would produce a jar on the pipes. A previous attempt to provide a valve at the lower end of the pipe so as to avoid having to climb the hill whenever the fountains were required, had entirely failed from this cause. To meet this a 3in. by-pass is provided for every valve, so that after the main valve has been closed, the by-pass can be manipulated. This expedient has been found to be thoroughly successful.

The current is conveyed to the house by means of armoured cables more than half an inch in sectional area. This cable leads to the main distributing switchboard in the centre of the building, from which point all the distribution is effected by means of a number of small circuits; a pilot wire being brought back from this point to the dynamo room to enable the engineer to keep the voltage constant at the point of distribution. The voltage at the house is maintained at 105, and the whole of the wiring is on the parallel system. The accumulators are of the "D.P." type, capable of discharging at 120 amperes for four hours. Endeavours have been made to simplify the arrangements and to avoid all complicated apparatus. The work was carried out by the contractors with the assistance of the Estate staff, working under the direction of Mr. Martin, the agent, and Mr. Woodhead, the Clerk of Works.

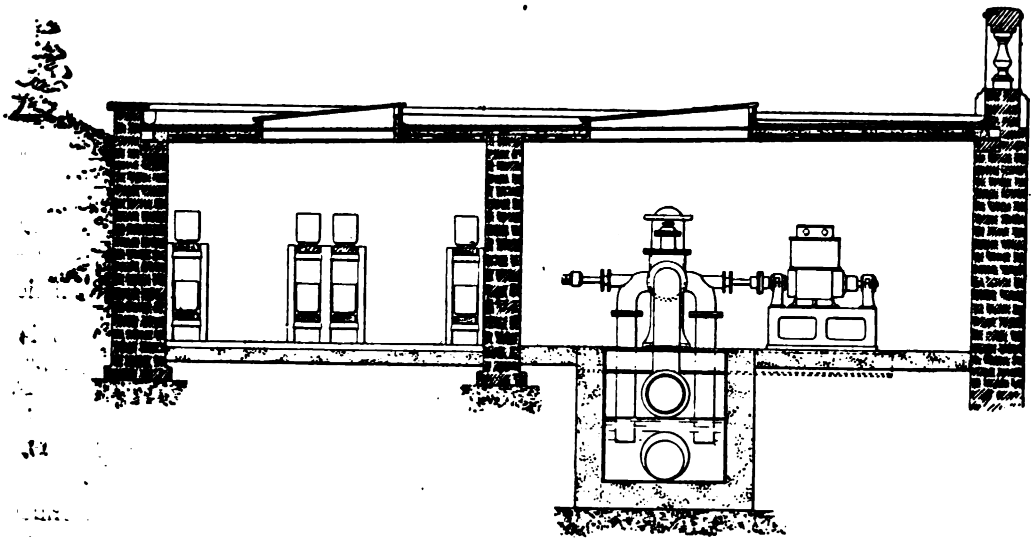

Fig. 2.—Section, showing Accumulators, Turbine, and Dynamo.

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LEGAL INTELLIGENCE.

The Medical Battery Company (Limited).

C. B. Harness, Managing Director of the Medical Battery Company, J. M. M'Cully, and C. B. Hollier, surrendered on Wednesday to their bail before Mr. Hannay, at Marlborough-street, to answer the charges of having conspired together to obtain money by false pretences from various persons.

Mr. T. E. GATEHOUSE was recalled and further cross-examined by Mr. Avory. He said he would recommend the use of electricity for neuralgia and paralysis of the arm or any limb of the body. He did not know that he would recommend electricity for any other diseases. From experiments he had made during the last five weeks, he found that a Harness belt would not contract the muscles or nerves of recently-killed frogs. He came to the conclusion that one milliampere was the minimum dose of electricity to be given, because the nerves of the human body were less sensitive than those of frogs. He was of opinion that a current of one milliampere would produce no effect upon the body unless repeatedly made and broken. The current to be obtained from a Harness belt applied to the average human body (when properly connected) would be from one-hundredth to four-hundredths of a milliampere. Even if the body were very moist, in his opinion the current would not amount to two-tenths of a milliampere. It would not amount to one-tenth unless artificial moisture was applied. He thought Mr. Joel said in his evidence that from a belt worn on his own body he had obtained a current of two-tenths of a milliampere, and he also stated that he measured the resistance of the human body with a Wheatstone bridge and a battery, which was an entirely fallacious method. He did not dispute that the belt might ring a bell without the use of a concealed battery by the aid of an electrolyte. The sores were produced by the chemical action of the perspiration on the zinc, which produced oxychloride. He agreed with Dr. Lewis Jones that impurities in the zinc in the presence of moisture would produce electricity, and ordinary commercial zinc did contain impurities. As soon as the webbing of the belt got saturated with the moisture of the body the electricity passed through the webbing and not through the body. He had proved that by experiment. He looked upon Dr. Harries as an authority upon electro-therapeutics, and he coupled him with Dr. Lewis Jones in his Paper. He had no knowledge of what Mr. Lynd knew about electro-therapeutics. He could not say whether he described Mr. Lynd in 1887 or 1888 in the *Electrical Review* as a gentleman who had made electro-therapeutics a special study. Until Mr. Lynd was in the witness-box in the present case he did not know that he had set up an establishment similar to that of Harness. He believed he heard Mr. Lynd admit having written the letter of December 8, 1886, produced. The witness, after reading it, confessed that he did not understand its contents. He understood that Mr. Lynd in that letter recommended that belts should be made without any metal connection between the zinc and the copper.

Mr. R. W. SELLMAN was recalled, and his examination-in-chief continued: He said he knew Sharman, who had been the advertising manager at Oxford-street, for the last three or four years. He knew there was an association connected with the premises called the British Association of Medical Electricians, and he believed Mr. Harness, Dr. Carter Moffatt, and Mr. Sharman were members of it. Six years ago the witness was present as a vocalist at the *matinées* given at 52, Oxford-street. He used to sing there daily. He saw, to the best of his knowledge, bells rung by belts. He did not see how it was done, because he was in a back part of the room. He saw incandescent lamps lighted.

At this point Mr. HANNAY again adjourned the case for a week, allowing the defendants the same bail as before.

Edison-Bell Phonograph Corporation v. Edison Phonograph Company.

Mr. Justice Day, in the Queen's Bench Division last week, heard an application made by the representatives in this country of Mr. Edison, seeking an injunction restraining the "Edison Phonograph Company" from infringing two patents, the property of the Edison-Bell Phonograph Corporation.

The defendants did not appear, and the plaintiffs obtained judgment with costs, the damage sustained by the plaintiffs to be ascertained.

CORRESPONDENCE.

MOTIVE POWER AND GEARING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should like to suggest that, in the interesting discussion between Mr. H. T. Brydon and Mr. E. Tremlett Carter, found in your last week's Correspondence column, a definition of the point at issue is missing, viz., the definition of Force. Mr. Brydon argues that, if force and resistance are equal, no work can be done; and Mr. Tremlett Carter says: "His statement is simply untrue and opposed to the facts of dynamics," and also, "To every action there must be an equal and opposite re-action. This is universally true, whether of bodies at rest, in uniform motion," . . . &c.

It occurs to me to ask: Does the latter statement represent "facts of dynamics," or does it represent fiction of dynamics?

In dynamics Force is by definition $M\frac{L}{T^2}$. Since time enters into the force of dynamics, this force can not exist apart from motion. In words: Force is the length-rate of change of energy.

A body of falling water transmits energy on to the water-wheel; that changes it on to the flour disintegrator; that changes it on to other matter.

The energy in the water, when it reaches the wheel, is $\frac{1}{2g}Mv^2$ foot-pounds, M representing the mass of the body of water in lbs., v its velocity in feet per second. The energy in the water, when it leaves the wheel, is $\frac{1}{2g}Mv_f^2$, v_f being then the velocity of the water. If L be the distance of contact between water and wheel, in feet, and F the mean force of the transmission, then $F=\frac{1}{2g}M\frac{v^2-v_f^2}{L}$ pounds. Now for the equal opposite force: The direction of motion of the water is the direction of F. By Tremlett Carter there is an opposite equal force. This means, by the given definition, that there is an opposite exchange of energy at the same rate. The resulting change rate of energy must be the sum of the two, hence the resulting force,

$$F_s=\frac{1}{2g}M\left(\frac{v^2-v_f^2}{L}-\frac{v^2-v_f^2}{L}\right)=0.$$

It is safe to predict that under these circumstances, the rate of change of energy being zero, the rate of the flour-production will also be zero, which is in accordance with Mr. Brydon's suggestion.

There is yet a simpler way of wording the meaning of the equation—

$$F=\frac{1}{2g}M\frac{v^2-v_f^2}{L}$$

The force is the diminution of the v^2 of the water per foot of its journey in contact with the wheel. *Ergo*, the equal opposite force must be an equal increase in the v^2 of the water during the same journey. Result: the water must leave the wheel with the velocity with which it reached it, and no work can be done in the mill unless the mill be a *perpetuum mobile*.

Experience shows, however, that the water loses velocity, and the temperature rises in the things inside the mill. If we read Clausius, we find that the temperature rise means an increment in the v^2 of the molecules of the things, which, when multiplied by their mass, brings out the same quantity of energy which the water lost through the length L.

But to say that, at the action of the water on the wheel, there is an equal reaction, and then to let action and reaction stand as the equivalents of a force and an opposite force of dynamics, where force is $M\frac{L}{T^2}$, is pure fiction.

Perhaps Mr. Tremlett Carter's force is not at all the equivalent of the length-rate of a change of energy.—Yours, &c., F. V. ANDERSEN.

14, Westdown-road, Catford Bridge,
London, S.E., December 26, 1893.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I may satisfy Mr. Andersen that "Mr. Tremlett Carter's force" has the dimensions MLT^{-2}, as required by him. There is no specific difference between "the force of dynamics" (as Mr. Andersen calls it) and any other force; the dimensions of all forces are the same, and their relation to energy and motion identical. I would submit that if the total effort in any case is greater than the total resistance, then the energy expended by the effort is greater than that absorbed by the resistance; and, as a consequence, the energy lost by the acting body is greater than that acquired by the resisting body, so that energy is annihilated, and the doctrine of conservation cannot be applied to energy.

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When Mr. Andersen carefully adds the energy expended by the water to the energy absorbed by the flour mill, giving the one a positive and the other a negative sign, he discovers what is perfectly true, namely, that that sum is equal to zero. But when he assumes that because the sum is zero therefore no flour will be ground, he is unscientific. He might as well say that if I spend £10 and a shopkeeper receives the £10, then, giving the one £10 a positive and the other a negative sign, since the two added together are equal to zero, it is impossible I can have bought anything.

Once again let me appeal to Newton's laws of motion, which, despite the bad logic of paradoxists, have not yet been shaken. It can be shown experimentally that if we take a mass, M, and act on it with a constant force, f_1, at the same time opposing its motion by a lesser force, f_2, both forces acting in the line of motion; then the acceleration of the mass will be

$$a=\frac{f_1-f_2}{M},$$

whence $$f_1=f_2+M\,a.$$

Now, the dimensions of a are $L\,T^{-2}$, so we may express this as $$f_1=f_2+M\,L\,T^{-2}.$$

By Mr. Andersen's own showing $M\,L\,T^{-2}$ is the expression for force. Call this force f_3; then

$$f_1=f_2+f_3.$$

Now I, in common with most if not all writers on the subject, call the force f_1 the *total effort*; I call the force f_3 the *inertia resistance* of the mass; and I call the sum of f_2 and f_3 the *total resistance*. Whether it is "pure fiction" to say now, on the basis of these definitions, that the total effort is always equal to the total resistance, I leave it to Mr. Andersen to judge.—I am, &c., E. Tremlett Carter.

December 28, 1893.

COLOGNE CENTRAL STATION STATISTICS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Herr Feldmann's figures are interesting as showing the best figures that have as yet been obtained in Germany—still, in spite of your remarks, I do not think we English engineers have much to fear from comparison. Cologne has a good load factor, fuel is cheap, and as management charges are shared with the gas and other departments, they can be kept low as at Bradford. Still, taking the figures as they are, Herr Feldmann's figures for the year ending March 31, 1893, do not compare well with the Bradford half-year ending June, 1893, or the Liverpool figures ending December 31, 1892, as the attached small table shows very clearly.

—	Cologne. 310,000 units.		Bradford. 410,540.		Liverpool. 796,281.	
	Sum spent.	Per unit.	Sum spent.	Per unit.	Sum spent.	Per unit.
	£ s. d.	d.	£ s. d.	d.	£	d.
Coal	990 16 0	0·766	486 0 1	0·282	2,430	0·73
Water and petty stores	133 16 0	0·106	62 4 8	0·036	500	0·153
Wages	963 17 0	0·746	580 0 0	0·34	1,260	0·382
Repairs & maintenance	1,067 3 0	0·91	406 10 7	0·237	1,891	0·599
Management and other expenses	1,374 16 0	1·06	474 0 0	0·277	1,891	0·599
Total	4,518 8 0	3·5	2,008 16 3	1·17	8,052	2·42

Even when we compare several items with corresponding items of our London stations of equal output for half-year ending June, 1893, Herr Feldmann's figures are nowhere.

—	Cologne: 154,900 units.	Knightsbridge: 152,176 units.
	d.	d.
Coal	0·76	0·64
Water, &c......................	0·106	0·08
Wages	0·746	0·21
Repairs and maintenance	0·91	0·66
Total works cost	2·52	1·59

The price of fuel at Cologne is about 14s. 6d. a ton, and at Knightsbridge £1. 0s. 6d. The load factor at Cologne is 16 and at Knightsbridge 12. The actual weight of fuel used is 11·8lb. per unit at Cologne and 5·8lb. per unit at Knightsbridge.—Yours, &c., R. E. Crompton.

AIR CORE TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I observe in your issue of November 3rd a brief abstract of Mr. E. C. Rimington's Paper on "The Behaviour of an Air Core Transformer when the Frequency is below a Certain Critical Value," in which is brought forward the phenomenon of increased impedance and consequent decrease of current in the primary circuit, observed on closing the secondary circuit under certain conditions, which, for a particular case, are given in the Paper.

Although obvious to many, it may be of some general interest to state that the effect may generally be observed by anyone possessed of patience and a small induction coil of the usual pattern. The break, of course, must be disconnected and the primary excited by alternating currents.

About four years ago the phenomenon was observed at the laboratory of Prof. Elihu Thomson, and a note-book has a note, under date of December 31, 1889, a transcript of which is as follows:—

"December 31, 1889.

"Put primary of small Rhumkorff coils in series with nine lamps arranged in multiple arc, thus exciting it with an alternating current of about 10 amperes. When secondary circuit of coil was closed through Geissler tube, or conductor having high resistance, marked fall occurred in candle-power of the lamps used as resistance in the primary circuit. The impedance of primary was thus apparently increased; when secondary was closed through very low resistance, lamps brightened as usual."

The coil referred to, when used with break, gave about $1\frac{1}{4}$in. sparks; it was about 7in. long, secondary wound with No. 32 wire. The primary winding consisted of two layers No. 11 (0·09in. diameter) wire. Core was made up of exceedingly fine iron wires, and was one inch in diameter. The frequency was that at which the alternators of the Thomson-Houston Electric Company were run, *i.e.*, 125 periods per second.

The Geissler tube referred to was intended for use as a short-circuiting device; it was fitted with electrodes that came quite near together midway of the length inside the tube. A water rheostat was used for resistance.—Yours, &c., R. Shand.

Lynn, Mass., December 5, 1893.

THE PAST YEAR'S WORK.

Messrs. Anderson and Munro.—Like the majority of Glasgow firms, business has been brisk during the past year with Messrs. Anderson and Munro. The installation at the Clydesdale Bank consists of nearly 400 16-c.p. incandescents, and is noticeable for some excellent electrolier work executed by Munro's Electrical Manufacturing Company. One pendant electrolier of polished brass work is fitted for 40 lamps. The installation is nearly completed, to the plans of Dr. J. T. Bottomley, F.R.S.

Messrs. Clarke, Chapman and Co.—An extensive list of electric lighting installation contracts carried out by this Company during the past year includes no less than 25 large vessels, amongst them the cable steamer "Mackay-Bennett," for the Commercial Cable Company. Messrs. Armstrong, Mitchell and Co. have entrusted the lighting of seven of their new vessels to the Company. In addition to ship-lighting, for which the firm have special facilities, the list includes the lighting of the large dye works at Holmhead; the supply of two complete Suez Canal plants for Messrs. W. C. Martin and Co.; the lighting of Eldon Colliery, Bishop Auckland, including a pumping plant; and the docks, shops, and offices for both the Wallsend Slipway and Engineering Company and the Mercantile Dry Dock Company at Jarrow.

Messrs. Drake and Gorham.—In a review of the work of the past year this firm have to record very satisfactory progress, the amount of business representing nearly 150 installations, representing about 13,000 16-c.p. lamps. This list includes an extensive installation at Chatsworth for the Duke of Devonshire, 850 lights; Callaly Castle, 600 lights; Rhinefield, 550 lights; Great Northern Railway Company's new offices, 650 lights; the head offices of the Bank of England, 550 lights; the remainder averaging from 80 to

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400 lights. The Chatsworth installation includes a Turbine Plant, and the motive power in many of the installations is a Petroleum, Gas, Steam, or Turbine Plant.

MANCHESTER EDISON-SWAN COMPANY (LIMITED).—We have received from this Company a formidable list of installations carried out during 1893, consisting in all of 60 installations, not reckoning those nearly completed or just commenced. The list includes many of the principal business premises in Manchester, Blackpool, Preston, Liverpool, Rochdale, &c., in addition to the Blackpool Winter Gardens, the Literary and Philosophical Society, Manchester, the Royal Infirmary, Manchester, the Great and Little Co-operative Societies at Bolton, Prince's Theatre of Varieties at Reading, from which it will be seen that the Company, notwithstanding the general depression, have been fairly well occupied during the past year.

MESSRS. J. H. HOLMES AND CO.—During the past year this firm have built more than 170 dynamos of the "Castle" type for use in lighting, power transmission, and electro-deposition, varying in size from one-half to 200 E.H.P., the total combined output being 2,343,335 watts, equal to 3,141 E.H.P. The firm have been especially busy in ship lighting, and several of the largest vessels built during the past year have been fitted complete. Mill lighting contracts have included cotton spinning mills at Ashton-under-Lyne, Heywood, near Manchester (2), and Stockport. A 1,500-light contract has been carried out for Messrs. Walker, Reid and Co., at Dunfermline. Considerable attention has been paid to the production of the firm's latest type of drum-bar dynamo, in which machine the armature conductors, having to take heavy currents, are made in the form of laminated copper bars, connected across by means of spiral end connections. These armature cores are built up of thin discs of the best Swedish charcoal iron, and are insulated from each other with paper to prevent undue heating. A fan is mounted on the shaft, causing a current of air to pass through the core. A machine of this type of 120-unit capacity has been built for the Aluminium Company at Oldbury, and, when tested by Prof. A. B. W. Kennedy, gave an efficiency of 98 per cent. Amongst the contracts in hand is one for Messrs. Joshua Smith (Limited), of Manchester, for 1,100 lights; the Vulcan Spinning Mill, at Bury, 1,060 lights; and four large sugar mill installations in the West Indies. It will be seen that Messrs. Holmes and Co. have obtained their fair share of the work of the year in all parts of the world, as, of three large mill installations in the list one is at Nicaragua, another in Java, and another in South America.

MESSRS. MAVOR AND COULSON.—This Glasgow firm have been very busy during 1893, and included in the heavy contracts obtained is one for an installation of 3,000 16-c.p. incandescents for a woollen factory at St. Petersburg, about half of which has been completed, including the supply of the necessary plant, apparatus, &c.

MESSRS. RUSSELL AND CO.—This firm notify us that during 1893 a fairly brisk business in installation work has been done, including country and town houses, shops and factories, &c. The contracting business of Mr. Medhurst, at Cambridge, which was taken over in August last, has brought in a number of orders for Cambridge and district, including some from the Clare College authorities and the Corporation. In anticipation of the skating season a large field in the neighbourhood is being temporarily installed with the electric light.

WOODHOUSE AND RAWSON UNITED (LIMITED).

The following is a list of the principal creditors in this failure. The actual number of creditors over £10 reaches the formidable total of between 270 and 280. It will be seen that, owing to the very large number of firms to whom Messrs. Woodhouse and Rawson extended their favours, only in a few cases does the amount of indebtedness reach a considerable sum. The bankers' claim is unusually small :—

	£	s.	d.
Adams (G.) and Son, Wolverhampton	307	5	4
Armitage (Sir A.) & Son, Manchester	43	3	0
Austin & Myers, Armley	76	12	6
Bates, Hendy and Co., London	223	6	9
Bankers' claim	32	4	6
Bayley Bros., Walsall	60	11	5
Beardmore and Co., Glasgow	42	11	6
Belfast Electrical Appliances Co., Belfast	53	4	0
Best and Lloyd	161	0	0
Billington and Newton, Longport	57	2	10
Binney, C. W., London	84	1	0
Binney and Son, Birmingham	40	12	5
Blake Bros. and Sons, Brighouse	124	4	2
Botton (T.) and Sons, Manchester	159	13	4
Bower G., St. Neots	32	2	2
Bolling and Lowe, London	86	0	7
Bonn, J., London	70	10	0
Bristol Wagon Works, Bristol	66	4	10
Browne, T. B., London	67	7	4
Brush Company, London	22	3	1
Cape Times, Cape Town	125	0	0
Carr (G. A.) and Co., Grimsby	200	0	0
Chamberlain (H. and F.), Barnsley	16	4	9
Cochran (H. & R.), Glasgow	54	10	6
Coglan & Drury, Leeds	88	11	9
Coes, L., London	145	12	7
Collin (J.), Manchester	52	12	6
Conradty (C.), Nuremberg	30	6	2
Currie (H. T.) and Co., Liverpool	59	8	0
Davis and Timmins (Limited) London	13	11	3
Dixon & Co., Liverpool	60	9	4
Dodman, A., King's Lynn	37	0	0
Donkin, B. (London)	159	4	6
Dunlop, Bell and Co., Liverpool	178	0	0
Electrical Accessories Co., London	11	16	11
Electrical Engineer, London	34	10	0
Electrical Review, London	93	14	0
Electrician Printing and Publishing Co., London	80	17	6
Electric Construction Co. (Limited), London	51	0	0
Electric Light Co., Australia	293	0	0
Electric Supply Co., Chicago	39	15	10
Engineer, London	139	4	0
Englebert and Co., London	27	0	C
Fossick & Co., London	26	8	3
General Electric Co., Manchester	53	8	8
Glenfield Co, Kilmarnock	40	14	2
Glover (Walter T.) and Co., Salford	139	0	6
Goolden (W. T.) & Co., London	24	11	11
Greenwood & Batley, Leeds	111	2	6
Hadfield's Steel Foundry Co., Sheffield	81	0	5
Hicks (W.), London	85	6	0
Hollingshead (Ed.), Tunstall	38	14	3
Holmes (J. H.) & Co., Newcastle-on-Tyne	134	18	3
Hordern (A.) and Son, Sydney	52	17	11
Illingworth, Ingham and Co., Leeds	27	5	3
Ironmonger, London	52	10	0
Japy Frères, London	55	8	9
Jenisch and Boehmer, Berlin	33	8	6
Johnson (H.) and Sons, London	33	11	0
Johnson (W. H.) & Co., New York	36	12	4
Joyner (C.) and Co, Birmingham	30	12	3
Kelly and Co., London	42	19	6
Kitson and Co., Leeds	42	13	7
Lacombe and Co., London	25	0	1
Lathom, J., London	86	17	0
Laurence, Scott & Co., Norwich	80	19	0
Lee, C., London	38	7	9
Lithanode and General Electric Company, London	11	2	8
Lloyd and Lloyd, London	14	2	4
MacIntyre (J.) and Co., Burslem	243	1	6
Marsden and Co., Manchester	36	8	0
Mather & Platt, London	53	19	2
Mellor (Moses) & Sons, Nottingham	39	1	9
Mosses and Mitchell, London	58	17	0
Musgrave (J.) and Son, Bolton	27	5	0
Nash, Bond and Co., Birmingham	73	1	10
Naylor (R. A.), Warrington	56	15	8
Oucking (G. A.), Belgium	40	0	0
Patent Nut and Bolt Co., Birmingham	34	15	7
Perfect Hydraulic Valve Co., Leeds	46	1	4
Phosphor Bronze Company (Ltd.), London	26	19	8
Pitkin, J., London	19	17	5
Quitman, Carl, London	64	8	1
Rashleigh Phipps and Dawson, London	10	12	2
Rawson, F. L., London	117	0	6
Rawson, H. G., London	80	1	6
Richard Frères, London	13	17	1
Richardson (H. G.) and Son, Stourbridge	40	10	2
Rickard (W.), Derby	27	9	9
Roberts (J. & S.), West Bromwich	232	9	6
Russell (T.) & Sons, Ltd., Wednesbury	64	9	7
Sankey and Sons	50	8	8
Seeger and Guernsey Company, London	35	15	0
Sheppard, Allarton and Madeley, Birmingham	26	18	3
Siemens Bros. and Co. (Limited), London	159	17	1
Smith and Sons, London	133	18	2
Snell (A. B.), London	58	0	3
Spencer (J. E. and W.), London	17	10	4
Spencer (M.) & Sons, Sheffield	73	14	6
Spenser Turner, Newcastle-on-Tyne	68	3	8
Spon (E. and F. N.), London	199	8	0
Stubbs (P.), Warrington	72	18	0
Swan, Sonnenschein & Co., London	35	15	0
Tannahill (A.) and Co., London	22	5	2
Taylor (C.)	30	4	11
Telegraph Manufacturing Co., Helsby	51	9	10
Tookey (J. T.) and Co., Sydney	100	0	0
Town Hall, Durban	77	14	3
Tullis (J.) and Son, Glasgow	82	12	7
Underwood (J.) & Co., New York	33	16	8
Walker (P. B.), Sydney	37	12	10
Ward, J. W., Sheffield	104	7	2
Webb (B.), London	54	19	2
Western Electric Co., London	86	5	4
Westinghouse Electric Co., London	25	10	11
Wheatley Kirk, Price, and Goulty, London	38	8	4
Whitehead, Morris, and Co., London	70	1	0
Wiggins & Son, London	12	9	2
Willcox (W. H.) and Co., London	13	8	0
Woodhouse and Rawson Supply Company	138	14	11
Wood (W.) and Co., Burslem	147	6	10
Worthington Pump Co., London	25	17	10
And other creditors under £30			
	£14,464	6	6

	£	s.	d.
Fully-secured creditors	£30,491	19	9
Other liabilities	249	2	8
Expected to rank.			
Preferential creditors	940	2	1
STATEMENT OF AFFAIRS.			
Liabilities	14,713	9	2
Assets, after deducting preference claims and loans on debenture bonds	44,349	17	5

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1893 Edition of "'THE ELECTRICIAN' ELECTRICAL TRADES DIRECTORY AND HANDBOOK" contains over 1,000 pages, several new and handy features having been added. Price 7s. 6d., post free 8s. 3d.; abroad 8s. 10d. *Comparison with any similar electrical publication is specially invited.*

The 1894 Edition is in preparation, and will be published in January. *New names, alterations of addresses, &c., should be sent in at once.* Full printed particulars can be obtained, post free, from "The Publisher," *Electrician* Office.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, which has a special interest at the present time, is now ready, and will be forwarded on receipt of the published price, 7s. 6d. (abroad 8s.), or it may be obtained from any bookseller. A prospectus can be obtained on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—This book, written by Mr. F. Marten Weymouth, is also ready, and will be sent direct on receipt of the published price, 7s. 6d. (abroad 8s.), or it may be obtained from any bookseller. A prospectus will be forwarded free on application.

TENDERS INVITED.—The Swansea Harbour Trustees invite tenders for the working, maintenance, and renewal of their electric light machinery and plant for five years (subject to earlier determination by the trustees). Particulars of Mr. Strick, Harbour Offices, Swansea.

TENDERS ACCEPTED.—The following tenders have been proposed for acceptance by the Highways Committee of the Sunderland Corporation for the supply of plant and apparatus for the introduction of the electric light into the borough. At the next meeting the Town Council will be asked to confirm the acceptance of these tenders, and to grant the committee permission to raise a loan not exceeding £25,000 for the carrying out of the whole scheme. The total amount of the tenders is £15,074, against an estimated sum of £21,000. Boilers and mountings, Hawkesley Wyld and Co., Sheffield, £1,380; engine and dynamos, Messrs. J. H. Holmes and Co., Newcastle, £4,340; motor alternators, Carlton Company, Chelmsford, £1,352; batteries, Electrical Power Storage Company, £763; insulated cables, India Rubber Works, Silvertown, £2,592; road work, Messrs. Simpson, Newcastle, £2,590; ironwork, Messrs. McLaren, Glasgow, £296; stonework, Messrs. Wilks and Maplebeck, Birmingham, £236.

CHANGE OF ADDRESS.—Major-General Webber, C.B., consulting electrical engineer, has removed his office from Portland House, Basinghall-street, E.C., to No. 27, Chancery-lane, London, W.C.

EXTENSION OF BUSINESS.—Messrs. Smiths and Co. (Limited), of George-street, Edinburgh, have added an electric lighting branch to their old-established business of lamp and oil dealers, under the management of Mr. W. Finlay.

DISSOLUTION OF PARTNERSHIP.—Messrs. H. C. H. Smyth and R. E. Holdom, carrying on business as electrical engineers, at 2, Great Russell-street, London, W.C., under the style of Smyth, Holdom and Co., have dissolved partnership. The business will be carried on by Mr. Smyth.

BANKRUPTCY.—A receiving order has been made in the estate of Free Chilton, carrying on business as an electric, cycle and general engineer, at 19, Adelaide-street, and Wellington-street, Luton.

ELECTRIC LIGHT CARBONS.—It has long been a reproach that the carbons used in this country for electric lighting are all supplied either from the Continent or from America. It has been for some time past in contemplation to erect a carbon factory in England, and the English Electric Carbon Company (Limited), of Brymbo, near Wrexham, has been formed with this object. The Company have decided that, for the present, only carbons of the highest quality, equal to the best Continental brands, are to be manufactured. The chairman of the new Company is Mr. J. H. Darby, the remaining Directors being Sir H. B. Robertson, and Messrs. J. C. Edwards, W. Darby, and Emil Mahla. The secretary and manager is Mr. T. G. Littleboy.

ELECTRIC POWER IN WELSH MINES.—Amongst other recent improvements at the pits belonging to the Aberdare Merthyr Collieries Company, electricity has taken the place of steam-power for working the pumping arrangements below ground.

"CONSTANTINOPLE IN LONDON."—We illustrate below some special designs of lamps and lamp fittings, used in the lighting of the extensive show now being held at Olympia, London. These lamps and fittings have been manufactured by Messrs. Benham and Froud (Limited) from the designs and under the supervision of Mr. R. M. Laws, the Company's manager. There can be no doubt that these elaborate displays, if not almost impossible without the aid of the electric light, are at least rendered doubly effective by its use. It is to meet an actual demand that Messrs. Benham and Froud have incurred heavy expense in manufacturing this special type of fittings for "Constantinople in London," and

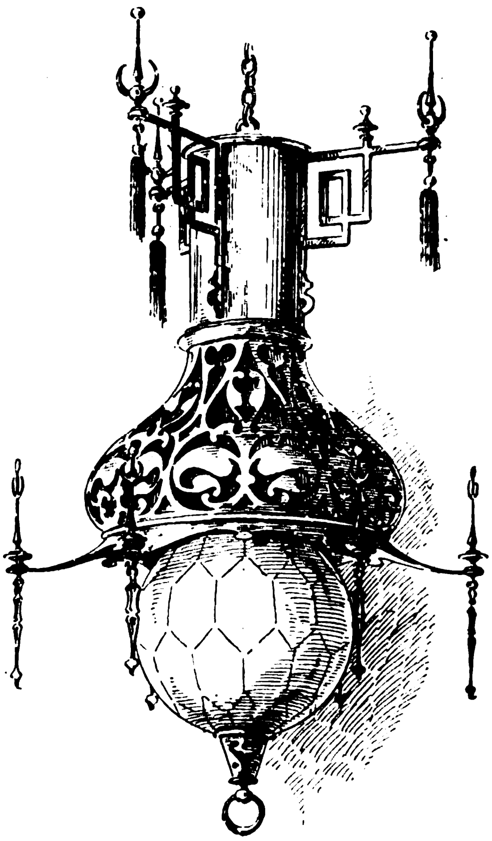

FIG. 1.

doubtless this enterprise will find ample recognition in the future in the adoption of similar artistic fittings for other national displays, which will doubtless follow "Venice" and "Constantinople." The firm have had great experience in this class of work, and in no case have they been more successful than at Olympia. The effect of the magnificent show is considerably enhanced by the remarkable fidelity to the general surroundings shown in the special designs under

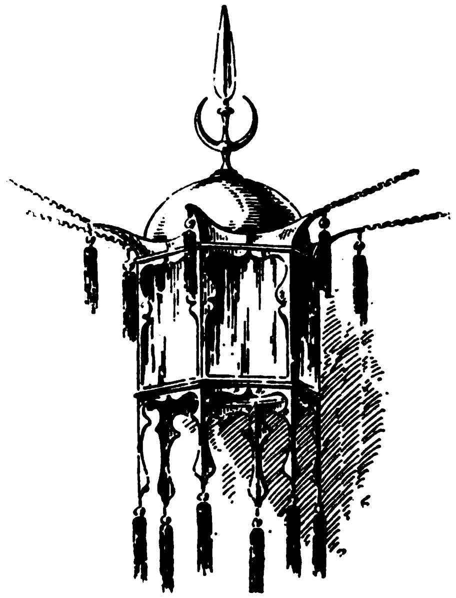

FIG. 2.

notice. Fig. 1 shows a large polished brass cover for arc lamps, perforated, and lined with transparent ruby drop rings, drops, and outer brass brackets, with crimson tassels. Fig. 2 is a brass lamp suspended across the streets by copper-coloured chains. These lamps have dark ruby domes, polished spears, crescents, and crimson tassels. In addition to the above, brackets are

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used for the streets and corridors, of hammered iron with brass and copper lanterns, and brass lamp-posts for the streets, bridges, &c. Quite an extensive variety of these special fittings are used at the exhibition.

Duplex Nozzles v. Solid Jets.—Messrs. Meldrum Bros., of Manchester, send us the results of some comparative tests of duplex or ring jets, and of plain solid jets of steam for forced draught for steam boilers. They claim that the solid jet is greatly superior.

Omnibus Lighting.—With regard to the paragraph on omnibus lighting in our "Trade Notes" last week, we are asked by the Bristol Electric Safety Lamp Works to state that the summonses at Bow-street were not due to any fault or weakness whatever of their battery, but solely to the insufficient time allowed for charging. The London General Omnibus Company's solicitor substantiated this when the first summons was heard, by stating that "the system acted admirably during the summer months," where there is apparently the same amount of vibration present as during the winter. As the Bristol Works are not light contractors to the London General Omnibus Company, but have only to keep 140 accumulators up to a specified efficiency, there can be no doubt that they are not responsible for the absence of a complete set of spare batteries which would give ample time for inspecting and charging. With regard to Mr. Elliott's letter the Bristol Company say that "any maker can, of course, construct a 40 hours' (what voltage ?) battery, but the question is of what weight, of what dimensions, and with what durability. Mr. Elliott does not supply these data, but should he or anybody else think that he can beat us we should only be too glad to submit a battery for competition on fair ground."

The General Electric Company's Catalogue.—We have received a new edition of this very complete catalogue. Several additions have been made, including a section on heating and cooking apparatus, and particulars of the various kinds of "Robertson" lamps. The section on telephones, which contains many useful diagrams of connections for various inter-communication systems has been revised. The catalogue consists of seven sections, viz., electrical supplies, plant, fixtures, cooking, bells, telephones, and medical apparatus. Tags are fastened to the margins at the beginning of each section, greatly facilitating reference to any particular part.

Diaries, &c.—We have received from the Brush Electrical Engineering Company a very convenient and excellently bound pocket diary, with pencil.

——— The Electrical Power Storage Company (Limited) have again adopted the useful large-size blotting pad and index diary for 1894, in addition to the useful postal information and calendar. Some tabulated particulars are given of the E.P.S. accumulators and apparatus.

——— The "Indian Engineers' Diary and Reference Book," issued from the English office of our contemporary, the *Indian Engineer*, is a demy 4to diary, interleaved with blotting paper, and containing many useful memoranda and engineering tables, including several conversion tables for Indian weights and measures.

——— We have also received a copy of the 1894 edition of "The Mechanical World Pocket Diary and Year Book," which contains forty per cent. of entirely new matter of a practical character. The sections of information deal with steam-engine practice, gearing, structures, pumps, hydraulic machinery, &c. The diary has 50 illustrations, and is issued in a handy form.

——— Mr. J. W. Vickers, of Nicholas-lane, Lombard-street, E.C., sends us a useful hanging sheet month-at-a-glance calendar, neatly printed, and containing face calendars for 1893, 1894, and 1895.

Brighton.—A discussion took place at the last meeting of the Town Council as to the rental to be derived by the Corporation from the Sea Shore Railway. The question of a poll tax, rental, or royalty having each in its turn received approval and condemnation, after Mr. Volk had explained that the Directors of the Sea Shore Railway Company could not entertain any idea of a royalty, and having expressed his surprise at the obstruction thrown in the way of the undertaking, the recommendation of the committee that a rental of £25 per annum be agreed to was accepted.

——— The demand for electric current from the Corporation's mains continues to increase so satisfactorily that, although very considerable additions have been made to the electric-lighting plant during the present year, still further extensions will, it is anticipated, be shortly necessary. The recent additions to the plant include three large boilers, capable of doubling the boiler capacity at the works, one new engine, and one dynamo ; and another engine and dynamo are on order.

Bristol.—The electrical committee of the Town Council at their meeting last week discussed the quesion whether Mr. Proctor, the resident engineer, should be allowed to employ improvers and to receive premiums. The matter was discussed on a previous occasion, when, by a small majority, it was decided against Mr. Proctor, but notice was given to rescind this resolution, and this motion was discussed at the present meeting. The committee decided to so rescind the previous resolution, and discussed a variety of proposals, one of which was that the premium should be fixed at £100, one half of which should go to the city authorities, and the other half to the engineer. Apparently, no definite decision was arrived at.

——— The *Western Press* understands that with regard to the extension of the lighting of Bristol, while the public lighting cannot be enlarged, Mr. W. H. Preece is of opinion that the incandescent lighting cables are capable of supplying three times the present load. The amount expended on the electric lighting scheme up to the middle of December was about £80,000, which is £3,000 in excess of the original estimate. The demand for the light is growing, and has much exceeded Mr. Preece's early anticipations. Mr. Preece is of opinion that, at the present rate of growth, the Corporation will be realising a profit 12 months from the commencement of the lighting. It is pointed out to the Council that they will undoubtedly have to contemplate extensions in the near future, and that, sooner or later, the capital for the scheme must be raised to £100,000, and that by this additional expenditure, considerably increased profits will result.

Chelmsford.—The adjourned special meeting of the Town Council, held last week, finally approved of the application by Messrs. Crompton and Co. for a Provisional Order for a period of 42 years for the public and private lighting of Chelmsford, the only modification being an amendment to Clause 80, dealing with the question of purchase. In the event of a sale, the Chelmsford Electric Lighting Company is to sell to the local authorities all buildings, lands, and plant as may be necessary for the public and private lighting of the town. A clause is inserted giving the Council power to purchase at the expiration of 21 or 31 years.

Chiswick.—The Local Board have received from the Board of Trade a copy of proposed regulations for the electric lighting of Chiswick. The Works Committee have the matter in hand.

Church Lighting.—It seems likely that the introduction of the electric light into the Bristol churches will become general. We recently announced that the light had been installed in Broadmead Chapel (Bristol); and now the churchwardens of St. Nicholas have instructed Messrs. King, Mendham and Co. to instal the light throughout the church. The present gas fittings are to be to some extent utilised, and consist of three massive chandeliers. The screens are also to be fitted with small lamps for the lighting of the choir, and the belfry and clock are also to be illuminated. To the latter the current will be automatically switched on and off by a movement in the clock.——St. Paul's Church, Bray (Ireland), has been lighted electrically, the current being obtained from the local electric light and power station.——Elgin-place Congregational Church, Clydeside, is to be lighted by electricity.

Coventry.—The Electric Light Committee's report to the City Council was discussed at the last meeting. The Committee have considered Mr. R. Hammond's specification and general conditions of the installation of the generating and distributing plant, the amount of the contract being £9,485, exclusive of the trenching of streets, the work for which the Corporation will themselves provide. The Committee's report was adopted, and a letter was read from Messrs. Fowler and Co. (Limited), of Leeds, explaining the connection of Mr. Hammond with that Company.

Dewsbury.—At the meeting of the Co-operative Society of Ravensthorpe, near Dewsbury, the President said that the question of introducing the electric light into the stores had been under the consideration of the Directorate for some time. The Halifax Flour Society had saved 50 per cent. on their gas bill by the introduction of the electric light. He estimated the cost of introducing the light at about £350, as it will be necessary to put down additional motive power. A resolution to the effect that the electric light be adopted was carried.

Douglas and Laxey Coast Electric Tramway.—Although the Company for working this tramway is not yet floated, sufficient progress has been made to warrant the promoters in anticipating that the tramways will be completed by June next. The works are being carried out by Mr. F. Saunderson, C.E., of Douglas. Messrs. Mather and Platt are supplying the plant. Mr. J. Aldworth is the Manager.

Dundee.—Messrs. Burt and Co. have secured the contract for lighting the Dundee Exhibition by electricity. The motive power will be supplied by a powerful "Acme" gas engine, similar to that used at the Celtic Park installation, Bristol.

Ealing.—The Local Government Board, having sanctioned the borrowing of a sum of £25,000 for electric lighting purposes, the Finance Committee of the Local Board recommend that application be made to the Local Government Board authorising them (the Ealing Board) to raise the sum of £50,000 by the creation and issue of Local Board Stock. This recommendation was not adopted at the last meeting, but was deferred for consideration at the next meeting.

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Electrical Engineers as Mining Agents.—It is something of a novelty, says *Industries and Iron*, to find an electric lighting company promoting what is practically a gold mine. The Redding Electric Lighting Company of Shasta Co., Sacramento, U.S.A., intend to complete the dam which it has put in for power purposes, and to use the races which run parallel to the Sacramento river as the river bed for a time, so that the rich gravel below the dam may be worked for gold. In addition to this the company contemplates continuing the races by ditches to a neighbouring agricultural district, Cotton Wood, for irrigation purposes, and to interest outside capital in this irrigation scheme. Wires will be run from the Electric Light Company's power-house, and the work by night will be accomplished with the aid of arc lamps strung along the river.

Electric Light in a Prison.—The electric light has been introduced into the prison of the little town of Vaetz, a few miles from Buda Pesth. Every cell is illuminated.

Night Work.—The St. James's Vestry (Westminster) are to discuss at their next meeting a motion that a condition prohibiting the carrying on of operations during the night and early hours of the morning be attached to consents given by the Vestry to electric lighting companies for the carrying out of works involving the disturbance of the public streets.

Electricity in the Theatre.—The *Era* contains a description of a new device used at Abbey's Theatre, New York, on the occasion of Mr. Henry Irving's production of "Becket":—

The "table" was installed by the Cushing Electric Company of Boston. The principal device is one whereby any combination of effects can be obtained before the change takes place, and then the whole change made instantaneously by one sweep of a main lever. The effect is obtained by throwing the different circuits in operation through the switcher, having first sent all the current through the rheostat. Every rheostat can be controlled by the main lever, and when the proper moment arrives, it is only necessary to operate the lever to produce the desired effect. The Abbey switchboard is elevated to perhaps a dozen feet above the stage floor. This is a desirable feature, as there is no danger of the handles of the switches or other paraphernalia on the board being broken during the shifting of scenery in a dark change. The stage manager stands below on the stage, and signals the electrician above just what to do by means of push buttons, which throw into operation pilot lamps, whose colours and positions are equivalent to the lamps in the borders, bunches, or foots. The board also possesses a larger number of "points" on its rheostats than any other board in any other theatre, except, perhaps, the New Metropolitan Opera House, where there is a larger board of the same design. This enables a much more gradual reduction of light to be made, the desirability of which can be readily understood. A feature of the pilot lamps is that they do not burn in connection with the main circuit which they represent, except when especially turned on with a switch of their own. The reason for this is that the number of pilot lamps is very large, and during a dark change the amount of light they would diffuse would be so great as to mar the effect of the scene; hence, although the circuit in the front corridors might be in operation, yet the pilot lamp would not show it unless the workman desired it to do so. In addition to the electrical features of the board, there is a perfect tube system whereby any part of the house may be reached by the stage manager, or *vice versâ*. Another ingenious device is the new orchestra lamp for use during a dark change. At the top of each music desk is a cylinder in which is contained two 16 candle-power incandescent lamps. The cylinder has a quarter-inch slit along its entire length, and when placed at a certain angle sheds light all over the page of music, while all around it is dark. The effect is very good, and far better than could be obtained from the ordinary shade. The device is patented.

Fleetwood.—As indicated in our last issue, the tender of the Brush Electrical Engineering Company has been accepted for the lighting of Fleetwood. At the meeting of the Improvement Commissioners, at which the tender was accepted, it was pointed out that only £70 had been spent in preliminary expenses. A resident electrical engineer is to be appointed.

Football by the Electric Light.—Notwithstanding the fog, a very successful football competition was held at the Celtic Park, Glasgow, on Christmas evening, at which about 5,000 spectators were present. The electric light was installed in the large private field in which the match took place, and sufficient light was provided by sixteen arc lamps to enable the spectators to follow every movement of the game. The match would have been impossible without the electric light.

Glasgow.—The electric lighting firms in this city report brisk business in installation work. For the present, however, the available current from the Corporation's Waterloo-street central station is all taken up, and further demands can only be met when the new generating plant provided for in the City Electrical Engineer's plans is put down.

Guildford.—The Town Council have consented to the application of the Holloway Electricity Supply Company for permission to apply to the Board of Trade for a Provisional Order, on condition that a clause is inserted giving the Local Authority power to purchase the undertaking within six months after the expiration of a period of ten years from the granting of the Order, and within six months after the expiration of every subsequent period of five years.

Huddersfield.—Extensions are being made to the electric lighting area, and it is contemplated to supply the districts of Marsh and Gledholt.

Leeds.—An attempt is being made by the Leeds Gas Committee to improve the quality of that illuminant. In the mean time many of their customers are adopting the electric light, and private installations are the order of the day.

Leyton.—It has been decided by the Local Board to present a memorial to the Board of Trade for an electric lighting Provisional Order.

Llandudno.—Messrs. Bellis and Kingsland have submitted a scheme to the Improvement Commissioners for the introduction of the electric light into Llandudno. With the sanction of the Commissioners, these gentlemen will take immediate steps to form a local company, and apply to the Board of Trade for a Provisional Order. The subject is to be further considered at a special meeting to be held in January. In the mean time Messrs. Bellis and Kingsland are to set out the terms upon which the proposed company will be prepared to transfer their undertaking after it has been established.

Lynton.—Considerable extensions and alterations are to be made at the electric lighting station here with the object of making room for additional plant.

Manchester Ship Canal.—As evidence that the opening of this canal is likely to materially influence the engineering trade of the district, Messrs. Galloways (Limited), of Manchester, will receive on January 1st, the date of the official opening of the canal, a cargo of 500 tons of steel plates, bars, angles, &c., from Glasgow.

Norwich.—The Town Council have agreed to light the Guildhall and the municipal offices by electricity at a cost of £150.

Sherborne.—Several of the tradesmen at Sherborne, Dorset, are using small electric lamps when on their country rounds. These lamps are similar to those used by the London 'bus companies. The lamps when run down are exchanged at the works of the Sherborne Electric Installation.

Stirling.—At a recent meeting of the Stirling Town Council a letter was read from the Caledonian Electric Supply Company (Limited) asking for the Council's observations upon their proposal to apply for a Provisional Order for lighting the town, and a further letter calling attention to the fact that the Company were still without the Council's remarks on the subject. Subsequently a motion was made that a preliminary meeting of the Council be held in order to obtain the necessary information as to whether they should take up the electric lighting as a Corporation, or hand it over to the Caledonian Company, this meeting to be held on December 26th, and to consider, amongst other business, the report from Mr. Arnot, the Glasgow Corporation's electrical engineer, who has been asked to prepare a report for the Stirling Council's consideration. After a heated discussion the proposal was adopted. There is to be a meeting on the subject on January 8th, when it will be finally decided whether the light is to remain in the hands of the Corporation, or upon what terms the Caledonian Company are to receive the Council's consent to their application for a Provisional Order.

Telephone Extension.—Mr. A. E. Cotterell, the district manager of the National Telephone Company at Birmingham, attended a meeting of Rugby tradespeople and others last week, at which the subject of the extension of the telephone exchange to Rugby was discussed. A committee was formed to ascertain the amount of support likely to be given to the scheme.

Water Power.—The *Rochdale Star* states that some time back Mr. T. Oddy, electrical engineer, of Rochdale, received instructions to prepare specifications for a scheme for the utilisation of water power for electric lighting and power purposes in Southern India, by which it is intended to transmit about 12,000 H.P. to two large towns some distance from the source. The plant is specified to consist of 12 1,000-H.P. turbines, 144 alternators, motors, and dynamos of an average capacity of 250 H.P., and 96 250-H.P. transformers, and will require the erection of two large central station buildings and two transformer stations. The whole scheme, which includes a telephonic installation throughout the district, when completed is to cost about £350,000. The current is to be utilised for power purposes and for lighting a number of cotton, corn, and rice mills, machine shops, &c., *en route*. A scheme similar in character is, according to the same authority, also being reported upon by Mr. Oddy for public authorities in Southern Russia. This project comprehends the transmission of 5,000 H.P. a distance of 93 miles.

Wolverhampton.—The Local Government Board have appointed Mr. T. Codrington, M.I.C.E., to hold an inquiry, at the Town Hall, on Thursday next, into the application by the Town Council to borrow £30,000 for purposes of electric lighting.

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YALDING (NEAR MAIDSTONE).—A water-power installation is at work at Cheveney, which is giving every satisfaction. The water-wheel drives an Elwell-Parker dynamo, and a battery of 57 large E.P.S. cells provides current for Cheveney Mansion (about a quarter-mile distant), Yalding Vicarage, Riverside House, the Cheveney Institute, the Boys' Brigade Room, &c.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

November 23, 1893.

22,43. F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, and A. SOAMES. London. Improvements in pivoted electrical measuring instruments.

22,439. F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, and A. SOAMES. London. Improvements in electrical measuring instruments.

November 24, 1893.

22,519. C. DARRAH (of the firm of Baxendale and Co.) and C. C. METCALFE. Manchester. Improvements in clips for electric conductor casing.

22,562. T. DAVIS and E. DAVIS. Liverpool. Improvements in, or connected with, electrical signalling apparatus.

22,570. SIEMENS BROS. AND CO. (LIMITED). London. Improved apparatus for working railway switches by means of electrical energy, and for signalling in connection therewith. (Messrs. Siemens and Halske, Germany.)

22,584. R. E. HOLDOM and H. SMYTH. London. Improvements in means for fixing fuses in electric circuits.

November 25, 1893.

22,594. W. J. DAVY. London. Improvements in arc electric lamps.

22,651. L. T. BUCKLER and T. CLARKE. Liverpool. Improvements in electric lamps and shade-holders.

22,674. R. HADDAN. London. Improvements in or relating to electric regenerative batteries or accumulators and in porous cells therefor. (H. Riguelle, Belgium.)

November 27, 1893.

22,698. W. ROUTLEDGE. Newcastle-on-Tyne. Detector galvanometers.

22,723. G. A. NUSSBAUM. London. Improvements in telephonic transmitters.

November 28, 1893.

22,765. J. McCRAITH. Melton Mowbray. Multiple telegraphy.*

22,817. H. ARON. Liverpool. Improvements in electric meters.

22,856. R. A. FOWDEN. London. Improvements in printing telegraphs.

22,858. E. ORLING. London. Improvements in electric lighting and extinguishing apparatus for gas burners.*

22,863. H. H. LAKE. London. Improvements in and relating to dynamo-electric machines. (The Thomson - Houston International Electric Company, United States.)*

November 29, 1893.

22,885. M. T. PICKSTONE. Salford. Improvements in and connected with electric generators and motors.

22,912. E. H. WHEELER. East Molesey. Improvements in electrodes and cells for secondary batteries or accumulators.

22,956. C. A. J. H. SCHROEDER and H. E. R. SCHROEDER. London. New improved electropositive galvanic battery electrodes.*

22,957. J. H. WHEAT and A. WHEAT. London. Improvements in arc lamps.

22,959. H. W. WILKINSON. London. Improvements in or relating to apparatus for controlling transformers used in feeding electric-current circuits.

22,960. H. W. WILKINSON and L. PENSON. London. Improvements in the method and means employed for controlling electrical devices from a distance.

November 30, 1893.

23,017. H. R. LOW and F. R. BROWN. Richmond. An improved arc lamp.*

23,022. G. H. NISBETT and J. B. ATHERTON. Liverpool. Improvements in or relating to junction service boxes for electric conductors.

December 1, 1893.

23,074. W. P. THEERMANN. Manchester. Improvements in electrical switches.

23,083. H. ARON, Liverpool. Improvements in apparatus for recording electric currents.

23,088. G. H. HODGES and J. W. I. HILLIARD. London. An improved electrical indicating target.

23,107. A. CRESPIN and O. F. LEHMANN. London. Improved electrical games or toys.

23,121. J. Y. JOHNSON. London. Improvements in incandescence electric lamps. (C. H. Stearn, Switzerland.)

December 2, 1893.

23,170. L. B. MILLER and M. W. WOODS. London. Improvements in electrical transformers.

23,211. W. T. GOOLDEN and J. S. LEWIS. London. Improvements in electro-mechanical governors, and in the means of operating the same.

23,221. H. H. LAKE. London. Improvements in sockets or receptacles for incandescent electric lamps. (C. A. Hussey and C. C. Edey, United States.)

December 4, 1893.

23,231. G. L. ANDERS and W. KOTTGEN. London. Improvements in micro-telephones.

23,241. W. J. S. BARBER-STARKEY. Manchester. Improvements in electric storage batteries.

23,253. J. H. BALLANTYNE. Glasgow. Improvements in electric alarms.

23,283. L. PENSON. London. Improvements in couplings for connecting together conductors of electricity.

23,303. A. J. BOULT. London. Improvements in, or relating to, accumulators. (J. Lecoq, Belgium.)

23,304. A. J. BOULT. London. Improvements in or relating to arc lamps. (J. Lecoq, Belgium.)

23,307. F. B. BEHR. London. An improvement in conductors and rubbers for electric railways or tramways.

23,308. M. HUTIN and M. LEBLANC. London. Improvements in continuous-current dynamos, either for generating or for receiving electric currents.

23,309. M. HUTIN and M. LEBLANC. London. Improvements in continuous-current dynamos for either generating or receiving electrical energy.

December, 5, 1893.

23,237. A. J. HOWES. London. Improvements in electric lamp fittings.

23,331. S. W. CUTTRISS. Leeds. Improvements in electrical current regulators and electrical heating apparatus.

23,337. H. C. L. HOLDEN. London. Improvements in electric meters.

23,364. H. G. SPEARING. London. Improvements in the manufacture or production of electrodes or plates for batteries, especially secondary batteries.

23,385. G. W. JEWELL and W. ZIMMERMAN. London. A combined ammeter and voltmeter.

23,395. J. A. SINCLAIR. London. A micrometer.

23,424. H. GREEN. London. Improvements in incandescent electric lamps.*

23,436. H. H. LAKE. London. Improvements in apparatus for electrolytically producing soda and chlorine. (The Union Chemical Company, United States.)*

December 6, 1893.

23,439. P. E. LITT and E. A. FLETCHER. Market Rasen. New safety glass ball stoppered aërated water-bottle opener and pourer at one operation.

23,444. F. BAILEY. London. The prevention of humming noise of dynamo-electric machines.

23,468. A. B. KENT. London. A method of adapting incandescent electric lamps to table, standard, hanging, and other oil lamps.

23,472. F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, and A. SOAMES. London. Improvements in electrical measuring instruments.

23,477. J. ORME. London. Improvements in contacts for electrical signalling.

23,478. A. COEHN. London. Improvements relating to the electrolytic preparation of oxygen and the halogens, and to the simultaneous production of electrodes.

December 7, 1893.

23,543. R. J. CANAVAN. London. Improvements in or connected with electric arc lamps.

December 8, 1893.

23,605. P. G. EBBUTT and J. B. VERITY. Birmingham. Improvements in the method of attaching reflectors to electric lamp-holders or sockets.

23,614. P. O'NEAL. London. An improved instrument for controlling the flow of current through electric circuit or circuits.

23,633. J. PARKIN. Newcastle-on-Tyne. An electric motor designed to drive continuously any clockwork or time-keeping mechanism.

23,669. P. SCHOOP. London. Improvements in electrolytic vessels for primary and secondary batteries or accumulators, and other processes of electrolytic decompositions and electrolytic action, such as for the extraction of metals from their ores, electro-depositions, and the like.

23,673. W. MOSELEY. London. Improvements in telephones.

23,676. H. V. COAD. London. Improvements in, and connected with primary batteries, and in safety lamps to be used therewith.

23,684. T. B. BATES and A. E. LEEFE. London. Improvements in connection with the electro-deposition of metals.

23,687. P. B. DELANY. London. Improvements in telegraphy and in the means employed for perforating tapes used for this purpose.

23,688. L. FORTOUL and C. THERYC. London. Improvements in, and relating to, electric batteries.

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December 9, 1893.

23,733. I. A. TIMMIS and G. N. ABERNETHY. London. Improvements in electrical means for signalling on railways in a fog and at other times.

SPECIFICATIONS PUBLISHED.

All Specifications 8d. each.

1892.

18,165. LAKE (Noriega.) Working gold and silver ores.
21,147. GARRARD and BLUMFIELD. Electric vehicles.
21,169. DULAIT. Electric arc lamps.
21,693. FEYS and LORWA. Electrical meter and recorder.
22,271. HAZELTINE. Electric arc lamps.
23,231. SCHARF. Electric glow lamps.
24,122. BOWKER. Electroliers, pendants, &c.

1893.

257. CROMPTON and DOWSING. Insulating electric wires.
757. BARNETT. Electrodes.
758. BARNETT. Electrodes.
3,488. FORBES. Telephones.
5,084. DAY. Fastening electrical conductors, wires, cables, &c.
8,176. HANBURY. Electrolytic apparatus.
10,765. CLUBBE and SOUTHEY. Secondary batteries.
15,519. BARKER (Lawrence Electric Co.). Electric Engines.
18,482. OPPERMANN. Determining the presence and intensity of atmospheric electricity.
18,894. MUIRHEAD and DEARLOVE. Standards of electro-motive force.
18,945 BROOKES (Cousens.) Telephonic transmitter circuits.
19,024. ANDERSEN. Trolley supports for electric railways.
19,789. PITT (Universal Electric Co.). Electric railways.
20,069. LUNDELL and JOHNSON. Controlling electric currents.

COMPANIES' MEETINGS.

Bedford Electric Light Company (Limited).

The annual general meeting of this Company was held at the offices on Wednesday last week, Sir Henry Mance presiding.

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN said the time had arrived when the Town Council must be pressed to give their consent to the Company commencing operations or must undertake the lighting of the town themselves, and be prevented from trifling any longer with the Company. In many places lately the local authorities had handed over the lighting of towns to companies, and that course was becoming more general daily, because in doing so those who had the light paid for it, and the inhabitants of those parts of a town who did not use it, and where it could not be worked at a profit, were not called upon to pay for those who did. When the system was carried out by a Corporation the capital necessary had to be obtained on loan, and repaid, with interest, in annual payments by all the rate payers, whether they used the light or not, but if carried out by a company the capital was an investment, and had not to be refunded, so that interest only has to be paid upon it. When the system was carried out by the Local Authority, even supposing that electric lighting over the whole town might at some distant day pay, it was taxing the present generation for the benefit of their successors. He concluded by moving the adoption of the Directors' report.

Major MOBERLEY seconded the motion, which was carried unanimously.

Mr. George Haynes was re-elected a Director of the Company. Major Moberley was appointed auditor in the place of Mr. William Haynes, who has left the town.

The following is an abstract of the Directors' report :—

"The Directors have made no payment during the past year from the funds of the Company, and have abstained from incurring any liability not absolutely necessary to maintain the Company in a position to act with advantage whenever they deemed a proper opportunity had arisen. It is now more than five years since this Company was registered and fully prepared to commence work, but up to the present time the Corporation have persistently refused their consent to the Company commencing operations. In October, 1890, the Corporation, acting as the Urban Sanitary Authority, obtained an Order to enable them to carry out electric lighting in the town. In July, 1892, they passed a resolution directing the clerk to the authority to apply to the Board of Trade to rescind their Order; but, at a meeting held on the 25th of the same month, the clerk was directed not to make the application until further instructions had been given. On January 19, 1893, the Authority passed a resolution that they should not undertake electric lighting, but should, if practicable, arrange to hand over their Order to a company; and in pursuance of that resolution, and others subsequently passed, advertisements were inserted in various papers, asking various companies and others to submit terms upon which they were prepared to take over the Order. This Company, with others, made proposals for taking over the Order (subject to certain modifications) upon terms which, although highly beneficial to the town and reserving to it a right of purchase at early and reasonable date, would, in the opinion of the Directors, enable the Company to carry out their works with the prospect of a fair return to the shareholders. The Committee appointed by the Authority reported in favour of the proposals made by this Company, and in the report stated that it was the only tender made in accordance with the terms of the advertisements issued, but up to the present time the Authority have not approved nor revised the draft agreement sent to them. The Directors have to remark that if electric lighting were carried out in the town with the extended compulsory area fixed by the present Order, it would necessarily result in a heavy loss to the ratepayers or any Company undertaking it, and they would certainly refuse to accept the heavy responsibilities of the Order without modifications. At the same time there is some doubt whether the Board of Trade have power to reduce the compulsory area without a new Act, or whether, if they have the power, they would do so on the application of the Authority. The Directors, therefore, considered it their duty to give the Authority and the Board of Trade the proper legal notices of their intention to apply for a Provisional Order. The Directors are willing to carry out with the Authority the terms of the draft agreement submitted to them in pursuance of the advertisements issued, which are, in their opinion, liberal to the Authority and fair to the shareholders, but under the circumstances reserve to the Company the right to apply independently for a Provisional Order should the Authority, notwithstanding the trouble and expense their proceedings have entailed upon the Company, refuse to carry out the proposed agreement."

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, pages 320-348, *&c., &c.*]

BRAYTON OIL ENGINE COMPANY (LIMITED).—This Company was registered on December 22, 1893, with a capital of £80,000, in £5 shares, to acquire a certain invention relating to improvements in hydro-carbon engines, for which letters patent have been granted to George B. Brayton, and to carry on the business of oil-engine manufacturers and dealers, iron and brass founders, machine and engineering tool makers, mechanical engineers, millwrights, metal workers, metallurgists, manufacturing chemists, &c.

R. AND C. HARCOURT AND SON (LIMITED).—This Company has been registered with a capital of £20,000, in 500 £10 "A" Preference, 500 £10 "B" Preference, and 1,000 £1 Ordinary shares, to acquire the business of R. and C. Harcourt and Son, of Birmingham, and to carry on business as brassfounders.

KILMOE COPPER MINES (LIMITED).—This Company was registered on December 21, 1893, with a capital of £30,000, in £1 shares, to acquire, develop, work and turn to account certain copper mines (position not stated), and to carry on the business of a mining, smelting and metallurgical company in all its branches.

J. G. STATTER AND CO. (LIMITED).—This Company was registered on December 21st, with a capital of £20,000, in £10 shares, to acquire and take over as a going concern the business of electrical and mechanical engineers now carried on by John G. Statter, Henry Foote, and Leonard Milne, under the style or firm of "J. G. Statter and Co.," at 68, Victoria-street, Westminster, and Millwall, both in the County of London, with a view to such acquisition, to enter into and carry into effect an agreement already prepared and expressed to be made between the three vendors of the one part, and John H. Ward (for the Company) of the other part, and to carry on the business of electricians, electrical, mechanical, and general engineers, suppliers of electricity for the purposes of light, heat, motive power, or otherwise, and manufacturers of, and dealers in, all apparatus and things required for, or connected with, the generation, distribution, supply, accumulation, and employment of electricity.

CITY NOTES, &c.

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ended December 24th were £950, as against £926 for the corresponding period of last year, being a decrease of £24. The total receipts for the half-year amount to £20,987, as against £20,820 for the corresponding period of 1892, an increase of £167.

HOBART ELECTRIC TRAMWAY COMPANY (LIMITED).—Interest on Coupon No. 4 of First and Second Mortgage Debentures will be payable at the Commercial Bank of Scotland (Limited), 62, Lombard-street, London, on and after January 1, 1894.

ROBEY AND CO. (LIMITED).—Under this title, we are informed that Messrs. Robey and Co., the well-known engineers, of the Globe Works, Lincoln, have converted their business into a limited liability company, with an authorised share capital of £300,000 in Preference and Ordinary shares, £272,710 of which are taken by the partners and holders of capital in the old firm, no issue of any of the Company's share capital having been offered to the public. In addition to the above capital of £300,000, there will be an issue of £125,000 Four and a-Quarter per Cent. Debentures, making a total capital of £425,000. This change has been made in consequence of the deaths of partners, and to facilitate family arrangements, leaving the present management of the business unaltered.

STOCK EXCHANGE NOTICES.—Application has been made to the Committee to appoint a settling day in and to grant a quotation to the further

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issue of 20,000 Six per Cent. Cumulative Preference Shares, Nos. 20,001 to 40,000, of the City of London Electric Lighting Company (Limited).

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the week ended December 22nd (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £3,446.

WESTERN UNION TELEGRAPH COMPANY.—A quarterly dividend of 1¼ per cent. has been declared by the directors.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price, Dec. 20		Price Wednesday, Dec. 27		Rate per Cent. Yielded (£ s. d.)	Dividend Due	Business Done During Week Ending Dec. 27: Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	12/6	Anglo-American	42	44	43	45	6 2 3	Jan. Apr., July, Oct.	43¾	..
£2,932,680	Stock	25/0	Do. Preferred	80½	81½	81¼	82¼	6 13 4	" "	82	81½
£2,932,680	Stock	5/0	Do. Deferred	7¼	7¾	7½	8	..	..	7⅞	7 3/16
£184,500	100	4%	African Direct Telegraph 4% Deb. (Reg. & Bearer)	101	104	101	104	3 16 11	January and July	–	..
130,000	£10	3/0	Brazilian Submarine	11¾	12¼	11¾	12¼	5 6 1	Mar., June, Oct., Dec.	11 15/16	11⅞
£18,700	£100	5%	Do. 5 per Cent. Bonds	101	104	101	104	4 16 2	January and July	..	–
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 190[illegible])	108	112	109	113	4 8 6	June and December	–	–
10,000,000	$100	7%	Commercial Cable Capital Stock	140	150	149	150	4 13 4	Jan, Apr, July, Oct.	–	–
16,000	10	8/0	Cuba Submarine	11¼	12½	11½	12½	6 8 0	February and August	11⅞	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2¼	3½	2½	3½	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8¼	9½	5 5 3	" "	..	..
60,710	20	8/6	Direct United States Cable, 1877	11⅜	11⅝	11⅜	11⅝	6 0 2	Jan., Apr., July, Oct.	11½	..
400,000	10	2/6	Eastern	15	15¼	15	15¼	4 5 3	" "	15 1/16	15
70,000	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16¼	3 13 10	" "	16¼	..
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	114¼	..
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	108	111	108	111	4 10 1	February & August	..	..
250,000	10	2/6	Eastern Extension	15½	15¾	15½	15¾	4 8 11	Jan., Apr., July, Oct.	15¾	..
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	114	117	114	117	3 8 5	February & August	..	..
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103	106	103	106	4 14 4	January and July	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	103	106	103	106	4 14 4	" "	–	–
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103	106	103	106	3 15 6	February & August	..	–
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	103%	109%	106%	109%	3 13 5	May and November	107	106½
180,227	10	1/6	Globe Telegraph and Trust	8¼	8¾	8⅜	8⅞	5 1 5	Jan., Apr., July, Oct.	8 13/16	8 11/16
180,042	10	6%	Do. 6 per Cent. Preference	15⅛	15⅝	15⅛	15⅝	3 18 1	" "	15¼	15⅛
150,000	10	5/0	Great Northern	20	20½	20	20½	4 3 0	Jan., April, and July	20¼	..
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 14 4	March & September	..	..
17,000	25	12/6	Indo-European	40	43	40	43	5 16 3	May and November	..	..
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	3 6 8	" "	..	–
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	105	108	5 11 1	March & September	..	–
£100,000	£100	4%	Pacific European Telegh. 4% Guar. Debs. "Red" 1942	102	105	102	105	3 16 2	..	..	–
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	..	..
3,381	£100 Cert.	35 0	Submarine Cables Trust 6 per Cent.	114	119	114	119	5 0 10	" "	..	..
15,609	10	5/0	West African Telegraph	5½	6½	5½	6½	7 13 10	January and July	..	..
£249,900	100	5%	Do. 5 per Cent. Debentures	98	101	99	102	4 18 0	March & September	99½	..
80,000	10	2/0	West Coast of America	2	3	2	3	..	January and July	2 7/16	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	103	100	104	7 13 10	June and December	..	..
88,321	10	1/0	West India and Panama	1	1½	1	1½	..	..	–	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10¼	9¾	10¼	5 17 1	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	108	111	108	111	4 10 1	June and December	..	..
64,242	15	4/6	Western and Brazilian	6	6½	6	6½	3 9 4	May and November	..	..
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5¼	5¾	5¼	5¾	..	..	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¼	1¾	1½	1¾	..	..	–	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	103	106	104	107	5 12 2	February & August	..	–
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	103	106	104	107	5 12 2	" "	..	–
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	106	102	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	–	..	–
224,850	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
220,000	£1	4·76d.	Oriental Telephone and Electric (11s. paid)	½	..	½	..	6 7 9	Yearly	..	–
484,597	5	2/6	National	4⅝	4⅞	4⅝	4⅞	5 2 7	June and December	4 13/16	4 11/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	13½	14½	13½	14½	4 2 9	" "	..	–
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	13	14	13	14	4 5 9	"	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅛	5⅝	5⅛	5⅝	4 13 0		5⅛	..
925,017	£100	4½%	Do. Deb. Stk. 4½%	113	115	113	115	3 18 3	Jan and July	114¼	113½
58,000	5	1/0	United River Plate	2	2½	2	2½	..	January and July	..	..
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0		..	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11¼	11¾	11¼	11¾	–		..	..
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	12¾	13¼	12¾	13¼	..	–	13	..
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	–	–
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	–	..	–
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	–	–
8,322	£5	..	House to House Electric	..		..		–	–	–	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		..	..	–	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	–	–
30,000	£5	1/9	Liverpool Electric Supply (£3 10s. paid)	4½	4¾	4½	4¾	..	..	–	–
15,000	£5	2/6	Do. (fully paid)	6½	6½	6½	6½		–	..	–
111,000	5	..	London Electric Supply	¼	¾	¼	¾		..	..	..
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	7¾	8¼	7¾	8¼	2 8 5	..	8¼	8
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	103	106	103	106	4 14 4	June and December	..	..
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	–	–	4½	..
19,980	£5	9½%	St. James' and Pall Mall	5½	6	5½	6	..	–	..	–
20,000	£5	7%	Do. 7 per Cent. Preference	7¾	8¼	7¾	8¼	4 4 10	–	..	..
59,900	5	1/6	Westminster Electric Supply (fully paid)	5	5½	5	5½	3 3 8	–	5⅜	5
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	2/1	Brush Electrical Engineering	2⅝	2⅞	2⅝	2⅞	6 5 8	–	–	–
90,000	2	6%	Do. 6 per Cent. Preference Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	–	–	..
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	105	107	105	107	4 4 1	March & September	106	..
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	4	4½	4	4½	..	January and July	4 3/16	..
12,139	5	..	Edison and Swan United	–		–		–	–	..	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	–	..	..
49,900	10	12/0	Electric Construction	½	1	½	1	..	–	¾	..
91,195	2	10/0	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜	–	–	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	–	¾	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21½	22½	21½	22½	5 11 1	February & August	22⅜	22
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	..	..	–
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	–	–
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/0	4/0	3/0	4/0	..		..	..
78,949	5	1/9	Swan United (£3. 10s. paid)	2¼	2¾	2¼	2¾	..	May and November	2½	2 5/16
37,350	12	12/0	Telegraph Construction and Maintenance	36	38	36	38	4 9 1	March and July	..	–
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	105	108	105	108	4 12 7	January and July	..	..
37,514	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		–	–	–	–
41,098	£5	..	Do. Preference (fully paid)	..		..		–	–	–	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	¾%	City and South London Railway	28	33	28	33	2 5 5	May and November	..	–
87,500	£10	..	Liverpool Overhead Railway	5	5½	5	5½	–	–	–	–

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Name of Comp[any] or Local Author[ity]	Belts, Ropes or Direct-Coupled.	Dynamos. Type.	No.	Agg. Kilo-watts.	Price of Board of Trade Unit.	Price of Gas in District.	Remarks.
Charing Cross and St... tricity Supply Co...	Direct	Edison-Hopkinson, Siemens	10	1,000	6d.	3/3	...
Chelsea Electricity Company	Direct	Elwell-Parker	...	...	8d.	3/1	Supply direct from low-pressure machines for area contiguous to Generating Stations.
City of London Elect...ing Company	Belt, rope and direct	Brush .... Thomson-Houston	16 11	3,130	8d.	...	Plant for 60,000 additional lamps in course of erection.
Crystal Palace Dist...tric Supply Comp...	Ropes	Elwell-Parker	5	450	8d.	2/9	The low pressure network is fed at several points from each sub-station.
House-to-House Elec... Supply Company	Ropes	Lowrie-Hall	6	550	8d.	3/-	...
Kensington and Knig... Electric Lighting C...	Direct	Crompton and Siemens	6[1] 7[2]	661[1] 645[2]	8d.	3/1	Plant capacity of both stations aggregates 45,000 30-watt lamps *without batteries.*
London Electric Su...poration	Ropes	Ferranti ...	6	4,200	7d.	3/- 2/6	35 miles of trunk mains.
Metropolitan Electr... Company	Direct, ropes and belts	Parker, Westinghouse, Kapp, Siemens, and Clark, Muirhead and Co.	...	...	7¼d.	3/-	Continuous current at Whitehall. Special pressures supplied at lamps where required.
Notting Hill Electr...ing Company	Direct	Crompton...	4	480	8d.	3/-	

The following Stations, also in operation

Newcastle-o.-T.	Newcastle-on-Tyne Electric Supply Company	R. C. Jackson	Alternate-cu... formers	... the gas retorts. ...
Newcastle-o.-T.	Newcastle and District Electric Lighting Company	W. D. Hunter	Alternate-cur... formers	10 %. The maximum charg... discount varying from 5 to 2...
Northampton ...	Northampton Electric Light and Power Company	W. E. Heenan	Two-wire	...tion also runs 60 arcs. ...nt of 5%.
Norwich	Norwich Electricity Company	F. M. Long ...	Three-wire wi...	8d. per B.T.U. for the period fro... sunset to eight p.m. on week da... on Sundays, and 4d. per B.T.U... the day and night.
Ogmore Valley	Ogmore Valley Electric Light and Power Company	G. Wilson ...	Low-pressure	... erected, two 40-H.P. ...on wheels.
Oxford	Oxford Electric Company...	J. Hardie McLean	High-pressure cont... transformers, dis... volts	...sure mains seven miles in lengt... ...d cables in iron pipes. Discou... ...cent. for monthly payments.
Preston	National Electric Supply Company	J. H. Tonge...	Three-wire ...	...
Reading	Reading Electric Supply Company	F. F. Yeatman	Alternate-curr... formers	about 90 1,200-c.p. arc lamps... shops, &c., the current be... by four T.-H. arc lighters.
Scarborough ...	Scarborough Electric Supply Company	G. S. Peck ...	Alt.-cur. trans. in s... under pavements i... otherwise on con... 2-wire distribution f...	...
Sheffield	Sheffield Electric Light and Power Company	W. Johnson (*Man. & Sec.*)	Alternate-current tra... in sub-stations and... with two-wire dist... sumers	...s arc machines of 150-li... (140 lights in use). Station ...cted during 1893.
Southampton ...	Southampton Electric Light and Power Company	J. H. Lee......	Three-wire ...teries	...iven for plant capacity includes p... electric cranes. B.T.U. (wit... scale), 7d.; 6d. for power.
Taunton	Taunton Corporation	Harold W. Couzens	Alternate-current sub-stations wi... distribution	...process of reorganisation. T... ...resent 78 arcs running.
Weybridge	Weybridge Electric Supply Company	H. C. Buchanan	Alternate-curr... formers	...hting: 119 20-c.p. Thom... ...n lamps.
Whitehaven ...	Whitehaven Town and Harbour Trustees	..	Three-wire ...	...eets in district lighted with [illegible] ...ps of from 8-c.p. to 100-c.p. ...em at 240 volts, 2 lamps in ser...
Woking	Woking Electric Supply Company	C. Turner ...	Alternate-current sub-stations feed... wire network	...oard have just accept... ...r for street lighting.

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NITED KINGDOM.

Agg. H.P.	Engines. Type.	No.	Agg. H.P.	Belts, Ropes, or Coupled Direct.	Dynamos. Type.	No.	Agg. Kilo-watts.	Price of Board of Trade Unit.	Price of Gas in District.	Remarks.
150	Brush	8	740	Ropes and Belts	Mordey	4	300	6d.	2/8	Also 4 50-light T.H. machines for street lights, 84 in number, and private lighting in shops, &c.
1200	Willans	7	...	Direct	Crompton	7	630	8d.	2/7	...
...	Horizontal, compound, non-condensing	6	580	Ropes	Lowrie-Parker	3	200	6d.	2/6	Discounts allowed. Arcs 16
650	Brush compound	6	650	Ropes	Mordey	6	375	8d.	3/6	...
1400	Willans ...... Marshall	8 1	1610	Direct	Siemens	9	970	4½d. 5d.	2/3	...
120	Brush engine Victor turbines	1 2	315	Belts	Kapp	2	120	8d.	4/9	Entire public lighting done by electricity, 31 arc 25 c.p. incandescents. Outlying districts li from mains of bare copper carried on ornam poles.
1800	Willans	6	1300	Direct	Goolden .... L. Clark-Muirhead	4 2	870	..	2/11	7d. for first two hours' daily u and 3½d. after.
...	Fowler...	...	...	...	...	...	...	7d.& 8d.	2/9	...
2300	Willans	9	1750	Direct	Siemens	5	806	6d.	2/8 2/10	Public lighting: 100 arc lamps in m tiple series.
...	Horizontal ...	2	...	Belts	Parker .... Goolden	2 1	30	7d.	5/–	...
...	Horizontal, compound, condensing	2	360	Ropes	Elwell-Parker	2	184	6d.	3/–	Charge for both gas and el tricity subject to discount.
800	Parsons steam turbine	3	600	Direct	Parsons	3	450	7d.	2/10	...
240	Willans	4	400	Belting & direct	Mordey ...... Crompton ...	3 1	...	1/–& 6d.	3/6 4/1	Arc lights in streets.
600	Compound condensing	9	570	Direct	Alternators ...	6	269	6d.	2/10	There are also 3 120-k.w. arc light the arc light mains being concent
1400	Horizontal, coupled compound	4	1000	Ropes	Lowrie-Parker	4	500	7d.	3/6 4/0	81 arc lamps in streets, the plant con ing of 3 Brush dynamos and 3 high-s engines.
...	Willans	6	660	Direct-coupled	Siemens	6	436	5d.	3/6	...
...	Fowler Compound	3	...	Belts	Lowrie-Parker	3	...	9d.	3/2	Brush arc lights on Parade.
450	Fowler horizontal compound Westinghouse triple expansion	3 2	420	Ropes	Mordey	3	200	6d.	3/1	Also 2 30-light T.-H. machin 35 arcs in operation.
80	Compound horizontal girder automatic expansion	1	...	Belts	Thomson-Houston	2	30	8d.	3/9	There are 21 1,200-c.p. T.- arcs in the streets.
...	Hercules turbines	2	...	Belts	Crompton and Statter	...	50	5d.	5/9	Charge for motors in day per B.T.U.
1800	Willans	9	1860	Direct	Siemens and Latimer Clark	9	1230	7d.	2/6	There is also an arc-light station 110-light capacity.
...	Brush	...	...	Ropes	Mordey	...	250	9d. 8d.	3/9	...
...	Davey-Paxman under-type Willans	2 2	170	Belts and direct	Crompton ...	4	132	8d.	2/9	The charge per B.T.U. subje to discount.
800	Vertical condensing	4	1000	Ropes	Mordey	4	500	6d.	2/9	Primary mains concentric.
...	Willans	4	400	Direct	Siemens	4	320	7d.	2/10	...
230	Westinghouse Victor turbine	1 1	100	Belts	Kapp	2	60	...	3/3	Also a 50-H.P. "Victor" turbine. C tracts made with customers based on bills.
400	Bellis closed type compd.	7	300	Direct	Siemens	3	195	6d.	3/–	The boilers are fed by mechanical stok using inland small coal at 12s. 6d. per t there are also two Siemens arc lighters.
...	Horizontal condensing engines, Corliss valve gear	2	100	Ropes	Mordey	2	50	6d.	4/7	Public lighting by 11 arc lam and 66 incandescents.
...	Compound condensing	3 1	700	Ropes	Lowrie-Parker	3	350	8d.	2/4	B.T.U. discount 10% to 25% and 5 for cash. Gas less 5% for cash.
3900	Willans	19	3800	Direct-	Siemens' Elwell-Parker	19	2000	7½d.	3/4	...
...	Water-power	2	200	Direct	Mordey	2	75	...	...	Lamps charged for by contract, 20 per 16 c.p. lamp per annum.
...	Robey	...	...	Belts and Ropes	Chamberlain & Hookham	5	225	8d. 4d.	2/6 3/0	...
...	Vertical compound condensing	4 6	1980	Link Belts and Jockey Pulleys	Edison-Hopkinson Elwell-Parker......	4 6	1420	8d.	2/6	With rebate when the electrical consum tion is over 480 hours per ann. of supp demanded.
...	...	...	...	Belts	...	5	120	7d.	3/11	Three generators for Dowson gas, and fi gas engines of a total of 260 h.p.

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NOTES.

The Companionship of the Bath conferred upon Mr. W. H. Preece on New Year's Day is a well-deserved and by no means extravagant recognition of a life-long connection with telegraphy and of nearly a quarter of a century spent in the service of the State. Unlike the majority of our public officials, Mr. Preece has, indeed, been much before the world as a vigorous advocate of electric lighting, as President of the Institution of Electrical Engineers, at British Association meetings, at exhibitions and similar gatherings; he has also made many contributions to scientific literature. But these activities have merely served as so many outlets for an energetic mind. The real work of Mr. Preece's life has been the perfecting of the electrical details of the telegraph system of the United Kingdom, of which all true Britons are in their hearts not a little proud. For his services to this State Department alone Mr. Preece has well earned the distinction now conferred upon him, and we congratulate him upon the fact that, in this respect at least, the State has not been unmindful of its obligations.

We have to express our thanks to the secretaries and engineers of electric supply companies and corporations for the response which they have made to our annual request for statistics. Greatly as our tables have grown in size this year, we are glad to find that they are well filled. Blank spaces are rare, and only two provincial companies of small importance have failed to revise the particulars printed last year. We have endeavoured to lighten the labours of our correspondents by omitting four columns, viz., the maximum load observed, the voltage at the lamps, the voltage at the station, and the number and type of meters. These are interesting in their way, but we are well aware that there is no limit to the number of questions that might be proposed, or the ingenuity of the analyses which might be obtained by dividing one column by another. Those who want to know the number of watts expended per square metre of district may easily satisfy themselves. We have specified the exact intention of some of the columns more clearly than on previous occasions. "Plant capacity" we defined as the aggregate 8-c.p. lamp capacity of the station if every dynamo in the station (inclusive of any so-called "reserve" machines) were running at full load, no allowance being made for C^2R losses. The total length of feeders, separate cables and strips of copper would not give a fair idea of the business of a supply company, nor would the miles of streets in which mains are laid be more accurate, since it frequently happens that a main is laid down one side of a street only. We have therefore asked for "the length in miles of house frontage or pavement along which distributing mains are laid." In another column we give a graphic representation of the growth of electric lighting in London and in the provinces.

Complaining of a recent leading article, in which his name was mentioned, Mr. W. L. Madgen alludes to but does not define "destructive criticism." If we had suggested that the Institution of Electrical Engineers was effete or useless, that it was impeding the advance of science, injuring the profession, or hindering trade; and if, besides this, we had advocated some reactionary movement, we would admit the impeachment. But, on the contrary, we rather deprecated a radical attack on the constitution of the Council; we remarked upon its lack of spontaneous action with regard to wiring rules, the standardising laboratory, and nomenclature. We called attention to an apparently simple method of largely increasing the value of the discussions, one that seems only to require a little firmness on the part of the executive; we recorded with satisfaction the foundation of a building fund; and, finally, we urged that some qualifications should be exacted of the candidates for associateship, for the purpose of raising the status and maintaining the *prestige* of the Institution. Every suggestion that we made was for its welfare and to increase its usefulness. Is this destructive criticism? Our correspondent seems to have mistaken a little plain speaking for "an example of the destructive order of criticism." It must be remembered that the members of the Institution have no voice in the election of the Council. There may be objections to this in theory, but it has become the accepted procedure of most scientific societies. We do not venture to object to it, but it excuses a little free criticism of such details as those on which we have commented. Mr. Madgen thinks otherwise, and prefers private action among members. Anything that will tend to the welfare of the Institution will be welcomed by us.

We print this week an abstract of an article by Mr. Kennelly on the fall of voltage which occurs in long lines when traversed by alternating currents. The results of the investigation there described have an important bearing on the problem of the transmission of power over long distances.

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Wherever this problem has been attacked high potentials have invariably been adopted, in order to avoid excessive waste in the leads. Mr. KENNELLY's article, however, shows very clearly that unless these high potentials are used the waste in the leads may be very much greater than has been hitherto suspected, owing to the fact that induction in the circuit lowers the power factor, and thus renders it necessary for a larger current to flow in order to supply the requisite amount of power. From the tables of numbers given by Mr. KENNELLY it appears that, if we compare two circuits each of 20 miles in length, the first transmitting power at a potential of 10,000 volts, and the second at 2,000 volts, in the former case the product of volts and amperes will only be about 10 per cent. greater than the number of watts transmitted, while, in the latter case the product will be double the number of watts. This means that the current in the latter case is twice as great as it would be if the line were used to transmit, by means of steady currents, the same amount of power at the same potential, and the waste of power in the leads would, of course, be four times as great. By raising the potential of transmission, the capacity effect of the line is increased, while the self-induction effect is unchanged, and, as these effects oppose each other, and are nearly equal in the case considered, the high potential system is almost free from induction troubles. The investigation shows, however, that the capacity and self-induction effects must be carefully considered in any scheme for the transmission of power to a great distance, for the capacity per mile which Mr. KENNELLY has assumed in his conductors, is no more than any two leads possess when placed at an ordinary distance from one another. Probably these effects will be negligible in the leads to be used at Niagara owing to the low frequency adopted for the current.

THE letter from Messrs. BENNETT and DRUCE, which we print with some reluctance this week, displays strange ignorance both of the professional conduct of certain members of the Council of the Institution of Electrical Engineers, and of the action of the London Chamber of Commerce. To accuse these members of allowing "their conduct at the Council to be influenced by their retainers," even insensibly, is an unwarranted insinuation. A professional expert, even with a general and permanent retainer, would be unworthy of office if he allowed himself to be thus influenced. We cannot agree with our correspondents that a discussion in the technical Press is the proper way to deal with draft regulations of the Board of Trade. When they suggest that "the matter seems to have escaped notice," and speak of "the indifference displayed by the electrical profession in the matter," they are evidently not aware that a special committee of the Electrical Trades Section of the London Chamber of Commerce are actively considering these draft rules. It is highly improbable, if the draft be referred to the Council of the Institution of Electrical Engineers, that a committee with only two practical engineers will be appointed to discuss it, as was the case on a former occasion. We agree that the draft is at variance in several respects with the report of the Joint Committee, especially in Rule No. 14; the Committee of the London Chamber of Commerce have, discovered this long ago It should, moreover, be noted that neither the "line" nor the "return" are mentioned, but only the "feeders." The trouble at Leeds was with the line and the return.

Obituary.—Mr. George H. Babcock, the inventor of the Babcock and Wilcox boiler, died at his home in Plainfield (N.J.), on December 16th, aged 62.

The New Caledonia Cable.—In the first three weeks after its opening to the public (October 19th) the New Caledonia cable transmitted a grand total of 90 messages!

Ealing.—The Local Government Board have given their sanction to the raising by the Local Board of a loan of £25,000 for purposes of electric lighting within their district.

A Proposed New Cable.—The French telegraph authorities are about to invite tenders for a cable connecting Madagascar and Reunion with the telegraph system of the world.

Central London Railway.—The Central London Railway Company have deposited a Bill asking for an extension of time for the completion of their undertaking until the next century.

The Anglo-American Telegraph Company and the Compagnie du Télégraphe de Paris à New York.—The action pending between these two Companies came before the Courts as announced last week, but the hearing was postponed for a month.

Bray.—At a meeting of the Township Commissioners on Monday last the Electric Light Committee recommended that the Town Clerk should be authorised to enter into necessary correspondence with electric light contractors for purchase of plant, &c. The report was adopted.

Berlin-Cologne Telephone Trunk Wire.—The telephone trunk wire between Berlin and Cologne (300 miles) is now open to the public. Three minutes' conversation costs one mark. Urgent messages, which are to take precedence of ordinary ones, are charged for at treble rates.

Society of Arts.—The ordinary meetings of this Society recommence on Wednesday, the 17th inst. On February 14th Prof. Henry Robinson will read a Paper on "The St. Pancras Electric Light Installation," and on February 21st Mr. W. H. Preece, C B., will read a Paper on "Electric Signalling Without Wires."

Railway Station Lighting.—At several of the large stations of the Bavarian railroads electric light plants have been established recently by the management, which reports not only a much-improved illumination but an important economy. The cost at Bamburg, Nuremberg, Ratisbon and Würzburg shows a saving of 44, 40, 54 and 26 per cent. respectively over gas.

Personal.—Mr. Angelo Fahie, of 9, Westland-row, Dublin, has been appointed to the Commission of the Peace for the city of Dublin.—Mr. Haydn T. Harrison has resigned his position as manager of the Testing and Standardizing Department of the Electrical Standardizing, Testing and Training Institution, Charing Cross-road, W.C., and has entered into partnership with Mr. N. F. Nalder.

Cable Interruptions:

	Date of Interruption.
Cayenne-Paramaribo	October 25th, 1893.
Cayenne-Vizeu	November 25th, 1893.
Lagos-Brass	December 4th, 1893.
San Domingo-Martinique	December 10th, 1893.
Haiphong-Hongkong	December 11th, 1893.
Garachico-Santa Cruz de Palma	December 27th, 1893.

Patents in 1893.—According to information derived from an official source, the number of patents applied for at the Patent Office during the year 1893 was 25,102, a number exceeding any previously recorded in a single year. In 1892, however, the number reached 24,166. There has been a progressive increase in the applications every year since 1885, from 16,011 to the figure given above.

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An Electric Traction Prize.—The Metropolitan Traction Company, of New York, has offered a prize of $50,000 to any inventor who before March will bring forward a system that shall "approximate the trolley as a standard of economy in operation but shall be without the features objectionable to the public." The Company has invited the State Railroad Commissioners to be the judges.

Geneva.—According to the report which has recently been issued by the Compagnie de l'Industrie Électrique, of Geneva, the number of consumers on the continuous-current mains of their station was 501, representing 9,996 lamps; and on the alternate-current mains 66 consumers using 1,017 lamps. The report is made up to the end of last March. The available power on the continuous-current mains is 950 H.P., and on the alternate-current mains 250 H.P.

Sunderland.—The Highways Committee of the Town Council have for some time had under consideration the supply of the electric light in the borough; and, as reported in our last issue, provisionally accepted tenders for the work, amounting to £15,074, as against the estimated expenditure of £21,000. At their meeting last Wednesday week the Council confirmed the acceptance of the tenders, and granted the Committee permission to secure a loan not exceeding £25,000 for carrying out the whole scheme.

Northern Society of Electrical Engineers.—We have received from the Secretary the following complete list of officers elected at the first general meeting of this Society:—*President:* Dr. John Hopkinson. *Vice-Presidents:* Mr. Henry Edmunds, Mr. W. P. J. Fawcus, Mr. G. E. Preece. *Council:* Dr. Edward Hopkinson, Mr. J. V. Swindells, Mr. A. Eckstein, Mr. G. W. Lowcock, Mr. E. A. Claremont, Mr. Alexander Marr, Mr. G. S. Corlett, Mr. W. C. Mountain, Mr. J. H. Rider, Mr. J. Taylor, Mr. H. Wooler, Mr. C. S. Northcote.

Accident on H.M.S. "Resolution."—At a further inquiry into the recent explosion on board the "Resolution," at Devonport, the primary cause of the accident was ascertained. Part of the mechanism of the evaporator consists, it seems, of a quantity of zinc slabs and copper pipes; the salt water to be distilled caused electro-chemical action to take place, and it was due to the accumulation of hydrogen and oxygen thus liberated that the explosion occurred. The evaporator is fitted with a safety-valve, which, if opened by hand, would have allowed the hydrogen to escape.

Patents Expiring this Year.—The following are some of the more important electrical patents expiring this year, if not already dropped:—

Dated 1880.	No.	Name.	Subject of Patent.
Jan. 2	18	J. W. Swan......	"Running on the pump."
Jan. 20	250	J. W. Swan	Parchmentised paper filament.
Jan. 23	315	W. R. Lake......	Thomson-Houston dynamo.
Feb. 10	578	T. A. Edison ...	Lampholders.
Apr. 5	1,392	W. R. Lake......	Maxim dynamo.
Apr. 6	1,397	C. D. Abel	Pilsen lamp.
Sep. 16	3,765	E. C. Brewer ...	Edison's bamboo filament.
Sep. 24	3,880	P. Jensen	Edison's feeder system.
Nov. 27	4,933	J. W. Swan......	Parchmentised cotton filament.

The Hull Corporation and Electric Traction.—At a recent meeting of the Electric Lighting Committee of the Hull Corporation a report was presented respecting the application of electricity as the motive power for the tram service. The report stated that electricity could be applied, and it was resolved to appoint a small sub-committee to watch the employment of electricity in this direction. A resolution was also passed asking the Town Clerk to insert a clause in any agreement with a new tramway company binding such company to use the electricity supplied by the Corporation as the motive power.

The Azores Cable.—The following extract from a letter written by a cable man in the Azores is rather amusing:—"The people at Pico said that the cable was the cause of the cyclone, but as it saved them from starving, by bringing the milho at once, they don't consider it such witchcraft as they did at first. It is a fact, though, that the fishermen have said that the 'talking' in the cables has frightened the fish away! People in Pico would not have the land-line insulators on their houses because of this same 'talking.' I have been told that if I had been here a quarter of a century earlier I should have stood a chance of being burnt, and should have figured in the annals of electricity as a martyr to the science."

The Dying-out of Alternating-Current Waves.—In a recent number of the *Electrical Engineer* of New York, Mr. A. E. Kennelly discusses the question of the final shape of an alternate-current wave after passage through a succession of induction coils. Briefly, Mr. Kennelly's statement is that coreless induction coils would transmit an initial sinusoidal wave through an indefinitely long series, unchanged in type. They would also sift an initially non-sinusoidal wave down to a sinusoid, so that practically the conditions might then be closely represented by a sinusoidal generator of reduced amplitude brought into operation further along the line, beyond the principal sphere of shifting action. With iron-core transformers there would broadly be a tendency for the sinusoid to survive.

Battersea Polytechnic Institute.—The classes at this Institute commenced yesterday. The prospectus offers no less than 54 classes, and of these we hope that a large number will be actually started. The nature of the instruction appears to resemble that of the trade classes at the Finsbury Technical College. Many of the classes will prepare for the examinations of the Science and Art Department, and the City and Guilds of London Institute; all students attending such classes are required to undergo the examination. With the exception of special classes for teachers, most of the instruction is given in the evening. The fees for the mathematical courses are specially low, in order to encourage attendance. The following courses are conducted by Dr. W. E. Sumpner:—Magnetism and electricity and laboratory work, technical electricity and laboratory work, for the electrical engineering department of the trade and commercial classes; and sound, light, and heat, for the special classes for teachers. Mr. A. E. Sillar takes a practical class in electrical wiring and house fitting.

Liverpool Overhead Railway.—The Liverpool Overhead Railway, which was started for traffic in March last, has now been taken over from the contractors, the Electric Construction Company. The contractors were under an obligation to work the line for two years from the date of opening at a fixed rate of 4d. per train mile, but we understand the working has been so satisfactory that the railway company has decided to take over the line as from 1st inst., and the Electric Construction Company are relieved from all responsibility of the working and maintenance. The Railway Company contemplate putting into execution the powers they have of creating no less than four new stations at the north end of the line. The Company are also proceeding apace with the extension of the line to Seaforth, where a very fine station is to be built. This extension means about an extra quarter of a mile of new work, and involves the erection of about 20 new spans, one of which is 85ft. in width, and crosses the Lancashire and Yorkshire goods yard. About 15 of the new spans are already erected. Several improved carriages are also to be constructed.

The Multiphase at Budapest.—The multiphase installation carried out at Budapest by Messrs. Schukert and Co., of Nürnberg, for the Budapest Gas Company, has now been in operation for two months. The first plant consists of two 150-H.P. machines, which, together with a battery of accumulators, capable of discharging at the rate of 500 amperes, and having a capacity of 3,000 ampere-hours, are sufficient to supply 6,000 lamps. It is expected that plant sufficient for 15,000 lamps will be laid down and come into operation by February, and the great demand has already induced the Directors of the Gas Company to consider the construction of two sub-stations and the extension of the existing central station. So far as we know, the Budapest system is unique, consisting, as it does, in the transmission of multiphase currents of 25 ∾, at a pressure of 2,000 volts, and its tranformation into continuous currents for the purpose of distribution.——We also learn that the Budapest Tramway Company has decided to extend the use of electricity to its entire system.

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Storage Batteries in Telegraph Work.—A recent issue of the *Electrical Engineer* of New York contains a description of the storage battery plant at the office of the Postal Telegraph Cable Company, at Baltimore. This is the first telegraph office in the United States to adopt storage batteries exclusively for the transaction of its business. As one end of a battery used on telegraph lines must be connected to the earth, it was found impracticable to charge the batteries direct from the street mains and at the same time use the batteries for telegraph work. To obviate the necessity of changing the circuits and using extra sets of batteries, a motor-generator was adopted for supplying current to the battery. In this way the street mains are entirely insulated from the charging circuit and the battery can be recharged and used at the same time. Although the voltage of one storage cell is only equivalent to that of two Daniell cells, it is found that where the working conditions are similar to those in the Baltimore office, one storage cell will replace five or more primary cells of the type now generally used in America. The plant at Baltimore consists of 500 30-ampere-hour "Donaldson-Macrae" cells. A Daniell cell in constant operation on a quadruplex circuit gives, says our New York contemporary, an average current of about $\frac{1}{10}$th ampere, or 875 watt-hours per annum, and costs to maintain, at the very lowest estimate, $1.10. The same number of watt-hours, if furnished by the electric light companies of Baltimore, would cost nine cents.

A Simple Method of Investigating the Conducting Power of Dielectric Liquids.—In recent times, says Herr K. R. Koch, in *Wiedemann's Annalen*, many investigations have been made as to the coexistence of dielectric power and electrical conductivity. If it be assumed that electrical conductivity in dielectric liquids is of the nature of electrolysis, we must look for galvanic polarisation in two electrodes inserted in it and connected with a galvanic battery. A capillary electrometer, in which the electrolyte is the liquid itself to be investigated, may be made so sensitive that the existence of a polarisation, and therewith of electrolytic conductivity, may be demonstrated. An ordinary Lippmann's capillary electrometer could not be used for this purpose ; Dewar's form is much more sensitive. This consists of a horizontal tube about 1mm. bore, connected on each side with mercury cups ; the mass of mercury in the tube is separated by a drop of dilute sulphuric acid, if the instrument is to be used in the ordinary way for measuring electrolytic forces ; in the present case the dilute acid was replaced by a drop of the substance to be investigated. If, now the two mercury cups are connected with the poles of a battery, the drops move one way or the other, according to the direction of the current, if the liquid conducts electrolytically, and thus when polarisation takes place at the opposite surfaces of the mercury. With these badly-conducting liquids the drop should not exceed ½mm. in length. Investigated in this way, all dielectric liquids, without exception, exhibit polarisation, always in the direction of an increasing surface-tension at the kathode due to polarisation. It is, however, probable that this phenomenon, in the case of benzole, for instance, is due to the presence of impurity.

Repairing Glow Lamps.—Judge Colt, of the United States Circuit Court of Massachusetts, says the *Electrical World*, handed down an opinion on December 13th, granting an injunction against the Davis Electrical Works, Springfield, Mass., restraining the latter from repairing lamps under the Edison patent by substituting a new filament. The Court states that the process of repairing consists in first breaking off the tip of the glass bulb of the lamp and reaming out a hole about one-half inch in diameter. The broken filament is then removed. The new filament, having its ends cemented into platinum sleeves, is then inserted into the glass chamber, the sleeves being pushed down over the two platinum leading-in wires and compressed upon them. A tube of glass made into the shape of a funnel is heated and placed over the hole in the lamp chamber. This tube is fused into the open end of the bulb, which brings it into the condition of the ordinary lamp bulb just prior to exhaustion. The air is then exhausted and the bulb sealed. It is evident, the Court decides, that this operation covers many of the constructive features of the ordinary lamp, whose claim consists of four elements : a carbon filament, a receiver made entirely of glass, conductors passing through the glass, and a receiver from which the air is exhausted. It is apparent, the decision says, that the defendants by substituting a new filament, making over the glass receiver, and exhausting the air from such receiver, produce a lamp in which all the elements but one (the leading-in wires) of the patented combination, are used either in a new or reconstructed form. The lamp thus produced is substantially a new lamp, and its voltage may be higher or lower than the old one. From the very nature of the Edison invention, the Court does not see how the glass bulb can be opened and a new filament inserted without making essentially a new lamp.

Brighton.—The following is an abstract of the report presented by the Electric Lighting Committee of the Brighton Corporation at yesterday's meeting of the Town Council :—A little more than two years ago a proposal to buy up the Brighton and Hove Electric Lighting Company by the Town Council for £7,000 was rejected by the Council, but two months ago negotiations were reopened by the Receiver and Manager, appointed on behalf of the debenture-holders of the Company. After some haggling, the contending parties came to the following agreement :—The Corporation to purchase the Company's undertaking for the sum of £5,000, one-half of which sum to be paid on September 30, 1894, and the other half to be paid within one month of it being certified to the Corporation that the overhead wires, posts, and apparatus belonging to the Company have been removed to the satisfaction of the Borough Surveyor ; the Company to continue to supply their own customers until September 30th, bearing all the expense and receiving all the revenue. As a considerable extension of the Brighton Corporation's present system will be necessary, if this agreement is ratified by the Town Council, the Committee instructed Mr. Arthur Wright to report as to the probable cost. For the purpose of the estimate, Mr. Wright has divided the 232 consumers at present connected to the Company's mains into three classes, viz., (1) consumers in streets in which the Corporation mains are laid, (2) in the Corporation's area of supply but where mains have not yet been laid, (3) outside the area of supply. The following table gives particulars of number of consumers, probable income, &c. :—

—	Consumers.	Lamps.	Units consumed.	Annual income.
Class 1	•162	7,159	122,920	£3,073
Class 2	43	1,113	19,080	477
Class 3	27	1,393	12,000	300
Total	232	9,665	154,000	£3,850

The total capital outlay is estimated by Mr. Wright at £19,227, the total annual cost of supplying the whole of the Company's customers is put down at £3,265, and the total annual revenue is put down at £3,850, leaving an estimated profit of £585, no allowance being made for the sum of £5,000, which it is proposed to give for the Brighton Company's business. The Electric Lighting Committee having also come to the conclusion that the time has arrived for providing the Preston district with the electric light, Mr. Wright also reported on that point, recommending the district to be supplied from the present Corporation station, but on the high-pressure alternate-current house-transformer system. The Committee, therefore, ask for power to borrow £35,000, the items of which are as below :—

1. Purchase money payable to the Company	£5,000
2. Additional mains and plant for supplying Company's customers	19,227
3. For plant and mains for supplying the Preston district	4,290
4. For laying on new house services and purchasing additional meters............	6,483
	£35,000

At yesterday's meeting of the Town Council some criticism was passed on the figure at which the Company's business was to be purchased, but eventually the report was adopted unanimously.

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MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 136.)

Storage of Energy.—Energy storage constitutes a most important mechanical and economic question in the design of motive power plant. The fact that energy can be retained for a long or short period in a state of reserve, both in a kinetic and in a potential form, is taken advantage of in several ways in machinery problems. Storage occurs both by accident and by design. Accidental storage is due to the fact that every moving piece of machinery will absorb or liberate an amount of energy proportional to its change of motion. This exerts a modifying influence, of course, upon the flow of energy through the chain of mechanical parts, as well as upon the distribution of stresses in those parts. Intentional storage occurs where a capacious reservoir is placed in the path of the energy flow, with the deliberate purpose of causing some or all of the energy to remain for a certain time in the reservoir instead of passing on to the dynamo. The general action of energy storage is illustrated in Fig. 6. Let the axis y represent the power or the driving force, and the axis x the time or the distance covered by the driving force respectively; then the area subtended by any curve on these axes will represent an amount of energy transmitted, or of work done. Now, let it be supposed that at any point in the path of the energy flow from the initial source to the dynamo there is a reservoir or store inserted. We may consider two cases which arise in practice: the first, in which the energy is supplied to this point at an irregular rate, such as is shown in curve (*a*), and is required to be drawn off at a regular rate, such as shown in curve (*b*); the second, where the conditions are reversed, the energy being given to the point regularly, but requiring to be taken away at an irregular rate. In the first case the power and the stresses in the mechanical parts nearer to the source than the reservoir will follow the irregular curve (*a*), and will at some times be very much above the average, as they will at other times be very much below that average. And the mechanical parts further from the source than the reservoir will be subjected to an even and steady state of stress and power transmission, as indicated by the curve (*b*). The distribution of power and of stress is reversed in the second case. In both cases there is a certain amount of energy which alternately flows into and out of the reservoir; flowing into it when the supply is greater than the discharge, and out of it when the discharge is greater than the supply. The amount of this fluctuating energy will determine the capacity which the reservoir should have.

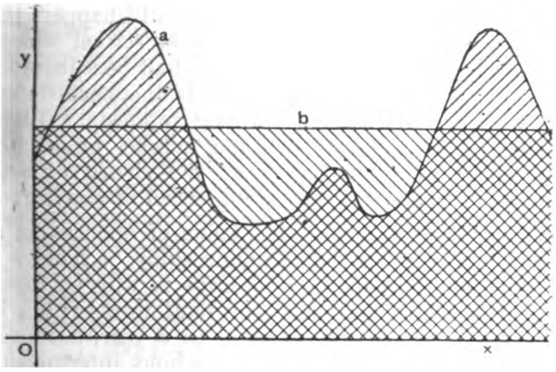

FIG. 6.

In relation to the production of mechanical motive power we may consider three forms of energy storage:—

(1) *Source Storage.*—In which the initial source of energy is conserved.

(2) *Transit Storage.*—In which the energy is stored at some point in its transmission through the chain of machinery from the source to the dynamo.

(3) *Supply Storage.*—In which the energy at its ultimate stage in the dynamo is passed into a reservoir at a steady rate.

Source storage is not always possible. Wind power is an instance in which it is impossible to conserve the initial source of energy; we must take the wind as it comes. In the water power of a small stream we find source storage not only possible, but often necessary; and with tidal motors it is always necessary. Coal stores represent a form of this class of storage. The two chief reasons for source storage are: (1) actual or liable irregularity, or complete failure, of the supply, the demand being regular or at a different rate: and (2) small, steady rate of supply, with a demand which is either continuously or intermittently very much in excess of this supply. Transit storage may be considered to occur when there is storage of energy after it has been prepared by artificial mechanism and before it has been passed into the dynamo. In Fig. 7, let A represent the source of energy, and B the dynamo to which it is being supplied. The line A B is taken to represent the chain of mechanical parts through which the energy is passed. A store, or reservoir, C, is placed somewhere in this line, so as to intercept the whole or part of the energy in its transit from A to B. In the case marked (*a*) the store transforms the flow of energy from an irregular into a regular rate, so that the mechanism in the line A C will be subjected to irregular actions as curve (*a*) in Fig. 6 while the mechanism in the line C B will be subjected to regular or steady actions. In the case marked (*b*) the converse conditions will hold; the first part of the chain of mechanism will be steadily acted on, while the second part will be subjected to variable action. Now, let it be required that each separate part of the chain of mechanism, A B, shall transmit the energy with as little stress, and at as small a maximum rate, as possible. These requirements will arise in practice on account of the fact that the size, weight, durability, &c., of the several parts, and, therefore, their prime and working costs, will depend directly upon the amounts of the maximum stresses and the maximum power which each will have to support. It will be well understood, then, that in practice we require to place the transit store or reservoir in such a position, and to have it so designed, that as much as possible of the line, A B, shall be subjected to as small as possible maximum of stress or power. Now, it is evident that the maximum will be as small as possible when the flow of energy is steady and regular, for then the maximum will be neither greater nor less than the mean value. The required conditions are therefore obtained when it has been arranged that as much as possible of the line A B shall transmit energy at a constant and regular rate. And in order to arrive at this result it will be necessary to place the store close to A in the first case, and close to B in the second case. There arises, then, the following general principle in regard to the use of an energy store for the equalisation of the stresses and power in machinery:—*In any arrangement of mechanical or other parts for the transmission of energy, the energy entering the arrangement at an irregular or fluctuating rate and leaving it at a regular rate, or* vice versâ, *the successive parts will be subjected to the least straining action, and will be required to transmit the least power if the store or reservoir, for transforming the rate from one value to the other, is placed at the least possible distance from the actual seat of the fluctuation.* In the subsequent sections of this work it will be seen that this principle is of vital importance, as

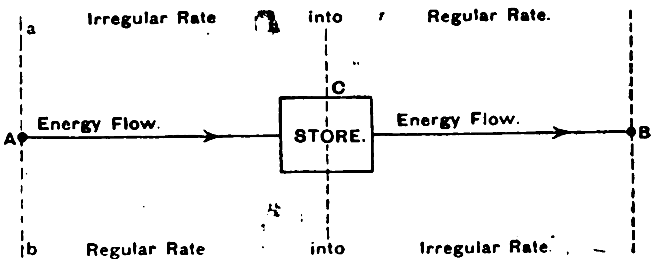

FIG. 7.

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affecting the design of machinery. As examples of transit-storage we may mention flywheels, hot water in boilers, and hydraulic accumulators. The last form of storage, namely, supply-storage, only affects the motive power plant indirectly, as it takes place beyond the point at which the energy is supplied to the dynamo. Nevertheless, its influence upon the mechanical design of that plant is very important; for where the dynamo is employed in pouring energy at a steady rate into a form of reservoir (such as that energy-reservoir called a secondary battery) it will be evident that the load-diagram of the dynamo, and of the mechanical parts which transmit power to the dynamo, will be very different from the load-diagram of a dynamo supplying power to a fluctuating demand. With this form of energy storage, in so far as it is electrical or chemical and not mechanical, we shall here have nothing to do; but with its effect upon the engines and the accessory details, some future articles must be concerned. Electrical engineers will do well, however, to apply to supply-storage, whether on lighting or traction circuits, those principles which we have already enunciated in regard to transit storage; for it is equally true in this case as in that, that the most advantageous and efficient arrangement tends to be attained the more closely the store is placed to the seat of fluctuation of the power.

A Statement of the Problem.

The study of motive power and gearing for electrical engineering may be regarded as one great problem, with which every engineer is confronted when he commences to make his plans and designs for an electric-power plant. And, as has already been said, it is in the form of a single problem that this study is made in the present series. Broadly speaking, the main problem may be stated thus:—*What are the best provisions which may be made for utilising the available energy for the performance of useful work and the production of a paying revenue?*

No final answer can be given to such a question in any general treatise; for there are many determining influences which are purely local, and which can only be taken into account when the local conditions are known, or, at most, when the relative local values of several proposed localities have been compared. For example, it would be impossible to give in a general treatise such information as would make it certain, without local inquiries, that at the little town of Waterville it would be better to use a water-power engine than a steam engine; or that at the village of Riverside it would pay to use a condensing plant rather than a non-condensing one. Yet, while this is so, it is to be noticed, firstly, that no proper estimate can be set upon the local advantages or disadvantages unless the general merits and demerits of each mode of producing motive power are thoroughly understood; and secondly, that in the majority of cases the local considerations are of lesser importance than the more general ones which may be rigidly defined in a standard treatise. All that can be done, therefore, is to perform the part of a guide to the engineer, to help him in affixing proper values to the various considerations which come before him. And the work of doing this is not unimportant.

Details of the Problem.—For the problem is by no means a simple one, but consists of a great number of inter-dependent details; and it has often to be approached from two or more points of view. In the first place there must be a comparison of the mechanical and electrical aspects of the problem. The questions of motive power must be influenced by the character of the electrical work which has to be done by the plant; as, for example, whether the power is to be used for electric lighting and general power distribution, or for electric traction, and as to the variation of load from hour to hour, or from moment to moment, which may be expected. It is impossible to have successful mechanical design where there is not a close acquaintance with the electrical duties which will be imposed upon the plant, and of the effect of these upon the relative merits of different forms of plant design. On the other hand, it is almost as important that the electrical engineer shall be cognisant of the peculiarities of each form of motive power, in order that he may, wherever possible, endeavour to modify the character of the electrical loads in such a manner as best to adapt them to the working of the mechanical plant. In other words, the electrical engineer who is familiar with the behaviour of various types and arrangements of engines in a power station, under various conditions of load distribution, will be in a position to avail himself of every opportunity to so distribute and modify the load as to get the highest economy, and the greatest revenue on a minimum capital, out of his plant. We shall presently see in what ways such a modification of the electrical load on the plant may be effected.

From another point of view, the selection of a type of motive power is influenced by the character, both of the local sources of energy and of the area to be supplied with power. The presence of water power in large amounts will always, of course, have a prime influence; but it may happen that even in such cases as this there will be conflicting conditions. Again, the attraction of a cheap site for a power station at the top of a hill may offer advantages in low rent, rates and taxes, but may have a corresponding disadvantage in the increased cost of cartage of fuel to the top of the hill, and possibly in the scarcity of water; while an alternative site on a canal or river side may offer advantages in cheap fuel and abundant water, but may have the electrical disadvantage of being some distance from the centre of the area to be supplied with power, thus necessitating the use of expensive cables or the adoption of a more expensive system of power distribution. Assuming the general type of motive power to have been already decided upon, it will still happen that the precise character of that type will only be settled when it has been decided which of these two sites shall be selected. The ultimate choice of a species of engine is therefore determined by the balance of many conflicting interests. There still remain the questions of the size and number of engines, the distribution of load on these, and the choice of accessory engine details, beside the separate question of gearing.

The Factor of Idleness.—The factor of idleness is a most important coefficient in the economic study of motive power. From the definition of this quantity it will be seen that if we multiply this factor by the total work which can be done by a station or unit of plant in a year, assuming full work to be done by all the engines without intermission, the product will be the idleness of the station or plant, expressed in available but unrealised units of work. It may be found convenient to express the idleness of a plant in horse-power hours. It is to be carefully observed that this factor depends only upon the total capacity of the plant and upon the character of the load diagram. In a station composed of many engines, the idleness of the entire plant is equal to the sum of the idleness of all the separate engines; and by no alteration of the distribution of load among the engines themselves can this quantity be either diminished or increased. Thus, it makes no difference to the total idleness if any given engine is worked for the whole time at half power, or if it is worked for only half the time at full power. Now it will be evident that the idleness of any portion of plant expresses the degree of unproductiveness of the capital invested in it; for, in proportion to the idleness there must be a scarcity of revenue. This question is altogether apart from the question of the efficiency of the plant at various loads, and relates solely to the proportion of the whole time during which the whole capital may be said to be active or productive. There are only two ways in which the idleness of a station or plant may be diminished. If the amount of plant is fixed, the idleness may be reduced by imposing upon it a load which is maintained for a longer time nearer to its maximum value; and the ideal state is where the whole plant is kept at full load for the whole time. If the character of the station load diagram is fixed, the idleness may be reduced by providing a system of energy storage whereby the load may be equalised on the engines throughout the time; provided, of course, that the capital invested in storage plant is not in excess of the capital saved in engine plant. An instance of the former occurs in the efforts which are made by electrical engineers to induce power consumers to take power at cheaper rates during

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the hours of minimum load; and an instance of the latter occurs in the use of extremely heavy flywheels on the engines of electric traction power stations, or again in the use of secondary batteries on electric power circuits.

(*To be continued.*)

ON THE FALL OF PRESSURE IN LONG LEADS TRAVERSED BY ALTERNATING CURRENTS.*

With short lines any inductive effect which is appreciable is due entirely to electromagnetic action; but when lines are of considerable length the effects of capacity and leakage become of great and, indeed, paramount importance. An approximate method of taking account of these new effects is to consider the capacity and leakage concentrated at one part of the circuit, and to treat these shunts as derived impedance circuits. But this plan is not rigorous, and the extent of its error is left in doubt. The object of Mr. Kennelly's article is to show how the rigorous computation for the fall of pressure in lines of known resistance, inductance, leakage, and capacity, carrying sinuous currents, can be most simply carried out.

Suppose a generating station, A, supplies a consumption point, B, at a distance of L miles or kilometres through two wires in metallic circuit, or through one wire with ground return. At B there are transformers or translating devices operated at a pressure u that it is usual to keep nearly uniform. Under this pressure, at any given load, a certain effective current of i amperes will traverse the apparatus at an angle of lag θ. We assume that the current and lag are experimentally known for the particular apparatus and load. Having then given u, i, and θ at station B, the problem is to determine the corresponding pressure U, and current I at A, or at any intermediate point along the line.

Let r = the resistance of the line in ohms per mile,
l = the inductance " " henrys "
g = the leakage conductance " " mhos "
c = the capacity " " farads "
ω = frequency $\times 2\pi$,
$j = \sqrt{-1}$, and L = length of line in miles.

Then, by considering the problem mathematically in the manner first shown by Mr. O. Heaviside, it can be proved that

$$U = u \cosh Lz + y\,i \sinh Lz. \quad . \quad . \quad . \quad (1)$$

$$\text{and } I = i \cosh Lz + \frac{u}{y} \sinh Lz, \quad . \quad . \quad . \quad (2)$$

$$\text{where } z = \sqrt{(r + jl\omega)(g + jc\omega)} \quad \text{and} \quad y = \sqrt{\frac{r + jl\omega}{g + jc\omega}} \quad . \quad (3)$$

These equations involve plane vectors or the "complex quantities" of algebra, and Mr. Kennelly proceeds to explain some properties of these functions, which are necessary for the solution of the present problem. The original article also contains a full description of a geometrical method of calculating the quantities given in the above equations, illustrated by the complete numerical working of the two problems referred to below. As, however, comparatively few electricians are familiar with the properties of the hyperbolic sines and cosines, or with the manipulation of vector quantities, we refer our mathematical readers to the *Electrical World* of New York for the detailed description of Mr. Kennelly's method, confining ourselves to the statement of the problems studied by him and the results which he obtains.

The first example considered is the following:—

At station B transformers are supplied at a steady pressure of 10,000 volts effective, and at 100 ∿, through two #0 A.W.G. wires of copper in metallic circuit, suspended on high poles at an interaxial distance of 2ft. The resistance of this conductor is 0·508 ohm per mile, the inductance 1·688 millihenrys per mile, the capacity 0·081 microfarad per mile, and the leakage negligible, or the leakage conductance 0 mhos per mile. To find the pressure and current at A, distant twenty miles from B, when a full load of 50 amperes is sustained with a lag of 10deg. at B.

* Abstract of a Paper kindly sent us by Mr. A. E. Kennelly.

This metallic circuit may be divided by the imaginary line O O (Fig. 1) into two halves, each as though independent of the other, and operating with ground return at 5,000 volts. We then have:—

$u = 5{,}000$
$i = 50$
$\theta = -10^\circ$
$r = 0{\cdot}508$
$l = 1{\cdot}688 \times 10^{-3}$ $\therefore$ $l\omega = 1{\cdot}061$
$c = 8{\cdot}1 \times 10^{-8}$ $\therefore$ $c\omega = 5{\cdot}09 \times 10^{-5}$
$\omega = 628{\cdot}3$
$L = 20$

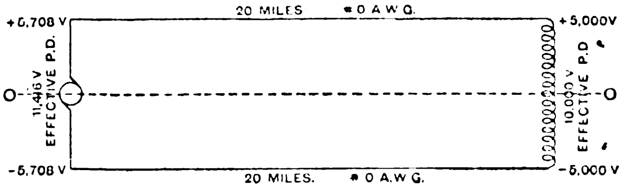

Fig. 1.

By solving equation (1) it is found that the two terms composing the voltage U
re 4,942 volts at a phase angle of 0° 18′,
and 1,173 volts at a phase angle of 54° 31′.

These are shown to combine by vector addition to
5,708 volts at a phase angle of 9° 54′.

Similarly, by applying formula (2), it is shown that the current I consists of two components, the first of which is
49·418 amperes at a phase angle of − 9° 42′,
and the second
5·072 amperes at a phase angle of + 90° 6′.

By summing these components it is found that
I = 48·81 amperes, the phase being − 3° 49′.

The effective pressure at A being represented in Fig. 2 by A C and the effective current by D F, the angle between them

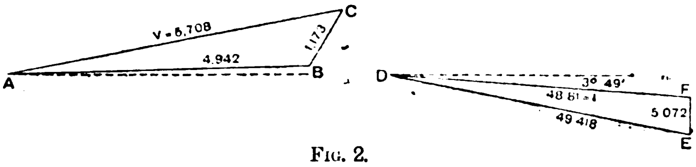

Fig. 2.

is 13deg. 43min., and the energy delivered to the line is I . U . cos 13deg. 43min. = 270·7 kilowatts. The energy absorbed at B is $i \cdot u \cdot \cos$ 10deg., or 246·2 kilowatts on each side of the circuit, and the loss in its transmission 24·5 kilowatts. This loss can only exist as $i^2 r$, the value of which must fall between $(50)^2 \times 10{\cdot}16 = 25{\cdot}4$ and $(48{\cdot}81)^2 \times 10{\cdot}16 = 24{\cdot}20$ kilowatts, the mean being 24·8, confirming the above calculation. The total pressure at A is thus 11,416 volts, and the current 48·81 amperes.

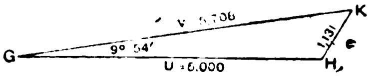

Fig. 3.

The drop on each wire is 708 volts; the drop due to I R on a similar continuous-current conductor would be 496 volts; the impedance factor for these wires being 2·316, the drop would be by magnetic impedance 1,150 volts; the actual drop between far and near ends of one line is shown in Fig 3 to be G K = 1,131 volts; the influence of electrostatic capacity has reduced the drop in the line as measured between line terminals from 1,150 volts to 1,131.

The other example taken by Mr. Kennelly is to suppose that 10,000 volts are maintained at B, and the load entirely removed. In this case the second term disappears from equation (1), and the first term from equation (2), so that we have at once $U = 5{,}000 \times \cosh Lz = 4{,}942$ volts, the phase being 0deg. 18min., and the two terms composing I are respectively

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6·576 × 10^{-3} and 0·1542, the phase of the former being 12deg. 47min., and that of the latter 77deg. 19min. These combine to 5·073 at a phase of 90deg. 6min. The energy absorbed at A is U . I . cos θ on each wire, or 44 watts. The impedance of a condenser having the same capacity as the line, viz :—1·62 microfarads at 100 ∿ would be 982·3 ohms, making the line current in this case 5,000/982·3 = 5·09 amperes, in practical accordance with the above.

Tables I. and II. illustrate the effect of distance and of pressure upon the drop in lines considered in the foregoing examples. In Table I. the current and pressure are marked off at 10, 20, and 50 miles from B at a supposed full load of 50 amperes, and at no load with 10,000 volts total effective delivery pressure, or 5,000 positive and negative measured from the zero point or load centre. Table II. gives the corresponding figures for 2,000 volts total delivery pressure or 1,000 volts on each side of zero. The drop is in the latter case much too great at full load for the conditions of ordinary practice, but the comparison of the two series shows how much the drop may be reduced in long-distance transmission over such wires by the employment of high pressure with a given current strength ; for the electromagnetic effect is practically unaltered, while the neutralising electrostatic effect is correspondingly increased. At no load the pressure here rises along the line.

Table I.

—	No load delivered at B.				Load of 2 × 246·2 kilowatts delivered at station B.			
Miles between stations A & B.	0	10	20	50	0	10	20	50
Angle of lead of volts	0	0° 4′ 30″	0° 18′	0° 56′	0	5° 8′	9° 54′	21° 44′
Volts P.D. on each side of zero	5,000	4,987	4,942	4,668	5,000	5 350	5.708	6,795
Amperes	0	2·54	5 073	12·43	50	49·5	48·81	46 65
Angle of lag in current	90°	90° 1′	90° 6′	90° 39′	10°	9° 20′	8° 32′	5° 1′
Kilowatts lost in line	...	...	...	...	0	12·6	24·5	59·4

Table II.

—	No load delivered at B.				Load of 2 × 49·24 kilowatts delivered at station B.			
Miles between stations A & B.	0	10	20	50	0	10	20	50
Angle of lead of volts	0	0° 4′ 30″	0° 18′	1° 56′	0°	19° 42′	29° 54′	42° 49′
Volts P.D. on each side of zero	1,000	997·4	988·4	933·5	1,000	1,423	1,927	3,516
Amperes	0	0·508	1·015	2 487	50	49·78	49·31	46 36
Angle of lag in current	90°	90° 1′	90° 6′	90° 39′	10°	9° 20′	8° 32′	5° 1′
Kilowatts lost in line	...	...	...	...	...	12·7	25·16	60·2

THE ELECTRICAL CONCENTRATION OF SULPHURIC ACID.

BY BERTRAM BLOUNT, F.I.C.

Since the publication in *The Electrician* of November 10th last of an account of the investigation by A. H. Bucherer from thermo chemical data of the possibility of electrically concentrating sulphuric acid on an industrial scale, C. Haeussermann and F. Niethammer have described in the *Chemiker Zeitung* certain experiments devised to test the conclusions arrived at by the former investigator on purely theoretical grounds.

In reducing any system of vitriol concentration by electricity devised by a mathematical process to practice, the point that first claims settlement is the decision between the merits of a direct and an alternating current. Hot concentrated sulphuric acid is not a very familiar electrolyte, and but few can foretell its behaviour with any pretension to accuracy. Direct experiment is the only means of filling the gap, and this has now been carried out. A current of 14 amperes and 7 volts sent through a bent platinum wire 30cm. long and 0·47mm. in diameter, dipping into a beaker of sulphuric acid at 60°B, raised the temperature of the acid to 190°C, and caused it to lose about 11 per cent. of its original weight in two and a-half hours, but failed to raise its specific gravity more than to 61°B. The comparatively large loss was due to electrolysis taking place between parts of the wire physically adjacent, but of different potential. The occurrence of electrolysis was also inferred from the separation of sulphur, which then entered into secondary reactions with the hot acid, and the escape of gaseous products of decomposition. A remedy for this state of things was sought in the decrease of the conductivity of the acid relative to that of the wire. This was accomplished by using a wire of the same length (30cm.), but of slightly greater thickness (0·5mm.), and disposing it so that it traversed a horizontal glass tube in a straight line. When the diameter of the glass tube was 27mm. sufficient electrolysis took place to account for a large part of the current, and it was not until the diameter had been reduced to 8mm. that tolerable results were obtained. Even under these conditions, however, the use of a direct current was not sufficiently successful to warrant its continuance.

When an alternating current was resorted to, the electrolytic difficulty nearly disappeared. Thus, working with an alternating current of 14 amperes and 7 volts, Haeussermann and Niethammer succeeded in concentrating sulphuric acid to 65·8°B with a loss of weight of rather less than 20 per cent. The expenditure calculated from this experiment amounted to 1,490 watt-hours for 1 kilo of the concentrated acid. This does not compare very brilliantly with the calculated expenditure, representing, as it does, an efficiency of 25 per cent. It will be remembered that even the theoretical expenditure given in the article in *The Electrician*, already referred to, corresponded with a higher money cost than that of the usual methods of concentration, whence it follows that with an efficiency of 25 per cent. the electrical concentration of sulphuric acid may be relegated to that millennial period when some 90 per cent. of the energy of fuel can be obtained as electrical energy in every day working.

PHENOMENA OF THE TIME-INFINITESIMAL.*

BY PROF. E. L. NICHOLS.

Science consists in the extension of our knowledge of the external universe, and it brings about this extension in great part by reinforcement of our senses. To bring into the field of observation the very distant and the very small are, therefore, regarded as important scientific achievements, and the telescope and the microscope, by means of which this widening of the realm of knowledge has been made, as important implements of research.

As between the study of the infinitely great and the infinitesimally small, whether of space or of time, there is a peculiar value to be attached to the latter, because the only methods which have proved the least fruitful in the analysis of the more complex changes which are going on around us are those which begin with the infinitesimal. We consider an element of mass or of volume, or sometimes merely the element of a surface or line, proceeding then to extend our statements so far as our powers of mathematical expression will permit.

Now the element of time is, of course, purely relative. In certain phenomena the time infinitesimal is so short as compared with any time interval with which we are able to cope experimentally as to be out of reach, just as in special relations the dimensions of the molecule and atom are such that we dare not hope to render these ultimate particles of matter visible even under the microscope. There are periodic phenomena, on the other hand, the periods of which are so great that a lifetime, indeed the entire era covered by history and tradition, affords us a glimpse of but a single time element. Lying between these two there is a great range of phenomena for which the element of time is within our reach. It is by the study of what takes place in such time elements, and the extension of the results thus obtained by analytical processes, that much of our knowledge of physics has been gained.

* Abstract of an address delivered before Section B (Physics) of the American Association for the Advancement of Science, Madison meeting, August 1893.

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It is to the extension of our powers in the observation of the phenomena of the time interval that we must look in great part for further progress. It has seemed worth while, therefore, to bring together for purposes of comparison some of the methods which have proved fruitful in this respect, and to consider along what line they may be further developed. It is an investigation which will lead us into all departments of science; for phenomena into which the element of time does not enter are unknown.

Since all study of phenomena involves the time element, the consideration of all dynamical problems must begin with the *phenomena* of the *time-infinitesimal*. There are two cases of chief importance:—(1) The study of the time elements of periodic phenomena; (2) the study of beginnings of changes which result from a sudden variation in the condition of equilibrium.

The methods which have been found most useful in the investigation of the phenomena under consideration may be classified as follows:—(1) Visual methods: (*a*) vision by instantaneous exposure, (*b*) vision by periodically interrupted exposure, (*c*) vision by the aid of the revolving mirror. (2) Photographic methods: (*a*) instantaneous exposure of a stationary film, (b) photography by the aid of the revolving mirror, (*c*) continuous exposure of a moving plate, (*d*) successive short time exposure of a moving plate. (3) Indirect graphical and electrical methods.

The inventor of the revolving mirror (Wheatstone) found it possible to study time intervals down to within a millionth of a second (*Philosophical Transactions*, 1834). He obtained a rate of revolution never since greatly exceeded, I think, of 800 revolutions a second. It is evident that he stood at the very threshhold of the discovery of the oscillatory discharge, and that it was merely an accident of the relation of resistance and capacity in the circuits which he employed, which prevented him from observing that important form of the electric spark. That he was fully aware of the wide range of investigations to which the revolving mirror is adapted is also clear. He says in the memoir which Faraday presented for him before the Royal Society in 1834: "But this instrument is not confined to observing merely the intermittedness of electric light; whenever a rapid succession of alterations occurs in an object which does not change its place, they may be separately examined by this means. Vibrating bodies afford many instances for investigation; one among these is perhaps worthy to be mentioned. A flame of hydrogen gas burning in the open air presents a continuous circle in the mirror, but while producing a sound within a glass tube, regular intermissions of intensity are observed, which present a chain-like appearance, and indicate alternate contractions and dilations of the flame corresponding with the sonorous vibrations of the column of air."

In a later paragraph of the same Paper he noted the applicability of the spark in the study of the phenomena of the time-infinitesimal, suggesting a method the importance of which is even now imperfectly appreciated. "The instantaneousness of the light of electricity of high tension affords the means of observing rapidly-changing phenomena during a single instant of their continued action."

In the hands of Foucault ("Recueil des Travaux Scientifiques," Paris, 1878), Michelson (*Proc.* A.A.A.S., 1879, also "Papers of Amer. Ephemeris," Vols. I. and II., 1882), and of Newcomb ("Astro. Papers of Amer. Ephemeris," Vol. II.), the revolving mirror has given us our best determinations of the velocity of light; in those of Feddersen ("Beiträge zur Kenntniss des Electrischen Funkens, 1857"). Also *Pogg. Ann.*, 103, 113, 116 (1859 to 1862), Rood (*Amer. Journal of Science*, Vol. II., 111, p. 160), Trowbridge (*Amer. Journal of Science*, Vol. XLII., 111, p. 223), and Boys (*Phil. Mag.*, Vol. XXX., 111, p. 248), and others, it has made it possible to resolve the oscillatory spark into its elements.

Feddersen's experiments are especially noteworthy because he succeeded (in 1862) (*Pogg. Ann.* 116, p. 132) in photographing the discharge of the Leyden jar, securing an excellent record of the images seen in the revolving mirror. We are apt at the present day to look back to the introduction of the dry plate as the step necessary to the application of photography to the study of fleeting phenomena, but certainly the results obtained by this early investigator, who used the ordinary wet-plate process of his time, are not inferior in definition or in detail to any which have been published in recent years. Feddersen's researches are indeed worthy of all admiration. He used a concave mirror, giving excellent images when driven at a speed of 100 revolutions a second. The velocity was under the regulation to within 2 per cent., and the millionth of a second represented not merely an appreciable distance upon the negative, it was an *easily measurable* quantity.

More than thirty years ago this German physicist stood, as Wheatstone had done nearly half a century before him, in the very gateway of the domain in which such activity has shown itself of late—the domain of electrical resonance. He was not only the discoverer along experimental lines of the oscillatory discharge and the demonstrator of the existence of effects which had already been embodied in the analytical work of Helmholtz, Thomson, and Kirchhoff; he anticipated also many of the discoveries of later investigators, and worked out quantitatively the dependence of the rate of oscillation upon capacity, induction, and resistance. Two of Feddersen's photographs have been brought to general notice by reproduction in the fourth volume of Wiedemann's "Electricität." There is another set which I consider even more significant, showing the increase in the number of oscillations with diminishing resistance.

Another forerunner in the development of the methods which it is my privilege to consider, was Prof. E. W. Blake, of Brown University. His results, too, have become classical; but I refer to them because they are related in ways not always recognised in later work. We are all familiar with his interesting photographs obtained by speaking into the mouthpiece of a Bell telephone (Blake, *Amer. Journal of Science*, Vol. XVI., 3, p. 57), to the diaphragm of which was attached a rocking mirror. Records obtained in a variety of other well-known ways, of some of which I shall have occasion to speak, indicate that these photographs do not give a complete trace of the vibrations which go to make up the articulate utterances by means of which they were excited, but the method is of interest in three particulars:—

(1) It is one of the earliest attempts to substitute photography for vision in the study of the transient phenomena of the sound wave.

(2) It substitutes a moving sensitive plate for the revolving mirror.*

(3) It is a distinct forerunner of the method applied some years later with somewhat better success by Froelich to the analysis of alternate-current phenomena.

Throughout the history of the study of the phenomena of the time-infinitesimal we find the tendency to be to supplant visual methods by methods of photographic record.

In the study of periodic phenomena two distinct methods of investigation have been established. The first of these consists in the isolation of a desired element of the cycle at each repetition for as long a time as may be necessary to obtain a satisfactory record of the existing conditions. By the selection successively of many neighbouring elements, we get in this way at last the data from which to construct a complete diagram of the cycle.

This principle has been most fruitful in enabling us to analyse periodic processes not easily approachable by more direct means. The most notable application has been that which is commonly spoken of as the "method of instantaneous contact," well known to the student of alternating-current phenomena.

It is to Joubert† (1880) that we owe this ingenious adaptation of the device of properly-timed repetitions of instantaneous observations of periodic phenomena (a principle which underlies the phenakistoscope and similar well-known instruments). He made use of it in the study of the changes of potential in the circuit of the alternating-current dynamo, and between the terminals of the Jablochkoff candle.

In the same year the method was discovered independently, and applied to the study of the Brush arc-lighting dynamo by B. F. Thomas.‡ Joubert pointed out the method of using the quadrant electrometer in alternating circuits, also that the galvanometer might be utilised. He discovered the retardation of phase in the current curves of the alternating dynamo, and the peculiar distortion of the curves in the circuit containing an arc lamp, a matter more fully investigated at a later day by Tobey and Walbridge.‖ Thomas during this first period in the history of the Joubert method used a ballistic galvanometer and condenser.

The periodic phenomena of the alternating-current circuit have been among the most important to which the study of the time-element has been applied, and it is to the method of instantaneous contacts that we owe much of the progress of the last thirteen years. It is interesting to note the extension of this method in the study of a variety of allied phenomena. After the publication of Joubert's Papers the method seems to have come into common use in the physical laboratories, particularly in the exploration of the fields of continuous-current dynamos and motors.

In 1888 it was applied by Duncan, Hutchinson, and Wilkes ("Experiments on Induction Coils," *Electrical World*, Vol. II., p. 160, 1888) to the study of induction coils and transformers. To

* Stein, in a Paper cited by Prof. Blake (*Pogg. Ann.* 159, 1876), describes a similar device, but it is difficult to ascertain from his Paper to what extent he succeeded with his experiments.

† "Sur les Courants Alternatifs et la Force Electromotive de l'Arc Electrique." *Comptes Rendus*, Vol. XCI., p. 161, July 19, 1880.

‡ "Observations on the Electromotive Forces of the Brush Dynamo-electric Machine." (Title only.) *Proceedings* A.A.A.S., Vol. XXIX., p. 277 (1880). Prof. Thomas gave the results obtained, and described the method eleven years later in a communication to the Institute of Electrical Engineers, entitled "Notes on Wiping Contact Methods for Current and Potential Measurements," *Trans.* of the American Institute of Electrical Engineers, Vol. IX., p. 263.

‖ "Investigations of the Stanley Alternate-Current Arc Dynamo," *Trans.* Am. Inst. Electrical Engineers, Vol. VII., p. 367.

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them we owe the first set of complete diagrams relating to the performance of this class of alternating-current apparatus. In the same year Meylan ("Sur les Appels Magnetiques," *La Lumière Electrique*, XXVII., p. 220, 1888) used an interesting modification of the method in the investigation of the vibratory magnetic call-bell of Abdank.

In the same year appeared the first definite data with reference to the Westinghouse alternating dynamo at the hands of Messrs. Searing and Hoffmann ("Variation of the Electromotive Force in the Armature of a Westinghouse Dynamo," *Journal of the Franklin Institute*, Vol. CXXIII., p. 93), of Stevens Institute. Then followed in the order named the researches of Ryan and Merritt ("Transformers," *Trans.* Am. Inst. Electrical Engineers, Vol. VII., p. 1, 1889), Humphrey and Powell ("Efficiency of the Transformer," *Ibid*, Vol. VII., p. 311), Tobey and Walbridge (*Ibid*, Vol. VII., p. 367), of Marks (*Ibid*, Vol. VII., p. 324), of Herschel (*Ibid*, Vol. VII., p. 328), of Fortenbaugh and Sawyer (*Ibid*, Vol. VII., p. 334).

In all these investigations the methods under consideration have been used with varying accessories in the problem of the transformer.

In 1890 it was applied under much more difficult conditions to the analysis of the "ball and point effect" by Archibold and Teeple (*see* Nichols, "On Alternating Electric Arc between a Ball and Point," *American Journal of Science*, Vol. XLI., p. 1).

In 1891 Thompson ("Study of an Open-Coil Arc Dynamo," *Trans.* Am. Inst. Electrical Engineers, Vol. VIII., p. 375) determined the intricate changes of induction in open-coil arc-lighting machines by means of the same method, and Ryan ("Relation of the Air-Gap and the Shape of the Poles to the Performance of Dynamo-Electric Machinery," *Ibid*, p. 451) utilised it in his investigations of the influence of the air-gap upon the performance of dynamos and motors. In 1892 Duncan ("Note on Some Experiments with Alternating Currents," *Ibid*, Vol. IX., p. 179) described modifications of the method of instantaneous contacts by means of which the rapidity of reading is greatly enhanced.

Such has been, in brief, the history of a method by means of which in greater degree than of any other we have been able to extend and complete our knowledge of alternating-current phenomena.

To the practical electrician and to the theorist alike, the domain has been one of the most attractive of those which have been developed in recent years. To the electrical engineers of the younger generation the very complexity of alternate-current theory has proved a benefit. It has forced them to increased mathematical proficiency and to more rigorous thinking; it has, indeed, served as an excellent source of discipline. What the problems of submarine telegraphy did for the English electricians who served their apprenticeship during the early days of the cable-laying industry, compelling the development of those sturdy qualities which have been so highly serviceable in every branch of electrical progress since, the intricacy of alternate-current practice is unquestionably doing for the younger school which is growing up to-day in this country. The difficulties which have to be met and overcome in this field of work will have an excellent influence upon the manner in which the problems of the future will be approached.

Another investigation, which owes its existence to a most ingenious application of this same principle of instantaneous contacts periodically repeated, is well known to all of you. I refer to Prof. E. H. Hall's* study of periodic heat-flow in the cylinder walls of the steam engine by means of thermo-elements embedded within the metal and connected momentarily during a selected time-element in the course of each stroke with a sensitive galvanometer. To my mind no more interesting example of the indirect method of studying the phenomena of the time element could be found than this suggestive memoir.

The method of instantaneous contacts has been a fruitful one, and productive of high results; but it does not yield a knowledge of any individual time-element, nor the picture of any single completed cycle. Numerous attempts to record single cycles have been made, the results of which are of considerable interest, because they deal with the more direct study of the time-infinitesimal.

The device which lay nearest to hand, and which by its performance seemed to promise success in this direction, was the magneto-telephone. The investigations of Mercadier (*Journal de Physique*, Vol. IX., pp. 217 and 282) had already paved the way to some extent, when Froelich described his experiments upon the optical representation of the movement of the diaphragm of the telephone, followed almost at once by Thomson.

Froelich† reported his preliminary results to the Electrotechnische Verein of Berlin, in 1887. Elihu Thomson ("An Indicator for Alternating Circuits," *La Lumière Electrique*, Vol. XXVII., p. 339, 1888) brought out his indicator for alternating circuits, an instrument in which the movement of a diaphragm was amplified by levers, and then made visible by optical means (or photographed) in the same year. Froelich's method in its complete form, including the photography of the images from the revolving mirror,* was first described in the year 1889. Some of the curves published in the papers just cited, and particularly the experiments shown in the exhibition of the method at the Frankfort Electrical Exposition of 1891, are most striking; but considering the method by which they are produced, the question inevitably arises as to the part played by the inertia of the moving masses.

Froelich himself points out the necessity of great care in the matter of the adjustments, and of distinguishing the natural oscillation of the plate, which are frequently superimposed upon those to be recorded. Some experience with Froelich's method has convinced me that not only is extraordinary skill necessary in order to obtain, by means of a mirror attached to the diaphragm of a telephone, curves which should represent, even with a fair approximation, the law of whatever periodic changes we may desire to record, but that the attainment of the proper adjustment is a matter so entirely fortuitous, and its maintenance so uncertain, as to deprive the method of much of its usefulness. One may indeed hope to get, by means of successive adjustments, curves which correspond to a known type, but whether in passing to new and unknown types the apparatus retains its faithfulness, is always a question.

The difficulties of the method lay not merely in the tediousness of adjustment, but rather in the tendency to revert to complex forms under changes of condition so slight as to be entirely beyond control. The remedy clearly consists in the elimination of mechanism and the reduction of inertia of the moving parts. Following the suggestion of an assistant, Mr. E. F. Northrup, I tried the following experiments.—

A mercury stream flowing from the contracted nozzle of a funnel (Fig. 1) was made to pass between two metal terminals which were

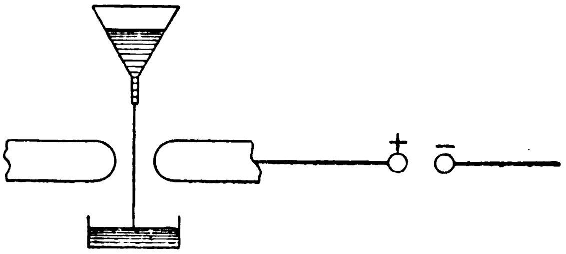

Fig. 1.

attached to the poles of a large Holtz machine. A portion of the falling column of mercury within the electrostatic field was illuminated by means of an arc lamp, and so much of it as could be seen through a horizontal slit was photographed by transmitted light. The sensitive plate was given rapid vertical motion through the field of the camera. When the machine was out of action there resulted a vertical trace running the length of the developed plate. As soon as the machine was put into operation, deflection of the mercury stream occurred. It was the object of the experiment to determine the performance of the stream under the sudden fluctuations of the field which occurred when the Holtz machine was under rapid discharge.

Fig. 2 is from a photograph taken when nearly 100 sparks a second were passing between the poles.

Other photographs were obtained in a similar manner, the deflecting forces, however, being due to the action between the lines of a stationary magnetic field and those of an alternating current traversing the mercury column. The arrangement of the apparatus is shown in Fig. 3. The mercury stream was introduced into the circuit of the alternating-current dynamo, already made use of in the experiments upon Froelich's method. It flowed through a strong magnetic field with horizontal lines. The transverse oscillations of the mercury under these conditions were very apparent. When photographed by means of a camera with optical axis parallel to the lines of force, the stream strongly illuminated from behind and viewed through a narrow horizontal slit, as in the previous experiment, a sinusoidal trace was obtained. All the complexities of the telephonic trace disappeared in these records, and curves corresponding to those of the method of instantaneous contact were always produced. The experiment was made by Mr. Henry Floy, to whose efforts the photographs by Froelich's method are also due. This method has not been further developed. I introduce it here to show that increased accuracy of record may be

* "A Thermo-Electric Method of Studying Cylinder Condensation in Steam-Engine Cylinders." *Trans.* Am. Inst. Electrical Engineers, Vol. VIII., p. 236.

† "The Optical Representation of the Movements of a Telephone Diaphragm." *La Lumière Electrique*, Vol. XXV., p. 180 (1887).

* Froelich: "Ueber eine neue Methode zur Darstellung von Schwingungskurven." *Electrotechnische Zeitschrift*, bd. X., pp. 345, 369 (1889).

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looked for as the result of reducing in any practicable manner the mass of the indicating device.

Another attempt to record single periods in dynamo-electric work should be mentioned here. It is described by Moler* in a recent Paper. By means of a D'Arsonval galvanometer with a period of vibration of a few thousandths of a second, curves of varying potential are traced, which show excellent agreement with measurements by the method of instantaneous contacts. The instrument is not free from the errors due to inertia. It is reliable only in recording changes of period considerably greater than its own, but its use is a step in a direction along which progress may be looked for.

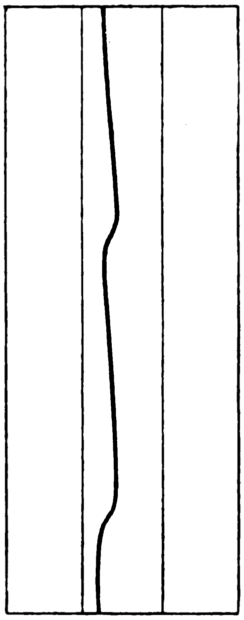

FIG. 2.

Thus far I have dealt with methods of studying periodic changes, the time-elements of which are easily within reach through experimental devices. I might have devoted myself with as good reason to the consideration of recent advances in the study of electrical oscillations of a higher order of frequency. This is a department of physics in which much has been done of late, but so much has been written at second-hand, as well as in the way of original treatment, that further reiteration is uncalled for. The work of Hertz and of his host of followers is familiar to us all. In the study of electrical oscillations even of very high frequency, photography has been used with success, and details of the phenomena of time-elements truly infinitesimal have been secured. By the

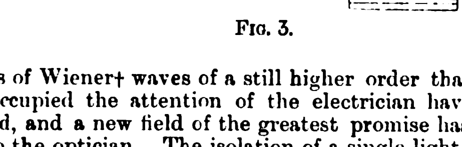

FIG. 3.

labours of Wiener† waves of a still higher order than those which have occupied the attention of the electrician have been photographed, and a new field of the greatest promise has been thrown open to the optician. The isolation of a single-light vibration may indeed still be as far from us as is the inspection of the molecule by means of the microscope, but in the meantime we have in the photography of a system of standing light-waves, an achievement well worth celebrating.

In the investigation of the phenomena of the time-infinitesimal, so far as periodic changes are concerned, we see that the experimenters of the present time are gaining much of detailed knowledge. There is another field equally important, in my opinion, which is as yet for the most part unexplored. The study of the beginnings of changes brought about by abrupt shifting of the conditions of equilibrium is one from which very much may be expected. Already suggestive beginnings have been made, but the researches have not been pushed to the limit of the experimentally possible. Oftentimes interesting observations of what might be termed "startling phenomena" have been recorded, but quantitative results are lacking. Take, for example, the brilliant work of Becquerel (*Comptes Rendus*, 96, pp. 121, 1215, 1853) with the phosphorescope. What a mass of fascinating and suggestive material that *savant* has gathered into the first volume of his book on light! (*La Lumiere*, i. pp. 206-422). What a world of interesting material these preliminary observations present to him who shall undertake to determine quantitatively, wave-length by wave-length, the changes which the radiations from the numerous luminescent materials undergo, beginning with the instant of exposure and following the vanishing light until it is gone.

Of a few isolated cases which have been forced upon us by their practical importance we have some complete knowledge already. With the phenomena in cables when current is suddenly introduced or circuit is broken, we are reasonably familiar. The case of the charge and discharge of condensers has been treated analytically under assumptions the precise truth of which is still to be verified. The detailed study by experiments carried to the utmost refinement, of the very cases which seem to have been most completely covered by theory, is especially important; since in this way only can the assumptions upon which our analysis is based be rigorously determined, and the necessity of modifications be ascertained. For some of this work methods already in use in the study of periodic phenomena will suffice. The curve-writing voltmeter, for example, may be made to give records running to within a thousandth of a second of the instant when a process such as electrolysis, electrolytic polarisation, voltaic action, or the charge and discharge of a condenser begins. Instruments such as the von Helmholtz pendulum, for the isolation of definite small time intervals, may also to be applied to a great variety of progressive phenomena, enabling us to approach by successive steps almost to the very beginning of the changes to be analysed. Concerning known methods let me point out, in conclusion, that photography with the moving plate is a means the limitations of which have not yet been discovered. It is equally applicable to periodic and to progressive phenomena, often with results of unexpected beauty and significance.*

The remarkable experiments of Mach (*Wiener Sitzungsberichte*, 95, p. 764, also 97, p. 41) and of Boys ("On Electric Spark Photographs," &c., *Nature*, Vol. XLVII., p. 415) indicate that the dry plate is still abundantly exposed within intervals so short that the swiftest of modern projectiles give images as of a body at rest.

The laws of electrical resonance have already been so far determined that we can construct condensers, the duration of the discharge of which is a matter of computation, and the precise moment of the discharge of which after a given event is quite within control. This single device, consisting of the exposure of the photographic plate by means of a properly-timed spark, brings under observation a set of time intervals of a new and higher order of brevity. Much is destined to be learned by means of it concerning the nature of matter, and much more, I think, from other, possibly still more powerful, methods which will doubtless be developed when the importance of the study of the time-infinitesimal is more generally recognised.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

SATURDAY, January 6th.

ROYAL INSTITUTION.

3 p.m. Juvenile Lecture on "Air: Gaseous and Liquid," by Prof. Dewar, F.R.S.

TUESDAY, January 9th.

ROYAL INSTITUTION.

3 p.m. Juvenile Lecture on "Air: Gaseous and Liquid," by Prof. Dewar, F.R.S.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper will be read: "The Concentration and Sizing of Crushed Minerals," by Mr. Robt. E. Commans, Assoc.M.Inst.C.E. At this Meeting the Monthly Ballot for Members will be taken, and the President and Council will hold a Reception in the Libraries.

THURSDAY, January 11th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting. Inaugural Address of the President (Mr. Alexander Siemens, M.Inst.C.E.).

* "A Dynamo Indicator, or Instantaneous Curve-Writing Voltmeter." *Trans.* Am. Inst. Elec. Engineers, Vol. IX., p. 223.

† "Stehende Lichtwellen und Schwingungsrichtung des polarisirten Lichtes." *Annalen der Physik*, N.F., Vol. XL., p. 203.

* In photographnig the alternate-current arc, a single exposure of a continuous-current lamp upon the moving plate, by way of check, brought out the seat and precise nature of the hissing of the arc in a manner scarcely to be reached in any other way. For the method used, *see* "A Photographic Study of the Electric Arc," *Trans.* Am. Inst. Elec. Engineers, Vol. VIII., p. 214, 1891.

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SPECIAL NOTICE.

With this Number is issued (Gratis) a Tabulated Statement showing the Central Lighting Stations of the United Kingdom in Operation, in Progress, and Projected.

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1893.

The painful accuracy which is now expected not only of pure science but of chronology becomes particularly painful when the unfortunate chronicler, denied the privilege of drawing on a fertile imagination, is at the same time deprived of facts that are interesting. Ten years ago it was not so. The great Crystal Palace Electrical Exhibition was a recent event, the first Electric Lighting Act had just been passed, and the ever-memorable Stock Exchange gamble was at its height. The enthusiastic hopes begotten of that marvellous "box of electricity," the Faure battery, and other similar novelties, had found a practical and prosaic expression in the granting of no less than 69 Provisional Orders, of which but seven survive to-day, and engineers were still not quite sure whether to admire or to ridicule the ingenious idea of generating electricity by means of coils strung at the end of prongs three yards long. In fact, electrical engineers were then young and excitable, whilst to-day, though but ten years older, they have become bored and difficult to please. The harnessing of Niagara is no longer the cause of enthusiasm, but, contrariwise, of much destructive criticism; and a neat and workmanlike

device like that by which Mr. W. B. Sayers sought to extinguish sparking, and which, had it been born in '83 instead of in '93, would have been sufficient to float a nicely-graduated series of companies was straightway reduced to the £ s. d. level. Experience in short has "made us sad" and perhaps a trifle captious.

The past twelve months, however, have witnessed a considerable and sound extension of the business of electricity supply, which still continues in this country to constitute nine-tenths of our heavy electrical engineering work. In the metropolis indeed no new central stations have been opened, but a municipal station is in course of erection at Hampstead, and the site for another has been purchased at Islington, whilst one or two other Vestries are engaged in the always deliberate and often dilatory process of considering the question of electric lighting. A better criterion of genuine progress than the coming into operation of new stations, is, however, afforded us by the growth of existing systems. At the end of last year the lamp connections of the twelve companies and one vestry at work in London amounted to some 500,000 8 c.p. lamps; to-day the figure is nearly 700,000 or 40 per cent. more, an increase at once satisfactory and healthy. Prices, moreover, have come down, and dividends, it is said, will go up. In the provinces some fourteen stations have come into operation during the last twelve months, of which no less than ten are municipal; Glasgow, Manchester, Bristol, Dundee, Hull, and Huddersfield being amongst the towns which have started in the electricity supply business. Indeed, were it not for municipal enterprise, the future of electric lighting would not, so far as the provinces are concerned, look remarkably rosy; as it is, towns like Aberdeen, Bolton, Cardiff, Coventry, Dewsbury, Halifax, Leicester, Salford, and Worcester are all committed to large schemes and a total expenditure of not less than £250,000; and the cry is, still they come, Belfast and Edinburgh leading the way. With such solid fare as this we can afford to forget the bubble ventures of 1883.

Electric traction on the other hand, notwithstanding a verdict in the Law Courts favourable to its pretensions, a distinct victory in the Legislature, and the boon of an elaborate set of brand new Board of Trade Regulations, still tarries. The Liverpool Overhead Railway was, it is true, opened to the public on March 6th, and a few weeks later an agreement was signed between Mr. Graff Baker and the Coventry Town Council, which may result in the electrical equipment of the tramways of that city. And as to tramway traction proper, did not a sub-committee of the Corporation of Glasgow report in January that in their opinion the disadvantages of electric traction outweighed its advantages? Evidently we are not to have a traction "boom"; at least, not yet awhile. When the pioneer concerns now at work have proved their right to exist by earning satisfactory and steady dividends, then, and not before, will it be time to deplore the slow progress of electric traction in England. London awaits, as it did this time last year, those lines, running north, south, east and west, which looked so attractive on a neatly-coloured map, and could be made to appear so profitable in a highly-coloured prospectus. The reason is not far to seek. The necessary capital cannot be raised just now. To attribute this to financial depression is but to give the situation another name, not to explain it. The past year has been a year of industrial calamity. The ignorant attack of Labour on Capital has resulted in the precipitate retreat of the latter. A large part of this calamity is the handiwork of labour agitators. They may say that it is no real calamity, but only a drastic remedy. It is a bitter draught which they alone shirk to taste. Millions flow readily enough to Australian loans, but no one dare invest in the proposed London electric railways. Are the so-called friends of the so-called unemployed satisfied? When Capital declines to face the risk of employing Labour, a well-meaning deputation goes whining to the Prime Minister to ask that the taxpayer shall be compelled to do what the capitalist dare not attempt.

Patent litigation, which has hitherto been the bane of the electrical industry, has been this year remarkable for its scarcity. On January 14th Mr. Justice Romer, indeed, delivered his decision in the three-wire case, upholding the validity of Dr. John Hopkinson's well-known and thoroughly straightforward patent 3,576 of 1882; but the action was actually tried at the latter end of 1892, and the decision in question was, therefore, an heritage from an era that it is to be trusted we have passed away from so far as concerns electric lighting. In the United States electrical patent litigation of all sorts still flourishes, and in the early part of the year was responsible for that interesting production known as the Westinghouse "removable-stopper" lamp, a glow lamp with iron leading-iron wires and bottle-neck. With us, 1893 witnessed the expiry of the Edison lamp patent and the Blake and Crossley telephone transmitter patents.

In the telephone world, perhaps the two most noteworthy engineering events were the completion of the Boston-Chicago trunk line, 1,200 miles long, and the telephonic connection of Glasgow with Belfast by means of a cable under the Irish Channel, an achievement that up to the present has not brought much grist to the Post Office mill. The Treasury Minute of May 23, 1892, containing certain proposals of the Postmaster-General to "enable the telephone companies and the Post Office to co-operate in services to the public," still remains without its logical sequence, to wit, a reasonable working agreement between the high-contracting parties. This agreement was originally to have been signed first and then presented to Parliament. Thanks to the persistency of a few members this order of things was reversed; but the draft agreement promised for November is still *in nubibus*. In August, the Glasgow Town Council, ever to the fore in the matter of municipal enterprise, decided to apply to the Postmaster-General for a telephone licence, but to no purpose; telephony, they were told, was beyond the sphere of a municipality. In the telegraph world the carrying-out of the recommendation of the Royal Commission on Electrical Communication with Lighthouses that certain lightships and rock lighthouses should be electrically connected with the main land, in one case by a non-continuous cable, should afford telegraphists a new field for the exercise of their skill and science, and has, in fact, already given rise to some experimenting and much theorising. In submarine telegraphy the year opened with a moderate raising of the rates to Australia, at the request of the Colonial Governments who desired to reduce their contribution to the Guarantee of the companies who had previously reduced the rates by over 50 per cent. to meet the wishes of the Australians. In August a cable was laid between Lisbon and the Azores, and at the end of November the Islands of Seychelles and Mauritius were placed in telegraphic communication with the rest of the world. The gaps which have been made in the ranks of those connected with submarine telegraphy have been both numerous and severe: Sir James Anderson, Sir George Elliot, C. V. de Sauty, H. Weaver, and Oliver Smith have all passed away since the year began. In physical science the only name of note is that of Tyndall, and electrical engineering has lost Anthony Reckenzaun and J. E. H. Gordon.

In what may be termed sensational achievements the year 1893 has been, so far as the purely scientific side of electricity

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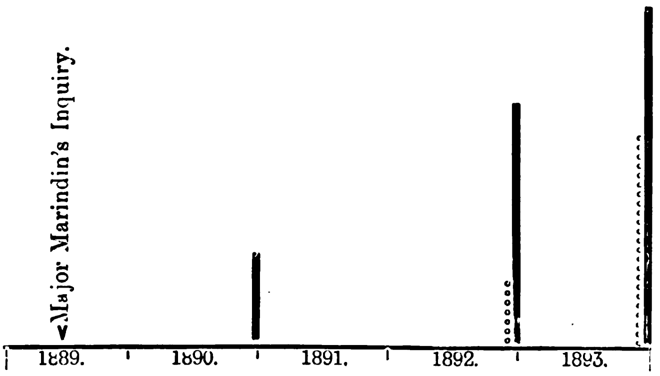
is concerned, a complete blank ; we are evidently in the trough of the wave, a position which has its advantages, and is, after all, as inevitable as the more exalted one. The International Electrical Congress held in Chicago in August was, however, a scientific event of no small importance. Not only did the Congress by giving international sanction to a coherent system of electrical units crown an edifice, the foundations of which were laid by Gauss and Weber some sixty years before, but by drawing the attention of the public to the existence of one set of international units, the Congress may be instrumental in overcoming the apathy in regard to the chaotic state of the more generally used measures. The gathering at Chicago was moreover distinguished from most of the previous meetings of the same kind by its thoroughly representative character, the high order of merit of the Papers read, and the increasingly large share that America, hitherto remarkable chiefly for its practical applications of scientific discoveries, is taking in the pure science work of the world.

DIAGRAM SHOWING THE TOTAL NUMBER OF LAMPS CONNECTED IN THE UNITED KINGDOM.



The height of the vertical columns shows the number of lamps connected, on the scale of 400,000 lamps to the inch, the full lines referring to London, and the dotted lines to the provinces The London total for the end of 1890 is taken from Mr. Frank Bailey's Paper read before the Society of Arts, viz., 180,000; the others, 500,000 for the end of 1892, and 700,000 for the end of 1893, are from our own collected statistics. The provincial totals for the end of 1892 and 1893 are respectively 147,000 and 425,000. "In recounting the history of electric lighting for the past year," says the *Journal of Gas Lighting*, "it is better to begin by acknowledging that this industry has made a certain amount of progress."

REVIEWS.

A Manual of Telephony. By W. H. Preece and A. J. Stubbs. (London: Whittaker and Co. 1893.)

It is a natural result of the Government monopoly of telegraphs in this country that there should be but a small demand for books on telegraphy, and that the joint author of the best one should be the Engineer-in-Chief and Electrician to the Post Office. But the Post Office has up to the present engaged in telephony to so limited an extent that, excellent as its work in this branch has been, it was hardly to be expected that Mr. Preece should also be joint author of the best book on telephony. This, however, is the case, and it is possible that monopoly has checked the production of a good book from other sources. The present work appears to have little in common with the volume on "The Telephone" which was written by Mr. Preece and Dr. Maier in 1888. Many promising instruments have, since that date, dropped out of use, and many important developments, especially in systems of exchange, have been invented and practically employed.

After an introductory chapter, the Bell telephone in its various forms is described, and this is followed by a clear account of the independent invention of the carbon transmitter by Edison, and of the microphone by Hughes; the difference between them, the disappearance of the Edison type, and the general adoption of the Hughes principle are clearly stated. Numerous receivers are described, with excellent illustrations, but no great detail of construction is attempted. Transmitters are then dealt with, and several instruments of a historical, rather than of a practical, interest are wisely kept together in a separate chapter. This section concludes with comparative tests of the performance of a few, too few, patterns. Whether the Johnson transmitter is on account of its results, or because it has not been widely used, passed over with so little notice, we cannot tell, but it is dismissed as having been "devised principally with a view to supply a pencil transmitter free of the Crossley patent." Nothing is said about the shunt which was inserted to prevent the breaking of the circuit when the carbons vibrated too far, a feature of, at all events, historical and scientific interest. A considerable number of varieties of the Hunnings transmitter are described, the tendency of the granules to "pack" is discussed, and methods of preventing it are explained.

Bells, batteries, switches, and magnets, generators, and other apparatus for simple telephone communication, have been treated by other authors, but too often the information has apparently been based upon either manufacturers' catalogues or upon Patent Office specifications. In the present book, not only is the scale of the illustrations in many cases given, but numerous numerical details of resistances as well, together with other practical and useful bits of information. In describing so large a number of instruments only the leading features are touched upon, but the action is always clearly explained. Such apparently small matters as the desirability of hanging receivers ear-piece downwards, to keep them free from dust, and to place them in a convenient position for grasping, are not lost sight of.

Beginning with the simple case of two telephones and an intermediate instrument, the principles of exchange systems are developed in a most lucid style, with the aid of excellent diagrams. The consideration of the effect of the resistance of the line on direct ringing, and on the use of relays, is somewhat beyond the "ironmonger, plumber, and sanitary engineer" who undertakes the "installation" of electric bells and telephones before developing into an all-round electrical contractor. But even this useful and often intelligent individual could with a little attention understand the calculations for battery power and the principles of the simple "bridge" system, so clearly are they written. The necessary current for the bells and relays of the Post Office telephone type and their resistances form the data of the calculations, the working of which is greatly facilitated by a simple scale or diagram, given in an Appendix, whereby the combined resistance of two resistances may be instantly found, by the application of a straight-edge.

Passing on to true exchange systems, the authors plunge into the really intricate subject of switchboards, the English Post-Office system having a short chapter to itself, and including not only an account of the apparatus, but a brief description of the mode of working local and trunk services, testing, construction of "silence cabinets," and telegraph-message working. A chapter on the Law, Mann, Miller, and Bennett-Maclean call-wire systems concludes this part of the work. But here we are only half-way through, for we find half-a-dozen chapters on details of construction and working of switchboards, seven more on miscellaneous switching and other systems, and finally, one on construction of lines, one on wire, one on cables, and one "On the Limiting Distance of Speech."

This last short chapter is occupied, of course, with a statement of the principle, of the application, and of the results of the celebrated K R law. It opens with Lord Kelvin's law of the speed of working submarine cables. The time-constant, $\frac{1}{250}$th of a second, is given for the highest speed in telegraphy, and $\frac{1}{8000}$th of a second for telephony. The K R law is explained to be another form of the Kelvin law, and the well-

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known constants, as determined by experiment, are given. As this law has been established upon strictly experimental data, and has not been used to found any new scientific theory, its author is fully justified in defending it, on practical grounds, against theoretical attacks. The great difficulty in the theoretical discussion of this law are the data on which K is determined: the capacity must be measured under telephonic conditions, but who is to define what these are? Sidney Smith, on being asked to define the office of an archdeacon, said that he was one who exercises archidiaconal functions.

It has been asserted that if the New York-Chicago line had been built in accordance with the K R law some 1,800 tons of copper, instead of about 430 tons, would have been required, and that the K R of the line is 32,000, more than twice the limit at which, according to Mr. Preece, speech becomes impossible. But on the last page of the book before us we find it stated that there is reason to believe that the K of the New York-Chicago circuit does not exceed 0·04 microfarad per mile. So complete is Mr. Preece's confidence in the K R law that he undertook the sole responsibility of recommending the construction of the London-Paris line, a line on which no preliminary experiments could be tried, and which depended on a severe extrapolation of this law. So strongly has his confidence been confirmed by the result, that we believe he would have no hesitation in using the telephonic quality of a circuit as a mode of measuring its capacity; always, of course, remembering that the capacity under telephonic conditions is understood. We quote the concluding sentence of this excellent manual: "Moreover, there is reason to believe that the beneficial influence of mutual induction in virtually neutralising the effect of capacity will lead to a revolution in long-distance speaking through submarine cables; and it is clear that there is no theoretical reason why speech should not be maintained between Europe and America." If, as seems probable, Mr. Preece uses the word "capacity" in a somewhat special sense, the term mutual induction in this passage may perhaps be employed in an unusual fashion. The reciprocal, as it were, to capacity is self-induction, it is by distributed self-induction that Prof. S. P. Thompson has proposed to cure distributed capacity. The use of mutual induction in that inventor's system is, we understand, rather to link together short lengths of cable each having negligible capacity. The capacity of the whole would then be no greater than that of a part; but, on the other hand, it would be no less. The thoroughness, condensation, and lucidity of this book, which would no doubt have been more easy to write in 750 pages instead of 500, does great credit to the author and the Post Office.

SUMMARY OF ELECTRICAL EVENTS FOR 1893.

January.

The Australian Cable Rates raised at the request of the Colonial Governments (1st).

Judgment given in the Action for Infringement brought by Dr. John Hopkinson against the St. James' and Pall Mall Electric Light Company. Mr. Justice Romer decides that Dr. Hopkinson's Three-Wire Patent, No. 3,576, of 1882, is valid (14th).

Opening of the Hull Municipal Central Station (16th).

Expiry of the Blake Telephone Transmitter Patent, No. 229, of 1879 (20th).

Publication of an Interim Report by the Royal Commission on Coast Communication recommending five Lightships and a certain number of Rock Lighthouses to be electrically connected with the shore (31st).

A Sub-Committee of the Glasgow Corporation report that they are of opinion that the disadvantages of electric traction outweigh its advantages.

Delivery by Prof. W. Cawthorne Unwin of a course of Howard Lectures on "The Development and Transmission of Power from Central Stations."

Belgian Telephone System taken over by the Government.

The American Institute of Electrical Engineers publish a series of important proposals with regard to the forthcoming International Electrical Congress at Chicago.

Dividends declared:—St. James' and Pall Mall Electric Light Company, 7½ per cent.; Anglo-American Telegraph Company, 2¾ per cent.; Newcastle-upon-Tyne Electric Supply Company, 4 per cent.

February.

Expiry of the Crossley Telephone Transmitter Patent, No. 412, 1879 (1st).

Death of Mr. J. E. H. Gordon and M. van Rysselberghe (3rd).

Inauguration of the Liverpool Overhead Railway by the Marquis of Salisbury (4th).

Judgment given in favour of the Leeds Electric Cars by Mr. Justice Kekewich (National Telephone Company *v.* Graff Baker) (4th).

Opening of the Boston-Chicago Telephone Trunk Wire (1,200 miles long (7th).

The price of the Board of Trade Unit reduced by the St. James' and Pall Mall, and Westminster and London Electric Companies, to 6d., with sliding scale discount down to a minimum of 5d.

New form of glow lamp with removable stopper, iron leading-in wires, and bottle-neck, brought out by the Westinghouse Company of America.

Death of Dr. Norvin Green, President of the Western Union Telegraph Company of America.

In an Action brought in America by the General Electric Company against the Beacon Vacuum Pump and Electric Company, the latter brought forward the Göbel Lamp as an anticipation of Edison's; Judge Colt decided that the Göbel Lamp did not warrant stay of preliminary injunction.

The Glasgow Municipal Electric Lighting Central Station comes into operation.

Remarkable results in the reduction of refractory ores obtained by M. Henri Moissan by means of the electric furnace.

Meeting of the National Electric Lighting Association at St. Louis.

Dividends declared:—Kensington and Knightsbridge Electric Lighting Company, 4 per cent.; Telegraph Construction and Maintenance Company, 15 per cent.; Westminster Electric Supply Corporation, 3½ per cent.; Newcastle and District Electric Lighting Company, 5½ per cent.; Electricity Supply Corporation, 5 per cent.; India-Rubber, Gutta-Percha and Telegraph Works Company, 7½ per cent.; Chelsea Electricity Supply Company, 2½ per cent.; Liverpool Electric Supply Company, 5 per cent.; Birmingham Electric Supply Company, 3½ per cent.; Keswick Electric Light Company, 2 per cent.

March.

The Liverpool Overhead Electric Railway opened to the public (6th).

A motion in the House of Commons by Mr. Pickersgill to secure the insertion of a London County Council Purchase Clause in the City and South London Railway Bills defeated by a large majority (9th).

Tramway clauses in the Salford Corporation Improvement Bill withdrawn owing to the demand of the National Telephone Company for a protection clause (16th).

A Select Committee of the House of Commons decide that the preamble of the Clapham Junction and Paddington Railway Bill is not proved. Great opposition was offered by the authorities of the Central Institution and Royal College of Science to the line being taken up Exhibition-road within a few feet of the laboratories (20th.)

Shareholders vote the voluntary winding up of Woodhouse and Rawson United (Limited) (20th).

Papers by Mr. C. K. Falkenstein, entitled "Notes on the Influence of Electricity in Tanning Operations," read before the Institution of Electrical Engineers (23rd).

Rejection of the Kilburn-Victoria Electric Railway Bill by a Select Committee of the House of Commons (24th).

Agreement signed between the Coventry Town Council and Mr. Graff Baker with regard to the working of the tramway system by electricity (31st).

Issue by the Board of Trade of an important memorandum on the effect of using glow lamps in ships' side lights.

Publication of the Report of the Committee of Investigation appointed by the shareholders of Woodhouse and Rawson United (Limited).

Dundee Municipal Electric Lighting Station comes into operation.

The National Telephone Company announced certain reductions in their London tariffs.

Edison "Feeder" patent upheld in the United States.

Dividends declared:—W. T. Henley's Telegraph Works Company, 5 per cent.; Direct Spanish Telegraph Company, 4 per cent.; Anglo-Portuguese Telephone Company, 5 per cent.

April.

Laying of a Post-Office Telephone Cable between Port Kail and Donaghadee (4th).

The Shareholders of Elmore's French Patent Copper Depositing Company (Limited) vote its voluntary winding up (6th).

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Death of Mr. C. V. de Sauty (11th).
Paper on "Distribution of Power by Alternate-Current Motors," read before the Institution of Electrical Engineers by Mr. Albion T. Snell (13th).
The Islington Vestry decide to undertake electric lighting (18th).
Friday Evening Discourse at the Royal Institution by Prof. A. B. W. Kennedy, on "Possible and Impossible Economies in the Utilisation of Energy" (21st).
The Leicester Town Council decide to accept the Brush Company's tender for a municipal plant on the alternate-current transformer sub-station system (25th).
The Edinburgh Town Council decide to undertake electric lighting (25th).
The Glasgow Town Council appoint a Special Committee "to consider the question of applying to the Postmaster-General for a licence to supply the community with an efficient telephone service."
Dividends declared :—Eastbourne Electric Light Company, 3 per cent. ; Metropolitan Electric Supply Company, 2 per cent. ; Hastings and St. Leonard's-on-Sea Electric Light Company, 5 per cent. ; Eastern Extension Telegraph Company, 7 per cent. ; Indo-European Telegraph Company, 10 per cent. ; Great Northern Telegraph Company, 8/6 per cent. ; London-Platino-Brazilian, 2 per cent. ; New Shanghai Electric Light Company, 7 per cent. ; Western Brazilian Telegraph Company, 2½ per cent. ; Submarine Cables Trust, 6 per cent.

May.

The Faure Accumulator patent upheld by the Court of Appeal in France (5th).
Death of Sir James Anderson (7th).
Paper by Mr. W. B. Sayers, entitled "On the Prevention and Control of Sparking : Continuous-Current Dynamos without Winding on the Field-Magnets, and Constant-Pressure Dynamos without Series Winding," read before the Institution of Electrical Engineers (11th).
Death of Prof. Moses G. Farmer, at Chicago (25th).
Halifax and Ealing decide to borrow £30,000 and £25,000 respectively for electric lighting purposes.
Cardiff authorised to spend £32,500 on electric lighting.
Dividends declared :—Reuter's Telegram Company, 5 per cent.

June.

Important Presidential Address dealing with Gas and Electricity, delivered by Mr. Denny Lane to the Incorporated Gas Institute, at Belfast (13th).
Inquiry by a Joint Committee of both Houses of Parliament as to the telephone protective clauses which should be inserted in private Bills relating to electric traction (19th, 20th, 21st, 22nd, 23rd, 26th, and 27th).
Action brought against the St. James' and Pall Mall Electric Light Company by the Trustees of the Windham Club for nuisance, settled out of Court ; similar action brought against the Electricity Supply Corporation was given in its favour.
Sanction given to electric lighting loan :—Aberdeen, £20,000.
Dividends declared :—Electric and General Investment Company, 25 per cent. ; Consolidated Telephone Construction and Maintenance Company, 2 per cent. ; Eastern Telegraph Company, 6½ per cent.

July.

Publication of the Report of the Joint Committee on Electric Powers (Protective Clauses). Tramways obliged to use insulated or uninsulated returns, telephones to metallicise their circuits (13th).
Action brought by a Strand clockmaker against the Electricity Supply Corporation for damages and an injunction, resulted in the jury deciding that while there was vibration it was very slight (14th).
Death of M. Marié-Davy (16th).
Death of Mr. S. E. Phillips (22nd).
The Commissioners of Sewers decide to sanction the running of telephone wires in the spare tubes of the City of London Electric Lighting Company only upon condition that double wire circuits, good instruments, and £8 rentals are guaranteed (25th).
Opening of the Huddersfield Municipal Central Lighting Station (29th).
The Tunbridge Wells Town Council decide to adopt an electric lighting scheme costing £13,000.
Death of Mr. Oliver Smith.
Dividends paid :—National Telephone Company, 5 per cent. ; Direct United States Cable Company, 3½ per cent. ; Globe Telegraph and Trust Company, 4⅝ per cent. ; Sheffield Electric Light and Power Company, 5 per cent. ; Edison-Swan United Electric Light Company, "A" shares, 10 per cent. ; Oriental Telephone and Electric Company, 2¼ per cent. ; Manchester Edison-Swan Company, 5 per cent.

August.

The Manchester Municipal Electric Lighting Station comes into operation (1st).
The Glasgow Town Council adopt the recommendation of their Telephone Committee and decide to apply to the Postmaster-General for a telephone licence (3rd).
International Electrical Congress held at Chicago. Important Papers were read by Prof. Ayrton on Phenomena connected with the Electric Arc, and by Prof. Silvanus Thompson on Ocean Telephony ; and an International System of Electrical Units and Nomenclature was adopted (21st-25th).
The Southport and Cheltenham Town Councils decide to adopt the high-pressure system of eelctric lighting ; the Stafford Town Council decide to adopt the low-pressure system of electric lighting ; and the Worcester and Coventry Town Councils definitely decide to adopt the alternate-current high-pressure system.
The Zipernowsky-Déri patent for running transformers in parallel, and the Zipernowsky-Déri-Bláthy patent for closed magnetic circuit transformers upheld by the Court of Appeal in France.
The Postmaster-General refuses to grant a telephone license to the Glasgow Corporation.
Cable laid by the Telegraph Construction and Maintenance Company between Lisbon (Portugal) and the Azores.
Dividends declared :—Electrical Power Storage Company, 5 per cent. ; Cuba Submarine Telegraph Company, 8 per cent. ; Brush Electrical Engineering Company, 6 per cent.

September.

Opening of the Municipal Electric Lighting Station at Whitehaven (2nd).
Opening of the Stockholm-Christiania Telephone trunk line (2nd).
Opening of the British Association Meeting at Nottingham (13th).
Postmaster-General promises to present the agreement between the Post Office and the National Telephone Company to the House of Commons in November (19th).
Death of Mr. H. Weaver (20th).
Reduction of the price of glow lamps by the Edison-Swan United Company from 3s. 9d. to 1s. 9d. (21st).
Bill introduced into the United States Senate directing experiments to be made with a view to the establishment of electrical communication with outlying lighthouses and lightships.

October.

Death of Sir Arthur Blackwood, Secretary to the Post Office (4th).
Opening of the Derby Central Station (10th).
Opening of the Queensland-New Caledonia Cable (19th).
Important Paper on "The Artificial Lighting of Workshops," read by Mr. B. A. Dobson before the Institution of Mechanical Engineers (25th).
Inauguration of the Blackpool Municipal Station by Lord Kelvin.
Bolton municipal electric lighting loan of £40,000 sanctioned by the Local Government Board.
The Electricity Department of the Bradford Corporation report a net profit for the financial year, after payment of interest, sinking fund, and arrears, of £1,269.
Dewsbury municipal electric lighting loan of £25,000 sanctioned by the Local Government Board.
Salford municipal electric lighting loan of £32,000 sanctioned by the Local Government Board.
Dividend declared :—Brazilian Submarine Telegraph Company, 6 per cent., plus bonus of 1s. per share.

November.

Opening of the Kingston-on-Thames Municipal Electric Lighting Station (4th).
Paper on "The Electrical Transmission of Power from Niagara Falls" read before the Institution of Electrical Engineers by Prof. George Forbes (9th).
Expiry of the Edison Lamp Patent, No. 4,576, of 1879 (10th).
Issue of Draft Electric Tramway Regulations by the Board of Trade (22nd).
Mauritius cable opened for traffic (23rd).
Statement made by the Postmaster-General in the House of Commons that the loss upon press telegrams amounted to at least £300,000 a year (27th).
Death of Mr. Anthony Reckenzaun.
Strike of Italian telegraph clerks.
The Kensington Vestry reject a proposed municipal electric lighting scheme by a large majority.

December.

Death of Prof. Tyndall (4th).
The Coventry Town Council accept the electric lighting tender of Messers. John Fowler and Company, Leeds, and decide to borrow £20,000 for the purpose of carrying it out (5th).
The City Commissioners of Sewers decide to remove the gas lamps in all streets lighted by electricity (6th)
Statue of Joule in the Manchester Town Hall unveiled by Lord Kelvin (8th).

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Death of Sir George Elliot (23rd).
Formation of the Northern Society of Electrical Engineers.
Formation of a Governmental Committee to inquire into the subject of the extension of the French Telegraph system, more especially of the French cable system.
Death of Henry Göbel, deemed by some to be the inventor of the incandescent lamp
Foundation stone of the Bolton Corporation Electricity Works laid.
Loan of £15,000 for carrying out a municipal electric lighting scheme at Yarmouth sanctioned by the Local Government Board.
Dividends declared: Swan United Electric Light Company, 7½ per cent.

THE ELECTRIC RAILWAYS AND TRAMWAYS OF THE UNITED KINGDOM.

Place.	Length.	System.	Worked by.
In Operation—	Miles.		
Bessbrook—Newry ..	3¼	Third Rail (Dr. E. Hopkinson)	Bessbrook and Newry Tramway Company.
Birmingham	3	Accumulator Cars	Birmingham Central Tramways Company.
Blackpool	2	Holroyd - Smith's Conduit	Blackpool Corporation
Brighton...	1	Third Rail (Volk)	Mr. Magnus Volk.
Carstairs................	1¼	Anderson - Munro	Mr. J. Monteith, of Carstairs (Private).
City and South London Railway (King William - street—Stockwell)	3¼	Third Rail (Dr. E. Hopkinson)	City and South London Railway Company
Douglas—Laxey (I. of Man)	...	...	...
Guernsey	2¾	Overhead (Siemens)	Guernsey Railway Company
Leeds (Roundhay Park Line)	3¾	Thomson-Houston Overhead Trolley	Thomson - Houston International Electric Company.
Liverpool Overhead Railway	6¼	Third Rail	Liverpool Overhead Railway Company.
Portrush (Giant's Causeway)	8	Third Rail (Siemens)	Giant's Causeway Electric Tramway Company.
Ryde	¾	Third Rail (Siemens)	Ryde Pier Company.
Southend Pier	1¼	Third Rail (Crompton)	Southend Corporation
Walsall, Wednesbury, Bloxwich, and Darlaston	7½	Overhead Side Trolley	South Staffordshire Tramways Company.
In Progress:—			
Coventry	5¾	Thomson-Houston Overhead Trolley	Coventry Electric Tramways Company.
Projected:—			
Barry Island	...	...	Barry Docks Railway Company.
Blackpool—Lytham.	...	...	...
Bolton	...	...	Bolton Corporation.
Brecon	...	...	Brecon Corporation.
Brighton — Rottingdean	...	...	Brighton and Rottingdean Seashore Railway Company.
Wellingborough and District Tramroads	2½	...	Wellingborough and District Tramways Company.
Wigan	5½	...	Wigan Corporation.
London—			
Central London Railway (City and Shepherd's Bush)	6½	...	Central London Railway Company.
City & South London Railway Extensions—			
Clapham	1	Third Rail (Dr. E. Hopkinson)	City & South London Railway Company.
Islington	2¾	Third Rail (Dr. E. Hopkinson)	City & South London Railway Company.
Finsbury Park and City	3¼	...	...
Finsbury — Walthamstow	...	...	...
Hampstead, St. Pancras, and Charing-cross	5¼	...	...
Waterloo — Baker-street	3	...	...
Waterloo—City ...	1½	...	South-Western Railway Company.

ELECTRIC LIGHTING NOTICES.

(SESSION 1894.)

The following is a list of the applications for Electric Lighting Provisional Orders deposited with the Board of Trade on or before December 21st last. The total number of applicants is 26, against 18 last year. Of the 26 applicants, 15 are local authorities. Since the publication in our issue of December 1st of the list of applicants who had advertised in the *London Gazette*, six have fallen out of the race, namely, the Kensington Vestry, the Plymouth Gas Company, the Preston Gas Company, Swansea (Crompton and Co.), the Penrith Local Board, and the Torquay Corporation.

THE METROPOLIS.

Districts.	Name of Applicant.
Portions of Beckenham, Croydon, Lambeth, Lewisham, & Camberwell.	Crystal Palace District Electric Supply Company.

THE PROVINCES.

Towns.	Applicants.
Aberdare.........	J. C. Howell (Limited).
Barrow-in-Furness	Corporation.
Bedford	Bedford Electric Light Company.
Birmingham ...	Birmingham Electric Supply Company.
Buxton	Local Board.
Chelmsford	Crompton and Co.
Chepping and Wycombe ...	Corporation.
Chesterfield ...	Corporation.
Clonmel	Corporation.
Grimsby	Corporation.
Guildford	Holloway Electricity Supply Company.
Harrow	Local Board.
Leyton............	Local Board.
Monmouth	Corporation.
Moss Side	Collier-Marr Telephone and Electrical Manufacturing Company.
Oswestry.........	Oswestry Electric Lighting and Power Company.
Peterborough ...	Corporation.
Plymouth	Corporation.
St. Austell	Veale and Co. (Limited).
St. Helens	Corporation.
Shrewsbury......	Shropshire Electric Light and Power Company.
Stirling	Caledonian Electric Supply Company.
Wakefield	Corporation.
West Hartlepool	Corporation.
Yeadon	Local Board.

NEW PUBLIC COMPANIES OF 1893.

The following are the more important limited liability companies connected with the electrical engineering and allied industries registered during the past year, with their capital:—

	Capital.
Acme and Immisch Electric Works	£25,000
George Adams and Sons........................	100,000
Advance Boiler Company	100,000
Aladdin Primary Electric Battery Company	5,000
American River Electric Power Supply Company..	25,000
Anderson, Anderson and Anderson	50,000
Anders Telephone Company	10,000
Ariel Company...	15,000
Sir William Arrol and Co.	150,000
Baily, Grundy and Barrett	10,000
Baily and Grundy, London	10,000
William Banks and Co.	4,000
Belliss (G. E.) and Co.	150,000
Bourne and Grant Electricity Supply Company.....	25,000
John Birch and Co......	40,000
Bolton (R.) and Co..	12,000
Brayton Oil Engine Company	80,000
British Volta Electric Glow Lamp Company	2,000
Caledonian Electric Supply Company	100
Canterbury Electricity Company	50,000
James Carmichael and Co.	65,000
Central American Public Works Company	100,000
Chemical and Electrolytic Syndicate	30,000
Clarke, Chapman and Co.	150,000
Colne Engineering Company	10,000

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	Capital.
Coventry Electric Tramways	£25,000
Jeremiah Cowdy and Co.	10,000
Credenda Tube Company	100,000
Dalziel's Atlantic Telegram Company	25,000
Roger Dawson	15,000
Detries (J.) and Sons	100,000
Dempster R. and J.	100,000
District Messenger Company of Paris	200,000
Domestic Telephone Company	20,000
Dougill (Alf.) and Co.	12,000
Dover Electricity Company	50,000
Ebenezer Timmins and Sons	20,000
Edinburgh Tramways Company	125,000
Edward Howell and Co.	15,000
Electric and Automatic Engineering Company	10,000
Electric Anti-Corrosion Company	6,000
Electric Construction Company	400,000
Electric Light Regulating Syndicate	1,000
Electric Semaphore Signal Syndicate	3,000
Electrolytic Separation Syndicate	25,000
Electro-Protector Syndicate	10,000
English Electric Carbon Company	10,000
English Electric Manufacturing Company	5,000
Europe and Azores Telegraph Company	200,000
Faraday Electrical Engineering Company	4,600
Farringdon Works	40 000
Ford-Lloyd Manufacturing Company	10,000
Foster Brothers	30,000
Gardiner, Sons and Co.	80,000
Gas Traction Company	100,000
General Electrolytic Parent Company	24,000
Gordon and Fell	100,000
Gorseinon Electric Light Company	1,000
Gravier Dynamo Syndicate	10,000
Harrison, Ainslie and Co.	100,000
Hart, Son, Peard and Co.	35,000
Harvey Steel Company of Great Britain	180,000
Herculite and Electrical Manufacturing Company	12,000
Hirst, Brooke and Hirst	40,000
Thomas Holcroft and Sons	120,000
Incandescent Electric Lamp Company	25,000
Isles (Limited)	20,000
Lamina Accumulator (Elieson's British Patents) Syndicate	12,000
London and Lancashire Electric and General Engineering Co.	20,000
Keay, E. C. and J.	50,000
Lister (R. A.) and Co.	20,000
James MacIntyre and Co.	50,000
Manchester Steel Nut and Tube Company	80,000
Marchent, Young and Co.	4,000
Mazarron Electric Light Company	15,000
Merionethshire Electric Lighting, Power and Appliance Co.	3,000
Merveilleuse Electric Arc Lamp Syndicate	15,000
George Moritz	5,000
William Muir and Co., Manchester	80,000
New Panulcillo	50,000
William Parnall and Co.	30,000
Newington, Priddle and Co.	7,000
North-Eastern Telephone Company	1,000
Omnibus and Tramcar Electric Lighting Company	60,000
Orme's Electric Signal Syndicate	7,500
Oswestry Electric Lighting and Power Company	10,000
Otis Elevator Company	50,000
Perkins and Bellamy	70,000
Pioneer Electric Carriage Company	20,000
Printing, Telegraph and Construction Company of the Agence Havas	130,000
Pyke, Harris and Co.	30,000
Rainbow Engineering Company	20,000
A. Ransome and Co.	59,000
Ramsden, Camm and Co.	50,000
Redruth Electric Supply Company	10,000
Thomas Robinson and Son	120,000
Rollason and Slater	30,000
Rollason's Wind Motor Company	35,000
Rose, Downs and Thompson	50,000
Rotherham Forge and Rolling Mills Company	25,000
Rugby School Electric Lighting Company	5,500
St. Martin's Electrical Manufacturing Company	500
St. Nicholas Construction Company	40,000
Salt Lake and Ogden Gas and Electric Light Company	300,000
Saxby and Farmer	25,000
Shillingford Works Company	10,000
Stannum Metal Company	40,000
Stephens and Co.	20,000
Statter (J. G.) and Co.	20,000
Swan and Harrison Smelting Company	30,000
Swinburne and Co.	25,000
United Gutta-Percha and Rubber Company	50,000
Universal Electric Lighting Company	5,000
Valveless Gas Engine Syndicate	15,000
Wallis and Steevens	60,000
Waterhouse Electrical Manufacturing Company	20,000
Waterhouse Electro-Metric Syndicate	20,000
Zohrab and Bigg's English Patents	32,007

PUBLIC COMPANIES WOUND UP, DISSOLVED, &c., IN 1893.

The following are amongst the limited liability companies which have been wound up during the past year, the asterisk denoting that the company was wound up by order of the Court :—

Abell's Electrical Engineering Company.
Aladdin Primary Battery.
Arcas Plating Company.
*Art Workshops.
Birmingham Telegraph Factory.
Blakey, Emmott and Co.
Boy Messengers and Electric Call Company (business taken over by the District Messenger Service and News Company).
British Electrical Installation Contractors (business taken over by the New British Electrical Installation Contractors).
British Tanning Company.
British Gas Engine and Engineering Company.
Edinburgh Electric Supply Corporation.
Electrical Supplies and Fittings Company.
*Elmore's French Patent Copper Depositing Company.
Electrical Engineering Company of Ireland.
Electric Construction Corporation (business taken over by the Electric Construction Company).
Emile Lansard Syndicate.
Engineering Exchange.
Foreign Electric Date and Time Stamp Company (new Company formed with same name).
Fowler, Lancaster and Co.
Freedman Battery Company.
Gordon (J. E. H.) and Co.
Halifax Mutual Electric Light and Power Company.
Law's Electrical Appliances Company.
*London Metallurgical Company.
London Battery Company.
*Mountain's Wire Manufacturing Company.
Nottingham Electric Light and Power Company.
Panulcillo Copper Company (business taken over by the New Panulcillo).
Powditch (J. R.) and Co.
Steam Loop Company.
Taunton Electric Lighting Company.
Telephone Company of Ireland (business taken over by the National Telephone Company).
Telephone Company of Austria (the Company's Exchanges having been taken over by the Austrian Government).
Thorneburry Miners' Safety Lamp Company.
Wenham Company.
Williamson Electrical Engineering Company.
Windsor and Eton Electric Lighting Company.
*Woodhouse and Rawson United.

The following Companies have been dissolved, or have ceased to exist, in most cases nothing having been done beyond registration, and no business having been commenced :—

Automatic Electrical Corporation.
Canterbury Electricity Supply Company.
Cardiff Electricity Supply Company.
Douglas Patent Block and Electric Meter Company (business taken over by the Electric Meter Company).
Dover Electricity Supply Company.
Electrical Works Construction and Maintenance Company.
Electrical Standardising, Testing, and Training Institution.
Electro-Automatic Fire Extinguishing Company.
Electric Anti-Corrosion Company.
Gloucester Electricity Supply Company.
Gordon and Fell.
Kingston-upon-Hull Electric Lighting Supply Company.
Lane Fox Electrical Company.
Leicester Electric Light and Power Company.
Loughborough Electricity Supply Company.
Manchester Electricity Supply Company.
Penzance Electricity Supply Company.
Portland Electric Light Company.
Provincial Electric Light and Power Supply.
Putney and Hammersmith Electric Light and Power Supply.
Redruth Electric Supply Company.
Sperryn, McDonald and Co.
Stoke-on-Trent Electricity Company.
Theatre Electrical and Specialities Production Company.
Weston-Super-Mare Electricity Supply Company.
Weymouth Electricity Supply Company.

The following changes in nomenclature have been made :—

Charing Cross and Strand Electricity Supply Corporation—formerly the Electricity Supply Corporation.
Hobart Electrical Tramways Company—formerly the Hobart Tramways Company.
Okonite Company—formerly the International Okonite Company.

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ELECTRIC SHOT-FIRING IN MINES.*

BY P. HOUGHTON.

It is not my intention to-night to treat the subject of "Electrical Shot-firing in Coal Mines" from a scientific point of view, but more from a practical one, seeing that, like myself, you are all practical men in connection with mining. I take it that we are living in an age of great improvements in connection with all branches of industry, and that, in the branch of mining, the increased depth of our shafts, and the great distance we now go underground, has necessitated the adoption of certain inventions with respect to the general working of our mines, and we find that the men belonging to what we often call the "Old School" have now little or no chance with the more advanced men of our times in the management of our collieries. Hence the importance of us all making ourselves thoroughly acquainted with the new systems under which our mines are now worked. Amongst the number of modern improvements in our mines we find, owing no doubt to the large number of lives that have been lost by explosions and the introduction of the high safety explosives, the question of electric shot-firing has made very rapid strides, and is now being pushed forward by Her Majesty's inspectors of coal mines as the only safe method by which the safety explosives now in use can be fired. In the Inspectors' reports for 1892, Mr. Hedley, Newcastle District, says:—"If necessary to use explosives at all, one of the higher explosives, fired by an electric battery, should be used." Mr. Stokes, Midland District, says:—"In mines worked with safety lamps, the use of a high explosive, fired by electricity, is being largely adopted, and I find, when the proper class of detonator and low-tension fuse, previously tested with a galvanometer, is used, there is little chance of a miss-fire shot, and the work is done with safety." Mr. J. G. Robson, South Wales District, says:—"Electrical firing is, I am glad to say, being extended, and this method with low-tension fuses, previously tested by a galvanometer, appears to give satisfaction. We all know that Mr. Henry Hall strongly advocates the use of the safety explosives fired by electricity in preference to gunpowder. The firing of a charge of explosive through the agency of a slow-burning fuse, though still very extensively practised in mining, presents such decided disadvantages in regard to uncertainty, and, in some cases, of danger when compared with the firing by electricity, that it is not surprising to find what rapid strides the question of electric firing has made. So far back as 1751 the possibility of applying the electric spark to the firing of gunpowder suggested itself to Mr. Franklin, in America; but it was not until some years after the discovery of what is called the electric pile by Volta that attempts were made to apply electricity as the firing agent of gunpowder charges used in mining and military operations. The first practical application of the voltaic battery in this direction was made over 60 years ago by French military engineers, and a few years afterwards Sir Charles Pasley was the first to bring the use of electricity in firing of gunpowder to a practical issue in England. These practical investigations were made with respect to the firing of gunpowder under water, finding that the slow-burning fuse, invented by Bickford in 1831, could only be used at comparatively small depths of water. But to-day the object of electrical firing is one of safety, though the mining fuse patented by Bickford effected an enormous improvement in the firing of charges in mines; yet there is little doubt that accidents in mining would be considerably reduced in number if electrical blasting were more frequently employed, especially in dangerous mines, instead of the uncertain system of firing by slow-burning fuse. Many men have met their doom through going up to a shot in the false belief that the fuse has burned out or become extinguished. In some instances the fuse has been burning for hours; also, explosive mixtures have been ignited and proved fatal to life, owing to the spit of the fuse when touched with the heated wire. With electric lighting the simplest precautions suffice to ensure absolute safety, and in no case where it is necessary that safety explosives have to be used ought they to be fired by any other agency than electricity, because it is not wisdom to adopt a safe explosive and use for its ignition an unsafe means, thereby destroying, to a certain extent, its safety as an explosive. Perhaps, in no other district in this country has the use of the safety explosives and the firing by electricity become more general than in this district of ours, under the inspectorship of Mr. Henry Hall. The electric exploders, cables, and detonators ought not to be treated or used as we might use a pick or spade, to be thrown down, handled, knocked, and kicked about by any or every person in the mine. They are things that require careful handling and using. The object of my Paper is to point out and suggest a better mode of treatment, by first pressing upon you not to rest satisfied by merely knowing that you have an electric exploder to use, but to get a fuller knowledge of both exploders and detonators, so that the carelessness which exists in many cases may be removed, and making the question of electric firing one of perfect safety. We will now consider the different systems of electric firing and exploders now in use, viz.:—

High and Low Tension Electric Exploders.

(*a*) Primary batteries: In this form of battery we have certain elements placed in an exciting fluid, and so arranged that when the circuit is complete, a current of electricity is generated sufficient to fire a certain number of shots; but these, when not in use, are constantly wasting, owing to local action. (*b*) Secondary or storage batteries are more lasting and more under control than primary batteries, as local action is modified, and they only give off when required a portion of the current previously supplied to them by a primary current. The disadvantages of the above forms are numerous, owing to the bulkiness and weight of the cells, and also from the presence of liquids, which makes it inconvenient for them to be carried about without spilling the acid contents. Currents can be more conveniently produced by mechanical contrivances in the various forms of exploders. They are very powerful, and, as the name denotes, are made on the dynamo principle. They are very permanent, and require little attention compared with primary and secondary batteries. Of course, in time they become weaker, and require re-magnetising, but, with proper treatment, will last a long time. Care should be taken where they are stored in the mine, and in removing them from a warm to a cold place or from a dry to a damp part of the mine, as these changes may to a certain extent affect them. Exploders are also called accumulators and generators. With accumulators you turn the handle with a quick action, 15 or 20 revolutions, and after you have ceased turning, press the knob or button.

In the generators you connect firmly one end of your firing cable to the shot, the other end to the terminals of the exploder, then turn the handle with a firm quick action three or four revolutions, and then while still keeping up the speed, the button should be firmly pressed to fire the charge. These are more adapted for coal shots, but for stone headings and sinking shafts where a number of shots require to be fired simultaneously a much larger and stronger exploder would be required. At all collieries where electric firing is in operation machines ought to be got to test the exploders from time to time as this would be a means of preventing the inconvenience and loss arising from miss-fire shots owing to weak exploders. For high-tension exploders you require a voltmeter to test the pressure of your current. If your firing cable detonator and connections are right for firing, an exploder registering from 30 to 40 volts ought to explode the charge, but as it may happen at times that the explosive substance in the fuse head is not sufficiently sensitive you will require a much higher voltage. Hence the importance of having an exploder of sufficient reserved power. This exploder registers 120 volts, and is supplied by the Roburite Explosive Company, being about the strongest for ordinary coal mining I have seen, and one wherein you have a great reserve of power. For low-tension firing you require a galvanometer, which I will explain when dealing with the testing of electric fuses, but before leaving the question of exploders allow me to give one word of caution—that whoever the person in charge of the firing he ought to keep the exploder in his possession, and should be the last person away from the force after connecting the firing cable to the fuse, as accidents have happened caused by connecting to the exploder, and persons being left in the vicinity of the shot; also in case of miss-fire always disconnect your firing cable from the exploder before any person returns back to the shot. We now come to the detonators used for firing the charge, and as we cannot explode any of the safety explosives only by means of a detonator, and that accidents have occurred through the tampering with these things, it is very important we should have a knowledge of what they consist, so that we may handle them with a little caution, thereby overcoming the danger. As commercially used, they consist of a metallic case, usually of copper. There are several sizes made, which vary in dimensions and in the amount of explosive contained in them. As a rule the very weak detonator, or those containing a very small quantity of explosive, is used for detonating dynamite, &c. Stronger ones, numbered 6, 6½, and 7, are used for such explosives as roburite. Too weak a detonator should never be used with any class of explosive, for in no case with a too weak detonator do you get a complete combustion of the charge, and may at times have a miss-fire altogether. I have known cases where the explosive has been blamed, but, when investigated, it has been the fault of having too weak a detonator. The explosive used is pure fulminate of mercury, or a mixture of the same with chlorate of potash and occasionally other substances. Fulminate of mercury is by far the most practical in use. When pure it is white. It is extremely explosive, and has very violent local action. It explodes with slight friction or percussion, or when heated to 360°F. Persons ought to avoid tampering with an open detonator, and should not insert anything to produce any friction. The detonators I have just described go to make both.

* Abstract of a Paper read before the Lancashire Association of Colliery Under-Managers, November, 1893.

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High and Low-Tension Fuses.

The low-tension fuse is made up as follows:—Two small copper wires of a certain length are attached to a suitable flat piece of insulating material, such as wood or gutta-percha. The ends of the wire are put through the insulated piece very firmly a certain distance from each other, generally about a quarter of an inch. The ends of the two wires protrude a little, and from each is soldered a bridge of very fine platinum wire. The small piece of insulated material with the bridge of platinum wire is then enclosed in a small cap or case made of very stiff paper or thin cardboard filled with a very small quantity of fine explosive substance, and sealed up at the end; this head, when complete, is then enclosed, and made secure in the copper case, called a detonator, containing the fulminate of mercury. The current meets with a much greater resistance when coming in contact with the fine platinum wire, which becomes heated sufficiently to ignite the explosive substance. That in turn explodes the fulminate of mercury. The advantage of the low-tension fuse is, it can be tested before being used by attaching the fuse wires to a galvanometer, and passing through the fuse from the meter a very feeble current of electricity, which is not sufficient to fuse the platinum bridge. If the fuse is perfect a movement is shown by the needle of the galvanometer. In testing detonators, or what is called low-tension fuses, care should be exercised by putting the detonator in a small tube or pipe, as it might happen for the detonator so tested to explode. The High-Tension Fuse: These differ a little from the low-tension fuse. Two small copper wires of suitable length are covered with gutta-percha, or other insulating material, for about half an inch at the end, care being taken that the wires do not come in contact with each other, and that the ends of the wire are bare (there is no bridge of fine platinum wire). The two wires insulated are inserted in the small head or case containing the explosive substance, which, on the current passing from a high-tension exploder, a spark leaps from wire to wire which fires the explosive substance, and that the fulminate of mercury. The high-tension fuse cannot be tested on a galvanometer, so care in the manufacture of these ought to be exercised that the ends of copper wire in fuse head is a proper distance from each other, and the priming explosive is not of an inferior quality, not put up damp, as miss-fires may happen owing to the composition in the fuse head not being sufficiently sensitive, especially if you have a weak exploder. In addition to exploders and electric fuses we want a good firing cable. This is usually supplied in twin form, the two wires being insulated with rubber or gutta-percha, and these wrapped with cotton or tape. Cables can be had any length required, and suitable for different classes of work. They are used for connecting the fuse wires at the shot-hole and to the exploder. For low-tension firing the diameter of the wires of cable require to be larger than for high-tension, the diameter of wires being regulated according to the distance from shots to battery and number of shots to be fired, as the resistance met with in a small diameter is so great with low tension that the power is lost in the cable. We now come to the different methods and ways of connecting a number of shots together for electric firing, the two principles being—

I.—*In Series, or Single Circuit.* II.—*Parallel, or Compound Circuit.*

Series, or Single Circuit.—This method is principally adopted with low-tension firing, as you are unable to get the same number off in parallel with low tension, the reason being that in parallel you increase the thickness of the fine platinum wire by the combined number of shots; hence the current passes on without meeting the resistance in the platinum wire sufficient to fuse it and explode the detonators, the current being too much divided.

Parallel, or Compound Circuit, is more adapted for high-tension firing. From experiments we gather that with low-tension firing we connect in series, or single circuit, that is, in a continuous circuit from one end of the firing cable to the other, care being taken to have the firing cable, the wires of which must be of sufficient thickness to get the full strength of the current to the shots, and that for high-tension fire we connect in parallel. It is possible to fire a number of shots simultaneously in series or single circuit with the high-tension exploder, but I have seen where the current has passed on and left one or two of the shots not exploded. Low-tension firing, with the shots connected in series for firing a number simultaneously, is the most generally adopted. There are two other ways of connecting, namely, combination and long-distance grouping, but, as these are more adopted for surface operations than coal mines, I will not take up any time in describing them, but will briefly consider the advantages of electric firing in mining. I have already pointed out the advantage and importance of electric firing in point of safety with reference to the safety explosives now in use in our coal mines. The advantages to be derived from electric firing in sinking shafts where black powder is often used to me is very great, and I have often wondered why electric blasting has not been more adopted in this class of work, especially when we consider the danger and risk in what is called "matching" the shots at the bottom of a sinking shaft. Accidents would become a thing of the past if electricity was the means of exploding the charges. In miss-fires caused by slow-burning fuse there is a great loss of time and danger; but with electric firing no time need be lost, because after disconnecting your cable from the battery there is no danger of the charge exploding. There is a great advantage in the firing of a number of shots simultaneously by electricity, both in stone headings and sinking shafts, in their power and saving of labour, because by this method of blasting it takes a less number of shots for the same work; also, the holes can be put in deeper, thereby getting hold of more ground. Much has been said of late with reference to miss-fire shots by electric firing, and the danger attending the recovery of the detonator, accidents having happened to the collier or some other person cutting too near the old shot-hole, and coming in contact with the detonator. The introduction of the safety explosives in coal mines having necessitated the use of a detonator for their ignition created a new danger, seeing they were put in the hands of persons to use who, up to a very short time back, had neither seen nor heard anything about a detonator; and even to-day there are hundreds in our coal mines who have neither seen one nor do they know anything of electric blasting. And only during this last month I visited a colliery where neither the under-manager nor the fireman had seen an electric exploder, or knew anything with reference to electric firing. With me prevention is better than cure, and, as I have already stated at the commencement of my Paper, we ought to make ourselves thoroughly acquainted with all those things that have been introduced for the safe working of our mines, not knowing how soon we may be working under conditions that will force these things upon us. I contend, owing to electric firing having been placed in the hands of persons not previously having had any knowledge of either the explosive detonators or the electric appliances for firing purposes, accidents have happened, not altogether through carelessness, but more from ignorance of those things which have fallen in their hands to use. But as knowledge is gained of what a detonator consists of, and its danger when tampered with, so will men become more cautious when a miss-fire happens to regain the detonator. We may consider more fully the causes of miss-fires from electric firing; and I give here, by the kind permission of the Roburite Explosive Company, some very useful instructions. Miss-fires by electricity may be caused by the following:—(*a*) Weak Exploders.—These with constant use become demagnetised, the connections become weak and corroded, the gearing damaged or worn. (*b*) Defective Firing Cable.—With constant coiling and uncoiling, and use at the face, the insulation becomes unreliable and defective, and then a cross connection is made, which prevents the electric current reaching the face. (*c*) Faults in Manipulation.—Cutting the fuse wire in tamping, kinking, or twisting them, rubbing off the insulation, bad joints, careless handling of the exploder when in the act of firing. (*d*) Faults with Fuses.—Allowed to get damp, not adapted to the exploder used, or suitable under the conditions existing, carelessness in manufacture of them. In charging a shot-hole great care should be exercised. (*a*) That the electric detonator is inserted and secured in the explosive. (*b*) That the fuse wires are kept from the explosive charge along the side of the shot-hole. (*c*) That the tamping used be not of a gritty or cutting nature. (*d*) That the leading wires be not kinked or otherwise damaged while ramming. (*e*) That the joints between the ends of the fuse wires and the ends of the firing cable are perfectly made by the two copper wires being quite clean, bare, and well twisted together. (*f*) That the ends of the firing cable connected to the terminals of the exploder are clean, bare, and firmly screwed down. In firing a shot great care should be exercised. (*a*) That the firing cable wires are not connected to the terminals of the battery while any workman is at the face while the shot-hole is being charged or while the fuse wires are being connected. (*b*) That the operator's hands do not touch the terminals of the exploder. (*c*) That the handle of the exploder be turned with a firm, quick action three or four revolutions, and then while still keeping up the speed the knob be firmly pressed to fire the charge. The strength of the current depends mainly upon the rapidity with which the handle is turned.

SLOPER'S INTERCHANGEABLE TELEPHONE SYSTEM.

Messrs. Gent and Co., of Leicester, are introducing a system of telephones, the invention of Mr. Thomas B. Sloper, of Devizes. It is on the interchangeable system and is specially adapted for factories, warehouses, institutions and dwelling-houses. There is no central station, the services of an attendant, therefore, not being required. The new system is so arranged that it is impossible to leave an instrument in a condition in which it interferes with the talking of other stations, or in a condition in which it cannot itself be rung up.

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These instruments are made in three classes. Class A, Fig. 1, is designed for connecting telephones with electric bells in private houses. Class B, Fig. 2, is made up with microphone, receiver, and bell complete. Class C instruments, Fig. 3, have connections for independent circuits, and they form a most complete system of telephones for either private houses, institutions, or business premises.

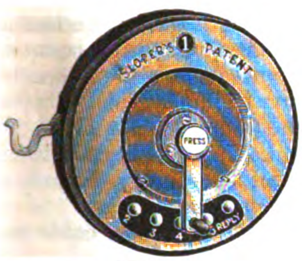

Fig. 1.

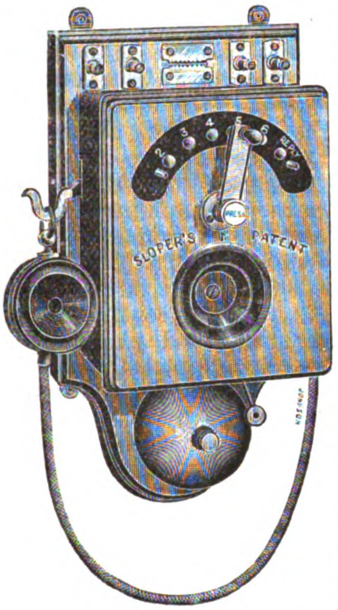

Fig. 2.

By means of a small lever shown under the switch hook in class "C" the earth or return circuit is cut off, and the current goes by the line of one station and returns by that of the other, thus giving a complete metallic circuit between the two stations, out of contact with the earth or return wire. This renders it quite impossible for the other stations to disturb the circuit while in use, or to over-hear.

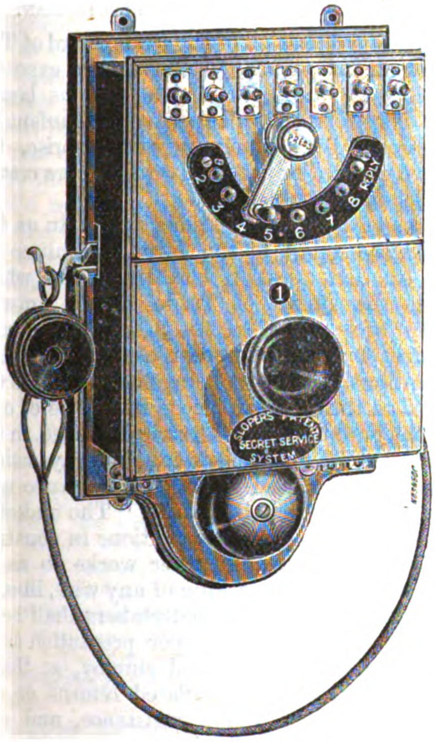

Fig. 3.

By means of a simple addition a reply signal can be received and given, which is a very great advantage for business purposes. Thus, suppose a manager at a factory rings up a certain department, say at No. 15, in all other systems it would be necessary to listen at the receiver until someone replied, and in case there was no one at No. 15 to answer, it would be time wasted, in addition to the annoyance. By the Sloper system it is only necessary for the manager to ring up No. 15, when he would wait until he received a reply signal, and if no reply came he would know there was no one at No. 15 to answer. The reply signal does not ring the ordinary bell, but causes a buzzer to sound; thus a direct call can always be distinguished from a reply signal. On receipt of a call, the "called" station (in the above case No. 15) puts his switch over to "reply," and presses a stud which causes the buzzer to sound at the station from which the call came. The ringing contact is combined with the switch in a very simple manner, so that it is only necessary to move the switch to the line required and press the switch itself.

A circular just issued by Messrs. Gent and Co. gives a few interesting diagrams showing how they can be connected to suit various purposes.

LEGAL INTELLIGENCE.

The Medical Battery Company (Limited).

C. B. Harness, Managing Director of the Medical Battery Company, J. M. M'Cully, and C. B. Hollier, again surrendered on Wednesday before Mr. Hannay, at Marlborough-street, to their bail, to answer the charge of having conspired together to obtain money by false pretences from various persons.

Mrs. MARIANNE CAROLINE EBBEN said that in January, 1892, she went with her husband to No. 52, Oxford-street. The gentleman she saw said that in three months he would make her walk as well as she used to. She was to pay 100 guineas down. The treatment did not do her any good.

Cross-examined by Mr. AVORY: Her husband was present when she wrote the cheque for 100 guineas. She had been under the treatment of two or three doctors for about eighteen months, but they did her no good. She was so disappointed that she was not better from the treatment she received that she communicated with her lawyers with the view of getting her money back. She knew that her lawyers commenced an action against the Company to recover her money, and the result was that it was settled by her receiving £75 and the expenses to which her lawyers had been put. That occurred about twelve months ago. The case was settled out of Court.

Mr. EBBEN, the husband of the last witness, cross-examined by Mr. AVORY, said the action that was brought to recover the 100 guineas was settled to the satisfaction of the witness. It was arranged in the settlement that all imputations on both sides should be withdrawn.

W. R. SELLMAN, recalled and cross-examined by Mr. AVORY, said that from 1887 down to the time he (witness) left there was always a qualified medical man on the premises in Oxford-street. As far as he knew there was no description of Mr. Harness on the premises as "Dr. Harness" after January 6, 1890. He was present at lectures given at the premises six years ago on electricity and chemistry. He remembered M. Loreau coming to the premises and heard that he was connected with the Salpêtrière Hospital, Paris. M. Loreau stayed at Oxford-street about two years, and during that time was engaged in designing improvements in the electric belts. He (the witness), as a matter of fact, treated numbers of persons, who went away either cured or very much better. Most of them wore belts as part of the treatment. Some of the persons that the witness treated sent him personal testimonials in addition to the ones they sent to the Company. About three weeks after he was arrested the prosecution first approached him to give evidence. Before he was arrested the prosecution had never asked him to do so.

Mr. W. H. JONES said that he visited 52, Oxford-street in 1892 to be treated for rheumatism in the feet. He was taken to a room, where a wire brush was passed about his ankles. He was then told that his case was serious and likely to get worse, and was advised to try one of the electrical belts, the price of which was five guineas. He said that he did not think he could afford so much, and was informed that it would be useless for him to have a cheaper one, as he required one of the strongest belts. At the time he had not five guineas about him, and he was asked if he had a banking account. He replied that he had, and then a blank cheque was procured, and the witness filled it up for five guineas. He wore a belt for about a month, but it did him no good. Acting on instructions he returned to the Medical Battery Company after the lapse of a month, and was told to wear the belt for a couple of weeks longer. Finally, he was given a new belt, and some weeks after the Company wrote, asking for a testimonial, when he replied that their belts were worthless.

Cross-examined by Mr. AVORY: He had consulted medical men about his complaint, but they had not cured him. He did not demand his money back from the Company. He did not think that what he said was a letter asking for a testimonial was merely a circular inquiring about the state of his health.

Mr. AVORY said that the defendants were anxious that the magistrate should visit the establishment in Oxford-street and examine the appliances there, but Mr. Hannay did not think there was any necessity for that.

The case was again adjourned for a week, the same bail being allowed.

Anglo-American Telegraph Company v. Compagnie Française du Télégraphe de Paris à New York.

The appeal in this action came before the French Courts last week, and was again adjourned for a month.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *December* 15, 1893.

The "Novak" Lamp Suit.—The decision of the Court in the Novak lamp case, argued at Hartford, Conn., last week, is awaited with much interest, as the issue is entirely different from that of the other great lamp cases. The validity of the Edison patent is not attacked, the contention being that of non-infringement. The Edison lamp patent rests upon a combination of a carbon filament and an all-glass exhausted receiver with leading-in wires; the defendants claim that as they employ an inert gas under a pressure of only one six-hundredth of an atmosphere they do not infringe the combination. It was claimed in the argument, and admitted by the plaintiffs, that vacuum lamps are not efficient unless the exhaustion is carried to at least one three-hundred-thousandth of an atmosphere. The plaintiffs also admitted that a lamp containing gas under the pressure of that in the Novak lamp would not blacken as readily as a vacuum lamp. Should the suit be won by the defendants it is probable that they will be met by a claim that all the points in their patent are covered by other patents of Edison relating to the use of inert gases in lamps.

The San Francisco Exhibition.—The midwinter Exhibition at San Francisco promises to be unusually successful from an electrical point of view. Mr. W. F. C. Hasson, who has charge of this department, will introduce several novel features, including a tower of light, and the electrical equipment thus far comprises generators aggregating more than 2,000 horse-power.

Cheap Lamps.—The General Electric Company has just announced a reduction in the price of incandescent lamps from 44 cents to 32½ cents.

CORRESPONDENCE.

THE MORDEY ALTERNATOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR,—Allow me to thank you for your editorial remarks on Prof. Forbes' criticism of the synchronising effort exerted by my alternators.

Put briefly, the experiments alluded to consisted in placing between two alternators a resistance considerably more than was required to absorb the whole output of one of them. As even under these circumstances the machines did not actually break out of step, I regarded the experiments as very satisfactory, and it was with the greatest astonishment that I heard Prof. Forbes cite them as showing the contrary.—Yours, &c.,

W. M. MORDEY.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your leading article (December 22nd) on the Institution of Electrical Engineers is an example of the destructive order of criticism, and I beg leave to express my regret that it should have appeared in such a paper on such a subject.

I might be disposed to revive your confidence by a more hopeful view of the prospects, but I am writing as a Member, and it is more becoming that, whatever the present shortcomings may be, they should be dealt with among ourselves and not paraded before the public.

Pemit me, however, to say, with reference to your fiat, that one must look elsewhere if one wants anything done—that the Institution is adequately representative of electrical engineers, and its future, with all its possibilities, rests with them.—Yours, &c.,

W. L. MADGEN.

8 and 10, Charing Cross-road,
London, W.C., December 27, 1893.

LA SOCIÉTÉ GÉNÉRALE DES TÉLÉPHONES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you kindly allow me to correct, through the medium of your excellent paper, various rumours set on foot with regard to the present position of "La Société Générale des Téléphones." As you are aware, this Company has been, and is still, carrying on an action against the French Government for the recovery of the amount due for its telephonic communications and plant taken over by the State. This lawsuit, which is likely to be protracted for a considerable time, placed the Company in a position of great difficulty, as contractors to the same Government, and hampered their energies as manufacturers. To avert these difficulties it has been decided to entirely separate the lawsuit from the manufacturing business, in order to gain a free hand. Consequently the "Société Générale des Téléphones" is to carry on the lawsuit. On the other hand, the various works of the Company, namely:—

1. For the construction of telephonic and telegraphic instruments and plant and appliances for every branch of electricity, situated 2, Rue des Entrepreneurs, Paris;
2. For the manufacture of india-rubber goods, cable and wire, &c., at Bezons (Seine-et-Oise);
3. For submarine cables, at Calais, were amalgamated, on December 9th last, with the well-known firm of "Menier," Paris, manufacturers of india-rubber goods and cables, and are to be carried on under the title of "La Société Industrielle des Téléphones."

Thus the two most powerful firms of the kind in France, which used to compete with each other, are now united, and the new Company, having got rid of an interminable lawsuit, has doubled its producing powers, and intends carrying on business with renewed vigour.—Yours, &c.,

G. A. NUSSBAUM,
General Agent for La Société Industrielle des Téléphones.

ELECTRIC TRACTION AND THE BOARD OF TRADE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Since the publication of the draft Board of Trade Regulations for electric tramways, we have been expecting to find attention called in the Press to the serious bearings these Regulations, if confirmed, will have on the infant industry of electric traction. But, much to our surprise, the matter seems to have escaped notice, and we therefore crave space for a few remarks on the subject.

In the first place, the Regulations appear to us to be out of harmony with the report of the Joint Committee which considered the traction question last June, and which recommended that the Board of Trade should draw up rules calculated to give effect to the Committee's views. The following extracts from the report clearly indicate the Committee's intentions, the italics being ours:—"The Committee, having regard to the evidence before them, are of opinion that it is not, in the present state of electrical science, in the interest of the public to insist upon electrical tramways using an insulated return conductor, and that such insistance would retard the development of electric traction." "The undertakers shall take all reasonable and proper precautions in constructing and using their lines, circuits, and other works so as not injuriously to interfere with the working of any wire, line, or apparatus. . . . provided always the undertakers shall be deemed to take all such reasonable and proper precaution as aforesaid, if and so long as they adopt and employ, at the option of the undertakers, either such insulated returns or such uninsulated metallic returns of low resistance, and such other means of preventing injurious interference with the electric wires, lines, and apparatus of other parties, and the currents therein, as the Board of Trade shall direct, and in giving such directions the Board *shall have regard to the expense involved and to the effect thereof upon the commercial prospects of the undertaking.*" The Board of Trade are empowered by Section 3 of the Report to make rules "for regulating the employment of insulated returns or of uninsulated metallic returns of low resistance, for preventing fusion or injurious electrolytic action on gas or water pipes, or other metallic pipes, structures, or

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substances, and for minimising, *as far as is reasonably practicable*, injurious interference with the electric wires, lines, and apparatus of other parties, whether such lines do or do not use the earth as a return." In their third and fourth recommendations the Committee express themselves altogether in favour of metallic circuits for telephones and railway block signals. Briefly, the Committee considered that, although every precaution was to be adopted in favour of earthed telephones and water pipes, the existence of these things was not to stop, nor to even hamper, electric traction. The Board of Trade respond to this expressed intention by proposing their Regulation No. 14:—"In the disposition, connections, and working of feeders the Company (undertakers) shall avoid injurious interferences with any existing wires." This was exactly the view of the National Telephone Company when they tried to stop the Leeds tramway. It was a view they could not persuade Mr. Justice Kekewich to adopt, it was a view they could not persuade the Joint Committee to adopt, and yet, after everything that has passed, the Board of Trade calmly go back to it and seek to make it law. There is no qualification such as the Committee indicated to the proposed regulation, and its adoption will place electric traction in a worse position than ever. By regulation No. 15 "sparking at the rubbing and rolling contacts in any part" is absolutely forbidden. Is that "reasonably practicable?" We say that it is not. The indifference displayed by the electrical profession in the matter may be, perhaps, due to the knowledge that the Board of Trade intend to take the opinion of the Council of the Institution of Electrical Engineers on the regulations before issuing them, but a word of warning appears necessary on this point. The National Telephone Company are most influentially represented on the Council by gentlemen who are, or have been, their retained experts. No doubt it may be said that these gentlemen will not allow their conduct at the Council to be influenced by their retainers, but can they avoid insensible bias, and would it be just to their employers if they did? We would suggest that the only proper course is for the Council to exclude all such partisans, whether for or against traction or telephones, from their deliberations when the rules are under consideration. That the National Telephone Company are alive to the occasion would appear to stand confessed by the circular letter issued from their offices on December 8th to their *employés* and others suggesting that they should substitute on their ballot papers the name of one of the Company's officials for that of one of the Council's candidates, and also endeavour to influence their friends to do the same. The manœuvre did not succeed, but it is significant. It is also noteworthy that the list of Mr. Ansell's proposed representative Council does not include any members for traction, whilst telegraphs and telephones are to be provided with three.—We are, yours, &c., BENNETT AND DRUCE.

Fishergate, Preston, December 30, 1893.

THE PAST YEAR'S WORK.

MESSRS. ROWLAND BARNETT AND CO.—This Newcastle firm have been busy during the past year, and included in the work completed is the supply of a complete electric lighting plant for the Times Steamship Company's "Juno," the plant for the Bitchburn Colliery, and the lighting of about 50 business premises, &c. The vast increase of work has necessitated the taking of larger premises for town show-rooms and offices, and the extension of their works at Walkergate. The firm obtained a gold medal at the recent Trades and Industrial Exhibition at Newcastle for their new North-Eastern dynamo.

MESSRS. BENNETT AND DRUCE.—Amongst the installations carried out during the past year by this Preston firm are included the premises of Messrs. Walker and Sons at Hyde, near Manchester (nearly complete), and the mills owned by Mr. Levi Fish, by Mr. John Humber, and by Messrs. Hartley Bros., all of Preston.

MESSRS. JOHNSON AND PHILLIPS.—Business in this firm's electric lighting department during 1893 was well maintained. Several of the branches have been exceptionally busy, necessitating an unusual amount of overtime in order to complete orders for cables, arc lamps, accumulators, &c. This satisfactory state of things has induced the firm to make fresh additions to the buildings and machinery at their Charlton Works, which are now in progress. During the year the contract for laying the Brooks system of mains for the Chatham and Rochester public lighting has been completed, comprising about twelve miles of conductors fitted with junction and terminal boxes, house service, &c. The Brooks system is well known to our readers, and possesses many advantages. Large orders for the well-known Brockie-Pell arc lamp have necessitated the fitting-up of new shops to meet the ever-increasing demand. These lamps have been adopted for the public lighting of Hull, Blackpool, Bristol, Portsmouth, Londonderry, Oxford, Burnley, &c.; and are also in use at the Imperial Institute, Woolwich Arsenal, the Winter Gardens at Blackpool, the Bute Docks, Cardiff, and at the principal stations of the London and North-Western and Great Northern Railways. The Continental and Colonial demand for these lamps has also made satisfactory progress. During the year the D.P. storage batteries manufactured by this firm have been in satisfactory demand. During 1893 Messrs. Johnson and Phillips have taken up the manufacture of the Perry meter. Large numbers of these have been made, and plant has been put down sufficient to cope with a considerable demand, which orders already to hand justify the firm in anticipating. Large multipolar machines, whose self-regulating qualities show a high degree of excellence, have been a special feature of the year's work, and included in the orders received have been a novel motor-alternator, for use at the University College, London, arranged to work either off the public mains or by means of independent belt power, and so designed as to demonstrate the phases of alternate-current working; and also a large multipolar steam dynamo for the military electrical School at Chatham. Messrs. Johnson and Phillips's latest form of transformer is commanding a large sale, those recently made for the Bristol Corporation being arranged for the three-wire system.

MESSRS. F. F. REID, FERENS AND CO.—Included in the electric lighting contracts completed by this Newcastle firm are the following:—A 260 16-c.p. installation at the Haswell Co-operative Stores, worked by a Hornsby-Akroyd engine, and including a battery of 53 cells. Four electric motors have been supplied for this installation; one for raising flour in sacks to the flour lofts, one for cutting hay and crushing oats, one for washing and drying currants, and the other for driving a ventilating fan. At Eppleton Colliery (Hetton) plant has been put down for 630 16-c.p. lamps, in addition to eight 2,000-c.p. arcs for lighting the railway siding, &c., for the Cornsay Colliery Institute. Mr. J. H. Love has presented an installation of 50 25-c.p. lamps for the use of the miners, the work being carried out by the above firm. Another contract has been carried out at the Widdrington Colliery, including the lighting of the owner's house, which is situated 1,300 yards distant from the dynamo house. For the Harton Coal Company's Colliery, Whitburn, an installation has been put down for electric lighting the schools owned by the Company.

TELEGRAPH MANUFACTURING COMPANY (LIMITED).—This Company report that they have been extremely busy in all departments during the past year. Their vulcanised cables have had a large sale, and they have supplied considerable quantities of both high and low-tension mains to various contractors for town work. The instrument factory has received very large orders from the Postmaster-General and the principal railway companies, and they have to record a satisfactory increase in every department of their extensive business.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1894 Edition of "'THE ELECTRICIAN' ELECTRICAL TRADES' DIRECTORY AND HANDBOOK" is in preparation, and will shortly be published. *New names, alterations of addresses, &c., should be sent in at once.* Full printed particulars can be obtained, post free, from "The Publisher," *Electrician* Office.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, which has a special interest at the present time, is now ready, and will be forwarded on receipt of the published price, 7s. 6d. (abroad 8s.), or it may be obtained from any bookseller. A prospectus can be obtained on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—This book, written by Mr. F. Marten Weymouth, is also ready, and will be sent direct on receipt of the published price, 7s. 6d. (abroad 8s.), or it may be obtained from any bookseller. A prospectus will be forwarded free on application.

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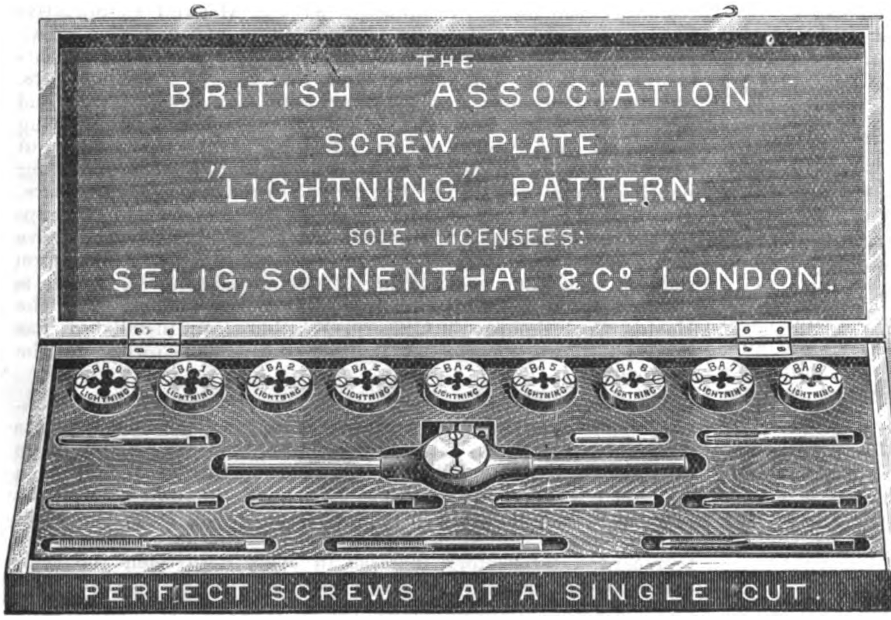
TENDERS ACCEPTED.—As stated in our last issue, the Sunderland Corporation have accepted the tender of Messrs. Hawksley, Wild and Co., for boilers, for £1,380 ; the tender of Messrs. J. H. Holmes and Co., for dynamos, at £4,640 (which will ultimately be reduced to £4,399) ; Messrs. Crompton and Co.'s tender of £1,352 for motors and alternators ; Messrs. J. H. Holmes and Co.'s tender of £575 for main switchboards and instruments. The E. P. S. Company's tender obtained the contract for accumulators at £763 ; the Silvertown Company for the cables at £2,592 ; and the British Insulated Wire Company's offer for potential leads at 10½d. per yard, amounting to about £90 ; Mr. G. E. Simpson's (of Sunderland) offer for the necessary road work obtained the order at £2,590 ; and Messrs. McLaren and Co., of Glasgow, for cast-iron work, at £290. Messrs. Doulton and Co.'s tender for the stoneware, pipes, &c., for £807, was also accepted, and other tenders agreed to include an offer for copper strip at 6½d. per pound from an English firm. The total amount of the tenders is £15,074, against an original estimate of £21,000. The whole of the tenders sent in came well within Prof. Kennedy's estimate.

——— The Fleetwood Improvement Commissioners have accepted the tender of the Brush Electrical Engineering Company (Limited) for the supply of the electrical plant for the central lighting station for the sum of £8,700. The entire cost of the installation will be £11,325.

LIQUIDATIONS.—A petition has been presented for the winding up of the Platinum Plating Company (Limited), which is down for hearing on the 11th inst.

——— A third and final dividend of 5s. is payable in the liquidation of the India-rubber Estates Company (Limited), at the liquidator's, 33, Carey-street, W.C., any day except Saturday.

BRITISH ASSOCIATION SCREW PLATE.—Messrs. Selig, Sonnenthal and Co. forward us particulars of the British Association screw plate recently introduced by them to meet a demand amongst electricians and other users of small threads. It is claimed for this plate that screws cut with it are more perfect than those cut with ordinary dies ; that they are equal to the best lathe work, and that no burr is raised above the true size. The dies have the strength and reliability of the solid die, but are not solid, being adjustable for wear so as to keep the exact size of the taps and to allow of nuts and screws for different purposes being made to fit together tightly or loosely, as desired. Accompanying the printed particulars sent are testimonials from users, who speak very favourably of the plate. The illustration shows the complete set as sold.



FOREIGN CONTRACTS. — A statement having been published that the Postmaster-General had given an order for a cable, "between Liverpool and New York," to "Siemens, of Berlin," Mr. Arnold Morley states that cables between this country and America being in the hands of private companies, the postal authorities have, of course, given no such order as above referred to, the facts of the case being that the Commercial Cable Company (as previously announced in *The Electrician*) have placed an order with Messrs. Siemens Brothers and Co. (Limited), of Queen Anne's-gate and Woolwich, for an additional cable to be laid between this country and America.

EPSTEIN ACCUMULATORS.—The Epstein Electric Accumulator Company have just completed the installation of a battery of 60 type R 11 cells for the Hunt's Bank Lighting Station of the Lancashire and Yorkshire Railway at Manchester, and the Company are very busy with a number of large battery orders, amongst which is one of 120 type R 13 cells for the Lancaster Electric Light Station, and another of 54 R 25 cells for Messrs. Barclay and Co., of Regent-street, as well as a traction set for the War Office.

MESSRS. CLAUD HAMILTON AND CO.—The Victoria Infirmary, Glasgow, has recently been completely fitted for the electric light by the above firm, the consulting engineer being Mr. T. Young, of West Regent-street. Plant and machinery to supply current to about 500 lamps have been put down.

MESSRS. NALDER AND HARRISON.—Mr. N. F. Nalder and Mr. Haydn T. Harrison have entered into partnership for the purpose of carrying on the business hitherto conducted by Mr. N. F. Nalder, and in order to cope with the increase of business they are now moving into larger premises at Trafalgar House, Great Newport-street, Charing Cross-road, London, W.C.

MESSRS. A. HALL AND CO.—Mr. G. Nicholson, trustee in the estate of the late firm of Messrs. A. Hall and Co., of Liverpool, has disposed of the goodwill and stock-in-trade of the business to Mr. L. J. Barnacle, who, with the assistance of Mr. H. H. Hall, the manager to the late firm, will carry on the business under the old name at 1 and 11, South John-street, Liverpool. The new firm are carrying out all contracts entered into by the old firm.

MESSRS. JEREMIAH HEAD AND SONS.—We are informed that Mr. Jeremiah Head has transferred his headquarters from Middlesborough to Victoria-street, Westminster, S.W., where he has taken into partnership his son, Mr. A. P. Head, M.I.M.E. The Middlesborough address will be retained as a branch office.

MESSRS. RASHLEIGH PHIPPS AND DAWSON.—This firm have secured the contract for lighting the new premises of the Bank of Scotland in Bishopsgate-street, E.C., by the electric light. Over 600 lights will be required for the installation.

CHARGE OF THEFT.—Charles Herbert Bent, the late manager of the Roundav Electric Tramway, at Leeds, was this week brought up at the Leeds City Police Court, charged with stealing £5. 12s. 8d., a suit of clothes, and other articles, the property of the Company. From the evidence of the clerk to the firm of chartered accountants employed by the Tramway Company who audit the accounts, it appears that the books were considerably in arrear, and that the cash book showed a fictitious balance. Witness further stated that there were a number of cash items paid to Mr. Bent which were not posted to any account. After some further evidence the defendant, who pleaded not guilty, was committed to the Quarter Sessions to answer the charge of falsification of accounts. Bail was allowed.

BRADFORD.—The Bradford branch of Messrs. Woodhouse and Rawson United (Limited) have recently completed an installation at the Harrogate Hydropathic Establishment, which has been lighted throughout by electricity. About 800 incandescents have been wired on the sub-circuit, with local distributing cut-out boards on each floor. The generating plant consists of two vertical engines of 12in. and 16in. cylinder, which drive two shunt-wound dynamos, so arranged that they can be run singly or together. The installation includes 60 R9-size Epstein cells.

BEDFORD.—The Electric Lighting Committee have recently replied to a communication from the Board of Trade in reference to the subject of the transfer of the Council's Provisional Order to the Bedford Electric Lighting Company, to which reference was made at the meeting of the shareholders of that Company reported in our issue of the 29th ult. The Electric Lighting Committee's reply shows that considerable difference of opinion exists amongst the ratepayers as to the proper course to be adopted by the Council.

BELFAST.—A discussion arose at the last meeting of the City Council as to the advisability of transferring the Council's electric lighting business from the Gas Committee to an Electric Light Committee (to be formed). After a heated discussion an amendment to leave the matter in the hands of the Gas Committee was adopted by 17 to 16.

BROMLEY.—Complaint is made by the local press of the dilatoriness displayed by the authorities in proceeding with the electric

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lighting scheme, notwithstanding that a site has been acquired for a central station.

Buxton.—In reference to the application of the Local Board for an electric lighting Provisional Order, it has been resolved that the amount of £10,000 be fixed as the sum proposed to be expended on electric lighting.

Chelmsford.—At the last meeting of the Town Council a resolution was adopted that the contract with the electric lighting company for the lighting of the town having been renewed, the existing gas standards were no longer required, and should therefore be removed forthwith. A discussion ensued upon the clause in the Committee's report dealing with the request of the Board of Trade that the electric light wires should be put underground. The Council in committee recommended that the matter be left to the decision of the Board of Trade; but Councillor Taylor considered this would be unfair to Messrs. Crompton, who agreed that, if the Council would assist them in this matter, they would reduce the charge for private lighting from 8d. to 6½d. per unit, subject to a further discount for prompt payment. He moved, therefore, that the Board of Trade be asked to meet the wishes of the electric lighting company as far as practicable in this matter. This amendment was agreed to. With regard to the question of the purchase of the undertaking at the end of 21 years or 31 years, Mr. Fawkes stated that the electric lighting company were prepared to accept the 21 years' arrangement on the understanding that the purchase should be as a going concern, and not at a break-up price.

Drogheda.—The Drogheda Steamship Company have in hand the lighting of their stores and wharves by electricity, and for this purpose have applied for and obtained permission from the Boyne Commissioners to erect the necessary posts for the lamps.

Dublin.—Graziers and dealers in live stock who ship from Dublin are now offered the facilities of the electric light at the ports for the inspection of cattle up to 8:30 p.m. This arrangement enables owners to have their stock forwarded by the same evening's boats to England and Scotland. Four of the principal companies already use the light, and the London and North-Western Company and Messrs. Laird are shortly completing their installations.

Edinburgh.—Plans for the electric lighting plant are nearly ready, and estimates for the work are shortly to be advertised for. The probable cost of the buildings is estimated at from £10,000 to £15,000, out of a total of £80,000 to be ultimately expended.

Electric Clocks.—The Bristol branch of the National Provincial Bank of England some time ago placed an order with Messrs. King, Mendham and Co., of Bristol, to fix a clock to be electrically driven and controlled on the bank's premises. The work has now been completed.

Howth (near Dublin).—A proposal is on foot to establish public lighting in this district. It is proposed to introduce petroleum oil lamps unless some enterprising firm comes forward with a liberal electric lighting scheme.

Leeds.—The extensive goods wharf and warehouses of the Great Northern Railway Company, at Wellington-street and Wellington Bridge, Leeds, have now been entirely fitted for the electric light, which is obtained from the mains of the Yorkshire House to House Company. About 30 Brockie-Pell arcs of 1,500 c.p. are used for the out-door lighting, and the warehouses are supplied with 100-c.p. incandescents. The cable for the installation was supplied by Messrs. Siemens Brothers and Co., and the lamps, lanterns, transformers, &c., by Messrs. Johnson and Phillips. The result is that work is now carried on with much greater expedition, and with greater facility and safety.

Londonderry.—The following is taken from the *Londonderry Sentinel*:—"In reading through a seemingly inspired article in to-day's *Standard* we observe there is an insinuation that we are keeping back the completion of the electric-light works. This we strongly repudiate. Any delay that has taken place, so far as our contract is concerned, has been entirely owing to the action of the Corporation. We would have had our part of the works completed long ago had the Corporation carried out their part of the contract and put us in a position to make satisfactory progress with the works. Since commencing the contract (for reasons not known to us) we have been handicapped and made to work up-hill. Notwithstanding this, we could have given sufficient engine power at the electric station to light the whole city months ago had we been empowered to do so. Even now, if the Corporation would permit us, we could have the town engines in full working order within fourteen days.—Alex. Brown and Sons."

Leicester.—The Co-operative Society in this town have just had their extensive premises at the corner of High-street and Union-street fitted throughout with the electric light. Owing to the difficulty previously experienced in obtaining proper ventilation, the electric light was adopted, and is giving every satisfactio The plant includes a 20-H.P. Robey gas engine of the latest tern. The installation consists of about 320 lamps.

Mill Lighting.—The mills and weaving sheds belonging to Messrs. Joseph Eccles and Co., Winewall Mill, Colne, and to Messrs. N. Smallpage and Sons, Kellbrook, near Colne, have recently been lighted up throughout by electricity. In the former case power is taken from the main shaft, driving two 25-kilowatt Gardner dynamos for about 800 lights. In the latter case there are 300 lights, and the current is supplied by a 20-kilowatt Gardner dynamo driven by a Gilkes turbine. In both cases gas has been entirely superseded. The buildings are wired with a separate pilot circuit, driven by a small steam engine and dynamo. Messrs. J. E. Spagnoletti and Crookes were the contractors for the wiring and switchboards, which latter form a special feature of both installations; Messrs. Gardner and Sons, of Cornbrook, Manchester, were the contractors for the generating plant; and Mr. Harold Smith, of Colne, was the consulting engineer for both installations.

——— The large range of buildings comprising the mills of the well-known firm of Horrocks, Crewdson and Co. (Limited), at Preston, have been lighted throughout by the electric light, the work being entrusted to Messrs. J. H. Holmes and Co., of Newcastle, under the supervision of Mr. W. C. Bennett. The mills are nearly the largest in the Preston district, and the lighting is voted a great success.

Monmouth.—The Town Council have received the revised estimates of Mr. Lailey, C.E., and the Brush Company, showing the cost of draining and electric lighting separately. The tenders together amount to £19,040, and a special meeting was called for yesterday (Thursday) to consider the matter.

Morley.—The Town Council have carefully considered several schemes placed before them for lighting the town and municipal buildings by electricity, and it has been decided to consult an electrical expert on the matter. The Council are to visit such London and provincial lighting stations as they consider advisable.

Reading.—A local company will shortly be formed for the purpose of carrying out a comprehensive electric lighting scheme. Mr. F. F. Yeatman, manager of the electric supply station at Reading, announces that arc lighting is increased in the town by 4 per cent., while the number of incandescents to which current has been supplied during the past year has trebled.

Sheffield.—Many of the business premises in this town have been supplied with electric current from the mains of the Sheffield Electric Light and Power Company, and the extension into residential suburbs, especially Ranmore, is in contemplation.

Ship Lighting.—Messrs. Laird Bros. have just launched from their works at Birkenhead a twin-screw torpedo cruiser, built for the Argentine Government, named the "Patria." The vessel is supplied with complete duplicate sets of electric lighting plant.

Sutton (Surrey).—The Local Board have discussed the question of advertising for tenders for lighting the district by electricity. Several local firms who have been approached have declined to tender, expressing their willingness to take the matter up should there be any difficulty experienced in obtaining suitable tenders. The matter has been, after some discussion, referred back to the General Purposes Committee.

Wigan.—A very serious deterioration of the books in the Free Library having occurred, it has been pointed out to the Gas Committee that not only is the lighting in the library insufficient and unsatisfactory, but that the safety of a very valuable collection of books was placed in jeopardy. The Library Committee, therefore, asked that a system of electric lighting shall be adopted forthwith.

Works Lighting.—At the beginning of the winter the Cart Vale Chemical Company decided to put down an electric lighting installation, the work for which was entrusted to Messrs. Robertson and Co., of Paisley. Seven 2,000-c.p. arcs have been fitted up, the plant including a Woodside dynamo and a 12-H.P. steam-engine.

——— The extensive works of Messrs. Dickson and Mann (Limited), at Armadale, Scotland, have recently been fitted throughout with the electric light, including the engineering, bridge building, and steel tool-making departments. The work was carried out by Messrs. Walter Dixon and Co., of Glasgow.

Yalding (near Maidstone).—In reference to our "Note" last week, we are informed that the Cheveney installation was completed in December, 1892, and that Messrs. B. Verity and Son erected the whole of the work, which has continued to give the greatest satisfaction from the start.

Annual Dinner.—The past and present pupils connected with the Manchester branch of Messrs. Woodhouse and Rawson United (Limited) held their first annual dinner on the 20th ult., at the Grosvenor Hotel, Manchester. A pleasant evening was spent.

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PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

Note.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

December 9, 1893.

23,744. R. J. Urquhart. Manchester. Improved method of, and appliances for, lighting railway trains by electricity. (P. de Y. Ysasmendi, Spain.)*

December 12, 1893.

23,857. D. Cook. Richmond. Apparatus for generating electricity.

23,862. E. H. South. London. Improved means for the automatic regulation of the position of the brushes of dynamo-electric machines and electro-motors.

23,881. W. P. Thompson. Liverpool. Improved method of, and apparatus for, heating metals electrically. (C. L. Coffin, United States.)*

23,897. C. J. Reed. London. Improvements relating to electric signalling or the transmission of information and energy by electricity, and to apparatus therefor.*

23,902. W. P. Hall. London. Improvements in and relating to electric motors.*

23,913. R. Haddon. London. Improved process and apparatus for dissociating soluble salts by electrolysis. (H. S. Blackmore, United States.)*

23,914. J. A. Bisson. London. Improvements relating to the insulation of submarine and other electric cables.

December 13, 1893.

23,951. T. Bassnett. Liverpool. Telegraphic apparatus.

23,962. A. C. Hewitt and G. W. Pyke. Maidenhead. An electric fire-escape.

24,001. J. Coombes. London. An automatic thermo-electric lubricating apparatus. (R. N. Coombes, Western Australia.)

24,017. E. Stouls. London. Improvements in or relating to processes and apparatus for obtaining and depositing metals by electrolysis, and in the treatment of the metals after leaving the electrolytic bath.

December 14, 1893.

24,035. G. Combe and Siemens Brothers and Co. (Limited). Halifax. A combined regulating switch, and motor for actuating same.

4,055. J. H. Cooper. Limerick. A means of governing or controlling automatically the electric current generated by a dynamo or electric generating machine.

24,081. R. Niewerth. London. Improvements in the manufacture of carbon for electric lighting and other electric purposes.

24,104. R. D. Ratcliffe. London. Improved combined tidal motor, dynamo-electric generator and storage batteries.

December 15, 1893.

24,111. A. D. Lagrelle. London. New or improved means for applying electricity for warming the seats of water-closets, close-stools, and the like.

24,131. M. A. Mosley, R. Wright, and J. H. Richardson. Bradford. Improvements in, or appertaining to, the electro-deposition of zinc.

24,154. R. L. Grahame and E. S. Cadman. Teddington. Improvements in electrical guides or indicators, and batteries therefor, specially applicable for carriages and the like.

December 16, 1893.

24,217. W. E. Ayrton and T. Mather. London. Improvements in electrical measuring instruments and apparatus for use with alternating currents.

24,234. A. C. Cossor. London. Improvements in the manufacture of filaments for incandescent lamps.

24,241. H. Weymersch and E. Freund. London. Improvements in primary batteries.

24,243. W. H. Lander. Dublin. An improvement in electrical arc lamps.

24,254. F. H. Nalder, H. Nalder, C. W. S. Crawley, and A. Soames. London. Automatic switch.

24,271. C. Bonnard and F. A. Piat. London. Improvements in and connected with telephonic apparatus.*

24,274. C. Kellner. London. Improvements in apparatus for the electrolytical decomposition of metallic salts.

24,276. H. Guthrie. London. Improvements in apparatus for electrolytic purposes.

24,285. H. Edmunds. London. Improvements in means for connecting or supporting electroliers, brackets for electric lamps, or the like, to or from ceilings, walls, or other places of support.

December 18, 1893.

24,295. H. F. Hoveler. London. Improvements in elements for secondary and other electric batteries, and in the manufacture of same.

24,344. J. A. Kingdon. London. Improvements in dynamo-electric machines.

24,353. C. K. Mills. London. A new or improved preparation of active material for electric accumulators. (C. J. Barbier, France.)

December 19, 1893.

24,389. A. Lehmann. Glasgow. Improvements in electrode plates for secondary batteries.

24,392. C. F. Winkler. Manchester. Improvements in and connected with electric motors for vehicles.

24,409. H. Bonser. London. Improvements in or relating to means for conveying electrical currents to the workings of coal and other mines.

24,414. W. P. Thompson. Liverpool. An improved means of underground current supply for electric railways. (A. Rast, Germany.)

24,417. J. B. Torres. London. Improvements in electric or galvanic batteries.

24,442. C. K. Mills. London. A new or improved electrical accumulator plate. (C. J. Barbier, France.)

24,446. W. A. Phillips. London. Improvements in electric lamps. [Date applied for under Patents, &c., Act, 1883, Sec. 103, June 3, 1893, being date of application in United States.]

December 20, 1893.

24,471. W. Thomson (Baron Kelvin). Glasgow. Improvements in electricity supply meters.

24,472. J. T. Bottomley. Glasgow. Apparatus for evaporation, distillation, or concentration of liquids by means of heat produced by an electric current.

24,517. F. J. Mockler. London. An improved advertising reflector for the top of electric light globes.

24,557. A. A. Common. London. Improvements in or relating to electric printing or signalling apparatus.

December 21, 1893.

24,606. E. A. Claremont. Manchester. Improvements in the means of suspending arc and other electric lamps and fittings.

24,607. E. A. Claremont. Manchester. An improved insulated lever for use in electrical switches and other like appliances.*

24,608. E. A. Claremont. Manchester. Improvements in the construction of, and in the means for fixing, flywheels to the pulleys of dynamo-electric motors and generators.*

December 22nd, 1893.

24,730. F. G. S. Curtis. London. Means for use in combination with conduits or conductors for the supply of gas or other fluid, or of electricity, for indicating the time during which such gas or other fluid or electricity has been consumed.

December 23, 1893.

24,736. J. Whitaker and T. P. Pollitt. Manchester. Improvements in electric bells.

24,751. J. S. Raworth. London. Improvements in safety appliances for use in connection with generating and distributing apparatus for high-pressure electrical currents.

24,757. W. Arnold and W. Crowther. Halifax. Certain improvements in electric apparatus for stopping steam or other engines.

24,771. F. V. Andersen. Catford. Improvements in electrical measuring instruments.

24,790. R. E. B. Crompton. London. Improvements in brush-holders for dynamo-electric machines.

December 27, 1893.

24,864. E. Thomson. London. Improved methods and means of compounding dynamo-electric machines.*

24,865. H. H. Lake. London. Improvements in insulators for electric wires. (W. B. Bond, United States.)*

24,867. J. C. Love and A. G. Wheeler. London. Improvements in electric railways.*

24,871. H. T. Johnson. London. Improvements in dry batteries.*

24,911. T. J. Dewees. London. Improvements in electric cables and in the method of making the same.*

SPECIFICATIONS PUBLISHED.

All Specifications price 8d. each.

1892.

22,285. Anders and Kottgen. Microphone transmitters.

23,750. Hough. Secondary batteries.

24,008. Shepard. Electric lamps.

22,422. Khem. Electric call apparatus.

1893.

1,354. Forbes. Electrothermal conductors, plates, &c.

1,894. Timmis and Smith. Dynamo-electric generators, &c.

1,902. Mavor and others. Electric conductors.

2,159. Rose. Electric arc lamps.

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2,167. KAHN. Registering telephone calls.
3,210. MAQUAY. Primary batteries for miners' lamps.
3,274. JOHNSON and PHILLIPS. Electrical transformers.
3,402. CLARK (Hartmann and Braun). Electric meters.
4,360. THOMPSON (Société Electric Phœbus). Plates for accumulators.
8,952. ELLERMANN. Electric accumulators.
10,095. DE PASS (Thofehrn). Electro-plating.
16,389. MCELROY. Car-heating apparatus.
18,386. LANCASTER. Electrical switches.
19,127. LINVILLE and HETTMANSPERGER. Printing telegraph systems.
19,529. NISSL. Telephone switch.
19,542. KELLNER. Electrolytical decomposition of salt solutions.
20,458. DE SEGUNDO. Electric switch.
20,735. BALL. Lightning conductors.
222. MITCHELL. Electric belts.

NEW COMPANIES, STATUTORY RETURNS, &c.

[In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, pages 320-348, &c., &c.]

CAPE ASBESTOS COMPANY (LIMITED).—This Company, which was registered on December 28, 1893, with a capital of £55,000, in £1 shares, in addition to the acquisition and development of certain lands containing asbestos in Griqualand West, includes the manufacture and sale of india-rubber, gutta-percha, caoutchouc, and all kinds of vulcanised and elastic goods, including telegraph and telephone wires and cables, tubing, pipes, &c.

COWLISHAW, WALKER AND CO. (LIMITED).—This Company was registered on December 30, 1893, with a capital of £10,000, in £10 shares, to carry on the business of general engineers, iron and brass founders, millwrights, boiler makers, machinists, &c., carried on by Cowlishaw, Walker and Co.

FROGGATT'S INVENTIONS SYNDICATE (LIMITED).—This Company was registered on January 1st, with a capital of £1,000, divided into 500 Ordinary and 500 Preference shares of £1 each, to purchase or otherwise acquire in any manner or for any term certain letters patent, patent rights, inventions, and processes for the generation and storage of electricity granted to or invented by Thomas Froggatt and others, and to carry on the business of electrical engineers and fitters, manufacturers of and dealers in electrical accumulators, lamps, and other electrical apparatus, contractors for the supply of electrical energy, for lighting, heating, and other purposes, suppliers of electricity, &c. The subscribers (with one share each) are William Price, Sydney Howarth, John Martin, Robert C. Page, Arthur Hampson, Benjamin Brancher, and Thomas H. Derbyshire, all of Liverpool.

JOHN LAMPITT AND CO. (LIMITED).—Capital £6,000, in £25 shares. General engineers, ironfounders, boiler makers, brassfounders, millwrights, and agricultural implement makers, of Banbury.

ARIEL COMPANY (LIMITED).—The statutory return of this Company made up to December 14, 1893, has been filed. The nominal capital is £15,000, divided into 1,000 Preference and 2,000 Ordinary shares of £5 each. 670 Preference and 2,000 Ordinary shares have been taken up, of which 400 Preference and all of the Ordinary shares have been issued as fully paid. Upon 50 Preference the full amount has been called, while upon the remaining 220 a call of £3 per share has been made, resulting in the payment of £910.

BEDFORD ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company, made up to December 27, 1893, has been filed. The nominal capital is £15,000, divided into 250 Founders' and 14,750 Ordinary shares of £1 each. 154 of the former and 882 of the latter have been subscribed for and allotted. Upon the Founders' shares the full amount has been called, while upon the Ordinary shares a call of 1s. per share has been made. The calls paid amount to £197. 19s., leaving 3s. in arrears.

LAMINA ACCUMULATOR (ELIESON'S BRITISH PATENTS) SYNDICATE (LIMITED).—The statutory return of this Company, made up to November 8, 1893, has been filed. The nominal capital is £12,000, in £1 shares, of which 4,007 have been taken up. Upon 3,757 of these a call of 3s. per share has been made, resulting in the payment of £563. 10s., and leaving £376. 15s. in arrears, while the remaining 250 shares have been issued as fully paid. The 6,000 shares which the vendors were to receive as their purchase consideration have not yet been allotted, the 250 shares mentioned above being the price paid to Moritz Immisch for certain electrical apparatus in connection with the patents of that Company.

UNIVERSAL ARC LAMP SYNDICATE (LIMITED).—The first annual return of this Company, made up to December 20, 1893, has been filed. Out of a nominal capital of £3,000, in £1 shares, 2,865 have been taken up. On these a call of 1s. 6d. per share has been made, resulting in the payment of £228. 15s. Holders of 15 shares have paid the full amount of £1 upon their shares.

VENEZUELA TELEPHONE AND ELECTRICAL APPLIANCES COMPANY (LIMITED).—The annual return of this Company, made up to December 7, 1893, has been filed. The whole nominal capital of £70,000, in £1 shares, has been taken up, of which 56,506 have been issued as fully paid, and the full amount paid on the remaining 13,494 shares.

CITY NOTES, &c.

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ended December 31st were £833, as against £966 for the corresponding period of last year, being a decrease of £133. The total receipts for the half-year amount to £21,820, as against £21,786 for the corresponding period of 1892, an increase of £34.

CITY OF BATH ELECTRIC LIGHTING AND ENGINEERING COMPANY.—Mr. H. G. Massingham has resigned his position as Director of this Company, owing to his having taken up his residence at Taunton.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of December are £3,700, as compared with £3,693 in the corresponding month of last year.

DIRECT SPANISH TELEGRAPH.—Estimated receipts for the month of December £1,895, against £2,092 last year.

DISTRICT MESSENGER SERVICE AND NEWS COMPANY (LIMITED).—At the ordinary general meeting of this Company the Chairman said their business progressed steadily and materially. For the first month—July, 1890—the takings were £1. 7s. 6d.; in July, 1891, they were £566; in July, 1892, they were doubled, amounting to £1,201; and in the month of July, 1893, they reached £1,607, since which date they had steadily increased. The British public were slow to move, and required time to take to a new enterprise. There were hundreds and thousands of people in London who had never heard of their system.—Mr. Campbell Praed said they were weak as regards working capital; when the balance-sheet was referred to the results attained during the last year were very satisfactory.—Mr. C. T. Russell (managing director) said that, notwithstanding the bad times and the many causes operating against the success of the system during 1893, the revenue had steadily increased, with but very little increase in the working expenses. The revenue derived from messenger service last week was £470, which exceeded that of the corresponding week last year by £105, and, in fact, exceeded any week since the inception of the Company. Out of 11,400 boxes installed 1,700 were paying a yearly rental of one guinea. As no boxes are now installed without a rental this item alone would go far towards paying a dividend for the ensuing year. The Company had received very little benefit from the amalgamation with the Boy Messenger Company; the expenses connected with the taking over the wires, call-boxes, offices, &c., had been a constant drain upon their revenue and resources. Eventually, the Company would derive substantial benefit in consequence of this amalgamation; to equip them they were operating some of their offices at a loss on account of want of sufficient capital. The Directors had decided to issue £40,000 of cumulative Six per Cent. Preference shares, to enable them to complete these offices and to pay off the debenture bonds, thereby saving a fixed charge of about £1,600 per annum. The Company was actually paying its full running expenses. Their system had become one of the institutions of London. While it has been a plant of slow growth, necessarily, from the nature of the business, it has become a splendid property. A continuous increase in the sale of the Company's coupons had taken place, amounting now to upwards of £60 per month, and the Directors have it under consideration to make a reduction to all tradesmen purchasing coupons. Another source of revenue had been created by placing a modest charge of 5s. upon all the call-boxes installed in the City, amounting to upwards of 5,000. He regretted to say that the Postmaster-General showed no desire to rebate any portion of the enormous tax placed upon the Company. They were not only taxed 1d. on each letter, but the nucleus of their business is also burdened by a tax of 2s. 6d. on every electric call-box, the total payments amounting to 12½ per cent. on the entire gross receipts.

EASTERN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of December amounted to £55,579, as against £59,776 in the corresponding period of last year.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of December amounted to £36,906, as against £42,295 in the corresponding period of 1892.

MEDICAL BATTERY COMPANY (LIMITED).—A winding-up order was made against this Company on November 22nd last, and a statement of affairs has now been submitted, accompanied by the observations of the Official Receiver and Provisional Liquidator (Mr. C. J. Stewart). The gross liabilities are returned at £23,916, of which £19,780 will probably rank, with assets £4,242. The total deficiency as regards contributories is stated to be £119,780. The Official Receiver asserts that the claims of unsecured creditors (£15,766) comprise claims for advertising and printing £13,867, and goods supplied £1,879. The machinery, valued as an asset, at £1,000, consists chiefly of mechanical appliances for the Zander method of treatment of disease, and cost the Company £10,777. A summary of Mr. Stewart's report and a general statement of the affairs of the Company will be found in our issue of the 15th ult.

NEW PANULCILLO (LIMITED).—This Company is formed for the purpose of acquiring from the liquidators of the Panulcillo Copper Company the mines and smelting works, with a view to developing them and working them in a more vigorous and economical manner than hitherto. The capital is £50,000, in £1 shares, payable 5s. on application, 5s. on allotment, and the balance in sums of 2s. 6d., at not less than one month's notice. The Directors are Sir John Pender, G.C.M.G., M.P., Mr. F. J. Johnstone, Mr. J. Denison Pender, and Mr. R. S. Archbold

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The Secretary and offices are Mr. W. Leigh Hunt, 3, Great Winchester-street, London, E.C. The subscription list closes for London at 4 p.m. on Tuesday next, and for the provinces and abroad by first post on Wednesday morning.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the week ended December 29th (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,719.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Divi-dend.	NAME.	Previous Week's Price, Dec. 27.		Price Wednesday, Jan. 3.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Jan. 3. Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	12/6	Anglo-American	43	45	43	45	6 2 3	Jan., Apr., July, Oct.	43½	43¼
£2,932,680	Stock	25/0	Do. Preferred	81½	82½	81	82	6 14 2	" "	82½	81½
£2,932,680	Stock	5/0	Do. Deferred	7½	8	7½	8	..	..	..	..
£184,500	100	4%	African Direct Telegraph 4% Deb. (Reg. & Bearer) xd	101	104	99	102	3 18 5	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	11¾	12¼	11¾	12¼	5 6 1	Mar., June, Oct., Dec.	11⅞	..
£18,700	£100	5%	Do. 5 per Cent. Bonds	101	104	101	104	4 16 2	January and July ..	..	—
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906) xd	109	113	107	111	4 10 1	June and December	—	—
$10,000,000	$100	7%	Commercial Cable Capital Stock	149	150	130	140	5 0 0	April and October..	..	..
16,000	10	8/0	Cuba Submarine	11½	12½	11½	12½	6 8 0	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October..	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	..	..
60,710	20	3/6	Direct United States Cable, 1877	11⅜	11⅝	11⅜	11⅝	6 0 2	Jan., Apr., July, Oct.	11½	11⅜
400,000	10	2/6	Eastern	15	15¼	15	15¼	4 5 3	" "	15 3/16	15
70,000	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16¼	3 13 10	" "	16⅛	15 15/16
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	—	..
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	108	111	108	111	4 10 1	February & August	..	..
250,000	10	2/6	Eastern Extension	15½	15¾	15⅝	15⅞	4 8 2	Jan., Apr., July, Oct.	15⅞	15⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	114	117	114	117	3 8 5	February & August	..	..
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900 xd	103	106	101	104	4 16 2	January and July ..	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900 xd	103	106	101	104	4 16 2	" "	—	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103	106	103	106	3 15 6	February & August	..	..
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	106%	109%	106%	109%	3 13 5	May and November	107	106¾
180,227	10	1/6	Globe Telegraph and Trust	8⅜	8⅞	8⅜	8⅞	5 1 5	Jan., Apr., July, Oct.	8¾	8⅝
180,042	10	6%	Do. 6 per Cent. Preference	15½	15⅝	15½	15⅝	3 18 1	" "	15⅝	15 3/16
150,000	10	5/0	Great Northern xd	20	20½	20	20½	4 3 0	Jan., April, and July	20	..
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 14 4	March & September	..	..
17,000	25	12/6	Indo-European	40	43	41	44	5 13 7	May and November	43	..
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	3 6 8	" "	..	—
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	105	108	5 11 1	March & September	105¾	—
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red" 1942 xd	102	105	100	103	3 17 8	..	..	—
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October..	..	..
3,381	£100 Cert.	35/0	Submarine Cables Trust 6 per Cent.	114	119	114	119	5 0 10	" "	..	..
15,609	10	5/0	West African Telegraph	5½	6½	5½	6½	7 13 10	January and July ..	—	..
£249,900	100	5%	Do. 5 per Cent. Debentures	99	102	99	102	4 18 0	March & September	..	..
30,000	10	2/0	West Coast of America	2	3	2	3	..	January and July ..	2 1/16	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902 xd	100	104	97	101	7 18 5	June and December	..	..
88,321	10	1/0	West India and Panama	1	1¼	1	1¼	..	—	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10¼	9¾	10¼	5 17 1	May and November	9 15/16	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917 xd	108	111	105	108	4 12 7	June and December	..	..
64,242	15	4/6	Western and Brazilian	6	6½	6	6½	3 9 4	May and November	—	..
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5¼	5¾	5¼	5¾	..	..	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¼	1¾	1¼	1¾	..	..	—	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	104	107	104	107	5 12 2	February & August	—	..
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	104	107	104	107	5 12 2	" "	..	—
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	105	102	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	—	..	—
224,850	10/0	3⅜d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	—
220,000	£1	4·76d.	Oriental Telephone and Electric (11s. paid)	¼	..	¼	⅜	5 6 5	Yearly	..	..
484,597	5	2/6	National	4⅜	4⅝	4⅜	4⅞	5 2 7	June and December	4⅞	4⅝
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	13½	14½	13½	14½	4 2 9	" "	..	—
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	13	14	13½	14½	4 2 9	" "	14½	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅛	5⅝	5⅛	5⅝	4 13 0	..	5⅛	..
925,017	£100	4½%	Do. Deb. Stk. 4½% xd	113	115	111	113	3 19 8	January and July	112½	112
58,000	5	1/0	United River Plate	2	2½	2	2½	..	" "	..	..
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock xd	90	100	90	100	5 0 0	" "	—	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11¼	11¾	11¼	11¾	—	..	11⅝	..
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	12¾	13¼	13	13½	..	—	13 7/16	13 1/16
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	—	—	—
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		—		..	—	—	—
8,322	£5	—	House to House Electric	..		..		—	—	—	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		..	..	—	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July ..	—	—
30,000	£5	1/9	Liverpool Electric Supply (£3 10s. paid)	4¼	4¾	4¼	4¾	..	—	—	—
15,000	£5	2/6	Do. (fully paid)	6¼	6¾	6¼	6¾	..	—	—	—
111,000	5	..	London Electric Supply	¼	¾	¼	¾	—	..	..	—
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	7¾	8¼	7¾	8¼	2 8 5	..	8 1/16	7¾
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	103	106	103	106	4 14 4	June and December	..	—
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	—	—	—	—
19,980	£5	9½%	St. James' and Pall Mall	5½	6	5½	6	..	—	..	—
20,000	£5	7%	Do. 7 per Cent. Preference	7¾	8¼	7¾	8¼	4 4 10	—	8⅛	8
59,900	5	1/6	Westminster Electric Supply (fully paid)	5	5½	5	5½	3 3 8	—	5¼	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	2/1	Brush Electrical Engineering	2⅜	2⅞	2⅜	2⅝	6 17 1	—	2 7/16	2⅜
90,000	2	6%	Do. 6 per Cent. Preference Non-Cumulative.	2⅛	2⅜	2	2½	5 6 8	—	2¼	..
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	105	107	105	107	4 4 1	March & September	—	..
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	4	4½	4	4½	..	January and July	..	—
12,139	5	..	Edison and Swan United	—		—		—	—	..	—
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		—		..	—	—	—
120,000	2	..	Electric Construction	¾	1	½	1	..	—	½	..
12,845	2	..	Do. 7% Cumulative Pref.	¾	1¼	..		..	..	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	¼	⅜	¼	⅜	—	—	—	—
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	—	—	—	—
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21½	22½	21½	22½	5 11 1	February & August	22	..
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	—	—
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	—	—	—	—
16,600	£10	..	Do. 8 per Cent. Preference	..		—		..	December and June	—	—
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/0	4/0	3/0	4/0	..	..	..	..
78,949	5	3/6	Swan United (£3. 10s. paid) xd	2¼	2¾	2¼	2¾	—	May and November	—	—
37,350	12	12/0	Telegraph Construction and Maintenance	36	38	36	38	4 9 1	March and July....	37	36½
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894 xd	105	108	103	106	4 14 4	January and July	—	..
37,514	£5	—	Woodhouse and Rawson Ordinary (£3. 15s. paid)	—		—		—	—	—	—
41,098	£5	—	Do. Preference (fully paid)	—		—		—	—	—	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	3%	City and South London Railway	28	33	28	33	2 5 5	May and November	..	—
37,500	£10	—	Liverpool Overhead Railway	5	5½	5	5½	—	—	—	—

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THE ELECTRICIAN:

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NOTES.

The loss that science has suffered by the untimely death of Prof. Hertz is feelingly expressed in another column by Dr. Oliver Lodge, who went so near to anticipating the discovery of those electro-magnetic oscillations which will for all time be inseparably linked with the name of Hertz. In the modesty and self-forgetfulness which blend so admirably with the spirit of true scientific research Hertz was singularly rich. A letter that we received nearly four years ago from Prof. Hertz in answer to a request for permission to publish a portrait of him has pathetic interest at the present moment, and is a striking instance of his invincible modesty:—

Bonn, June 22, 1890.

Dear Sir: You will oblige me very much by postponing for a year, or better, for two years, the kind intention you have in respect to my portrait. I feel as if presenting my portrait now in so prominent a place rather follows too quickly the little work I have done. I should like to wait a little, and see if the general approbation which my work meets with is of a lasting kind. Too much honour certainly does me harm in the eyes of reasonable men, as I have sometimes occasion to observe. If your kind intention is the same in two years, or even one year, I shall readily consent and help you in every respect. With many kind thanks, and the assurance that I feel only too much honoured, Yours truly, H. Hertz.

On Thursday last week, as was recorded in our "Notes" columns, the Brighton Corporation decided to purchase the business of the Brighton and Hove Company for the modest sum of £5,000—a sorry ending to a venture of no little technical and historical interest. Starting in the autumn of 1881 with an arc-light station, the Brighton Company's business developed under Mr. Arthur Wright into a station on the constant-current multiple-series system with over 1,500 lamps connected to its wires, and finally into a 10,000-light station on the house-transformer system. Notwithstanding all the ingenious devices by which Mr. Wright succeeded in making a tolerable success of so troublesome and impracticable a system, his hard work, in more than one direction, was destined to be thrown away. Not only is the constant current—an ill-advised choice from the beginning—extinct, but even when alternators and house-transformers were used, the success of this "pioneer" supply was not remarkable.

Twelve years ago the first Electric Lighting Act was *in futuro*, and municipalisation was not very much in evidence; had it been so, to have started an electricity supply business without previously obtaining the support, or, at any rate, the benevolent neutrality of the Brighton Corporation, would have been then as wild a speculation as such a course would undoubtedly be to-day. On the other hand, the Brighton Corporation has not been entirely without mercy, since it gives £5,000 for an undertaking which would, in all probability, have ultimately passed into its hands for nothing. The *Sussex Daily News* argues that the Corporation will get 11¾ per cent. on the purchase-money; so it will, but when we add the £19,000 fresh outlay that will be needed before the Company's present customers can be supplied from the Corporation station, Mr. Wright's estimated net revenue becomes 2½ per cent. on the capital expended, which is scarcely an extravagant return.

Monday last was a somewhat stirring day from the point of view of accidents connected with electrical conduits, mishaps having occurred in places as far apart as Newcastle-on-Tyne, London, and Bournemouth. At Newcastle a telephone repairer was endeavouring to thaw the ice which had collected on the lid of a street-box, when an explosion occurred, slightly injuring the man. In London, at the top of Ludgate-hill, some men belonging to the City of London Electric Lighting Company were opening the ground near a fire that they had kindled, when there was an explosion, resulting in the lifting of a couple of manhole covers and the injury of a small boy.

Hitherto the only mystery attaching to these electric-light main explosions has been due to the difficulty of accounting for the fatal spark, the necessary materials for mischief being admittedly ready at hand in the leakage of coal-gas from the gas mains into the electrical conduits. But at Newcastle and Ludgate-hill, however, there is no need to start ingenious hypotheses as to why electrical mains should suddenly betake themselves to sparking; the determining cause was present in each instance in the shape of an ordinary every-day flame.

Electric lighting seems destined to act the part of standard-bearer to the gas industry. The introduction of the glow lamp and arc lamp has led to the invention of the incandescent gas lamp, Wenham lamp, and many another improved burner. And now these too frequent street eruptions, supplemented by the pressure of adverse legal decisions (*vide* "Loveland *v.* Gas Light and Coke Company") seem likely to result in improved methods of laying and jointing gas pipes. On the other hand, the fact that gas manages to find its way into the electric light conduits is a proof that these, too, leave room for improvement. Sydney Smith was of opinion that our railway companies would never refrain from their detestable habit of locking their passengers in until a train caught alight, and a sealed-in Bishop got burnt. We trust that the

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two industries which are severally responsible for these little interruptions to the placid continuity of City life will not wait until the Dean of St. Paul's is blown up before they apply a drastic remedy.

THE accident at Bournemouth was of a different character to either of the preceding ones. As a two-horsed omnibus was drawing up at the Imperial Hotel, both horses suddenly fell down. One expired immediately, but the other was dragged away alive, all those assisting receiving slight shocks. Subsequently it was noticed that other horses on passing the spot, which was exactly over one of the iron-and-brick electric light chambers, kicked and plunged. The Electric Light Company was telephoned to, and on the mains connected to the hotel being cut off, the phenomena ceased. On Tuesday Major CARDEW was sent down at the instance of the Bournemouth Town Council to investigate the matter; the mains were tested by a battery, but no leak was revealed. It may be mentioned that three veterinary surgeons who made a *post mortem* on the unfortunate horse agree that it met its death through an electric shock. That electricity was the cause of this mishap there seems, therefore, to be no reasonable doubt, and that Major CARDEW was unable to discover an "earth" by means of a battery need not make a mystery of the matter; a 2,000 volt test, backed by a few horse-power, would probably soon do that. Major CARDEW's report to the Board of Trade will no doubt make the cause of the accident quite plain.

THE attempt to meddle with the standard candle having failed, a proposal is now made to relax the 16-candle quality of London gas. The public are told that it costs about 2d. per thousand cubic feet to doctor up the gas with cannel, petroleum, or other "enrichment," and that a gas of fourteen to fifteen candle-power, "if used with proper burners," would give at least as good light as consumers are getting now. Those "suitable burners" are an old trick. No comparison is ever made between electric light and gas, by gasmen, where the beloved London Argand burner is not used, if the muddle by Mr. TERRACE be excepted. We hope that the report on tests of gas burners, which we recently published, thoroughly exposed this artifice. The consumers of the South Metropolitan Gas Company are assured that the change will put £20,000 to £30,000 a year into their pockets. Will the Company have no corresponding profit? Who is going to pay for these "proper burners"? The Company, surely.

New Year's Honours.—Amongst the recipients of New Year's honours was Mr. W. R. Brooke, Director-General of the Indian Telegraph Department, who was made a C.I.E.

Newport (Mon.).—On Wednesday last week Col. John Ord Hasted, R.E., Local Government Board Inspector, held an inquiry into the application of the Newport Corporation for a loan of £28,000 for the purposes of electric lighting.

Madrid.—We have received a letter from the Electricity Supply Company for Spain, informing us that the paragraph in our issue of December 29th, relating to that Company, stating that a war of rates had broken out between them and the German Company, is "very inaccurate."

Obituary.—The death is announced of Herr A. Steinheil, who in 1851 organised the Swiss telegraph system, after having served his time in the Bavarian telegraph service. Herr A. Steinheil was a son of the famous Steinheil who discovered the "earth-return."

The Hermite Electrical Sanitation Process at Worthing.—Worthing is about to be the scene of some experiments in sewage disinfection by means of electrolysed sea water, the Town Council having voted a considerable sum of money to enable M. Hermite to get to work during the present month to demonstrate the value of his system.

Electric Traction in the Hartlepools.—A deputation went last week from the Hartlepools to Leeds for the purpose of inspecting the electric tramcars. It is proposed to utilise the existing tram lines between the Hartlepools for electric cars, a syndicate having been formed with that view. The Mayors of the two boroughs accompanied the deputation.

The Telegraph Revenue.—The receipts from the telegraph service for the quarter ended December 31, 1893, amounted to £620,000, as against £615,000 for the corresponding period of 1892. The receipts for the period, April 1 (1893)—December 31 (1893), amount to £1,955,000, as against £1,925,000 for the corresponding period; an increase of £30,000, or ·15 per cent.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
San Domingo-Martinique	Dec. 10th, 1893	Jan. 8, 1894
Cayenne-Paramaribo	Oct. 25th, 1893	—
Cayenne-Vizeu	Nov. 25th, 1893	—
Lagos-Brass	Dec. 4th, 1893	—
Haiphong-Hongkong	Dec. 11th, 1893	—
Garachico-Santa Cruz de Palma	Dec. 27th, 1893	—

The Home Office and Accumulator Works.—The *London Gazette* of Friday contains a declaration by the Home Secretary, under the Factory and Workshop Acts, to the effect that the following processes carried on in factories or workshops are dangerous or injurious to health:—The manufacture of red, orange, or yellow lead, lead smelting, the tinning and enamelling of iron hollow ware, electric accumulator works, flax mills and linen factories.

Electric Traction at Liége.—An overhead trolley line, about two miles long and with a maximum gradient of 3½ per cent., has recently been opened between Liége and Herstal. The pressure is 550 volts, and the cars, which weigh about a ton and seat 32 people, are fitted with one 25-H.P. motor, each worked with single reduction gearing in the ratio of 1:5. The plant is of local origin, and much of the experience of American engineers appears to have been disregarded in the construction of the line.

Electrical Properties of Thallium.—In a Paper read before the Royal Society of Victoria last month, Mr. W. H. Steele describes his researches on the physical constants of thallium. Mr. Steele gives, as the specific electrical resistance of this element, 20,200 C.G.S. units at 20°C., with a coefficient of variation of resistance of 0·00392 in the neighbourhood of this temperature. He also finds that the absolute thermo-electric height of thallium is $(216 - 0{\cdot}79\theta)$, where θ is the temperature on the centigrade scale. The coefficient of linear expansion with rise of temperature was found to be 0·0000225 per 1°C.

Electric Tramways on the Continent.—The Halle Tramway, although its extension has only been nine months at work, pays 7½ per cent. dividend. The Breslau Tramway has been working since June; the Essen Tramway has been running since the end of August; the Kieff Tramways are all to be changed into electrically-driven roads. Electric traction is being started also at Chemnitz, Dortmund, Lübeck, and Christiania. All the above undertakings have been, or are being, carried out by the Allgemeine Elektricitäts-Gesellschaft. The Leipzig Town Council have published a specification for an electric tramway in certain parts of the town, on the basis of a 40-year concession.

Electrical Typewriting Machine.—An electrically-operated typewriter, says the *Engineering Magazine*, has been for some time in use in Boston, which is so arranged that it may not only be used in the ordinary manner for office correspondence and copying, but may be electrically connected with a similar instrument at a distance, so that a copy of the work may be

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automatically reproduced thereon, even in the absence of an attendant. In its long-distance action it has been anticipated, of course, at any rate in principle, by Prof. Hughes' type-printing telegraph. But, in the office, if the instrument is more silent than its mechanically-operated prototype, it ought to find a ready welcome. A silent writing machine, which could be run off a 100-volt lighting circuit, would be a great boon.

Electric Motors on H.M.S. "Centurion."—On Thursday morning last week the first-class battleship "Centurion" went through her gunnery trials at Portsmouth. The "Centurion" is interesting as being the first battleship in the Royal Navy in which electric motors will be made use of, in a very tentative manner it must be confessed, to assist the working of heavy guns. It is intended to fit electric-motors to the elevating apparatus, designed for a large angle of fire, viz., minus 7deg., plus 35deg. elevation. The loading station being almost horizontal, the electric motors will be valuable adjuncts to the hand-elevating appliances when the guns have to be moved through the angle from loading position to maximum elevation cr thereabouts. The motors, however, are merely auxiliaries, as the elevation can be accomplished by the manual gear, though less expeditiously. An electric motor is also being fitted to the upper hoist for rapid transport of the charges to the guns.

German Central Stations.—The following table of statistics is of use for purposes of comparison, and is taken from the *Elektrotechnische Zeitschrift*:—

Station.	Years in work.	Output B.T. units.	Percentage of energy sold to energy produced.	Cost of coal pr.B.T. unit.	Works costs per B.T. unit sold.	Hours pr. day per lamp.	Profit in percentage of capital outlay.
Barmen	5	122,026	84·2	0·685	2·98	2·48	7·65
Cologne	1	307,074	...	0·81	...	2·67	6·62
Dusseldorf...	1	337,285	69·7	0·41	1·63	3·10	10·85
Elberfeld ...	5	305,794	97·5	0·85	2·88	2·29	14·09
Hamburg ...	4	513,183	94·5	1·20	2·53	3·09	18·05
Hanover	2	365,114	80·7	0·48	2·09	2·56	11·34

Copper.—According to Messrs. Stedman, Crowther and Co.'s metal report for 1893, copper was at its highest in January, the price being £46. 12s. 6d. at the beginning of the year. The price then fell almost continuously until it touched £42. 15s. by the end of May. After a rise to £45. 2s. 6d. in June a decline again set in, and in August, £40. 12s. 6d., the lowest price of the year, was reached. A good deal of buying, both for consumption and speculation, was induced by the low price, and the value improved £2. 10s. by the middle of September. The available stock has now been falling month by month almost without a break since April, 1889, nearly five years; and, although there was an increase in the world's annual production of over 40,000 tons in the same period, this was absorbed, and an additional 70,000 tons from stock. Putting 1889 (when consumers' stocks, abnormally small during the reign of the syndicate, had to be filled up) out of the question, there still remains a reduction in stocks of 48,500 tons during the last four years, *i.e.*, from 95,700 tons on January 1, 1890, to 47,295 tons on January 1, 1894.

Wolverhampton.—On Thursday, last week, Mr. Codrington, one of the Local Government Board inspectors, held an inquiry at Wolverhampton, relative to an application for a loan of £30,000, for the purpose of carrying out an electric lighting scheme in the borough. The Town Clerk said the Provisional Order was granted in August, 1890. The central switch station would be at the Town Hall, with branch stations at the Art Gallery and the Free Library. The estimated cost of the scheme was £30,000, of which £17,442. 14s. 2d. was for plant, and £1,320 for arc lamps, and £2,243 would be left for contingencies. With regard to the question of the repayment of the loan, he had written to the Local Government Board asking whether they had any powers to suspend the operation of the sinking fund with respect to this undertaking for a few years, in order to enable the Corporation to turn round during the time between the commencement of the work and the completion of it. It was not to be supposed that the Corporation would make instant profit. The electrical engineer estimated the dead annual expenditure at £3,307, and to cover this a minimum annual consumption would be required of 193,600 units at 6d. per unit.

Electric Propulsion of Canal Boats in France.—On the canal between the Seine and the Saône there is an interesting application of electric power to the propulsion of canal boats. It occurred to M. Galliot, an engineer at Dijon, to utilise the water power of the fall of water at the lock sluices to drive turbines and dynamos for this purpose. This scheme is now actually realised, and an efficiency of 30 per cent. between the turbines and the canal boats is said to be attained. The turbines are placed on the falls with their spindles vertical, and are each capable of developing from 15 to 20 H.P. The vertical shaft of the turbine is geared by bevel wheels into the horizontal shaft of a dynamo. The electric power is conveyed along the canal by means of a phosphor-bronze overhead line, 8mm. in diameter. Each towing boat is provided with a motor, which is driven by power taken from this trolley line. In addition to working the canal boats, the electric power is partly utilised to light up the interior of a length of tunnel through which the canal passes. The propulsion of the towing boat is effected, not by means of propellers on the boat itself, but by a train of gear wheels connecting the motor to a chain which extends along the bottom of the canal, and by means of which the boat drags itself along.

The Telegraph in Zambesia.—In the course of a lecture on "The Capabilities of Zambesia for Commercial Expansion and Development," delivered by Mr. Archibald R. Colquhoun (the first Administrator of Mashonaland), on Monday, before a meeting of the London Chamber of Commerce, the lecturer said:—"The telegraph is now being carried northwards towards Zambesi, to form connection later with Nyassaland, joining all the lakes, and eventually linking on the Cape to Cairo, an important project planned by Mr. Rhodes, which has been pronounced rather visionary. I hold it, however, to be perfectly practicable. In a country like Zambesia the telegraph must be the precursor of roads and railways, as it has been in Persia and China, where there were, and still are, practically, no roads and no postal communication. In those countries an enormous volume of correspondence and business is done by the wire, which replaces the postal service of Europe. The laying down of communications varies with the conditions of the regions; for instance, in Europe the railways follow the roads, because we had roads; in America the country is covered with railways and telegraphs, while there are virtually no roads even now; in Asia and Africa the telegraph naturally comes before, or simultaneously with, the railway."

Distribution of Electric Stress in the Higher Regions of the Atmosphere.—A recent number of the *Comptes Rendus* contains a note, by M. André, on the variation of the electric state of the high regions of the atmosphere in fine weather. During a previous attempt to investigate this point, the author unfortunately met with an accident which has prevented him personally making any more observations; the measurements contained in this note have, however, been made under his directions. At opposite corners of the car of the balloon were fixed two cylindrical reservoirs, filled with distilled water, and insulated on plates of sulphur. To the base of each of these vessels an india-rubber tube, about 20 metres long, was attached, each tube having a small jet at its end. When the balloon had come to rest at any desired height, the difference of potential existing between two points, at a known vertical distance, was determined by means of an Exner electrometer connected metallically with the water reservoir. This difference of potential, the distance being kept constant, gave a measure of the strength of the electrical field. As a result of two series of observations, the author considers that in fine weather the strength of the electrical field does not increase with the altitude, but is the same at a given instant at any point along the same vertical.

Franklin Institute.—The Committee on Science and Arts of the Franklin Institute request us to bring to the notice of our

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readers the character and conditions of the awards at their disposal:—The Elliott Cresson Medal, founded in 1848 by the gift of the late Elliott Cresson. This medal is of gold, and by the terms of the deed of trust may be granted for some discovery in the arts and sciences, or for the invention or improvement of some useful machine, or for some new process, or combination of materials in manufactures, or for ingenuity, skill or perfection in workmanship.—The John Scott Legacy Premium and medal (twenty dollars and a medal of bronze), awarded by the City of Philadelphia. This medal was founded in 1816 by John Scott, a merchant of Edinburgh, Scotland, who bequeathed to the City of Philadelphia a considerable sum of money, the interest of which should be devoted to rewarding ingenious men and women who make useful inventions. The premium is not to exceed twenty dollars, and the medal is to be of copper, and inscribed "To the most deserving."—The Edward Longstreth Medal of Merit, founded in 1889, by Edward Longstreth, machinist, and late member of the Baldwin Locomotive Works. This medal is of silver, and may be awarded for useful invention, important discovery, and meritorious work in, or contributions to, science or the industrial arts. Full directions as to the manner and form in which applications for the investigation of inventions and discoveries should properly be made will be sent to interested parties on application to Mr. William H. Wahl, Secretary, Franklin Institute, Philadelphia, Pa., U.S.A.

Braking and Trolley Accidents.—In view of the outcry which has been raised against the inefficient system of braking electric cars in America, Mr. McFarlan Moore makes the following criticism:—"Even with the present methods of electric street-car control, accidents will soon become less frequent than on horse-car lines during the past. Many of the communications in both the daily and electrical papers lead one to infer that the present list of accidents is to continue indefinitely, unless the present methods of car control be radically improved. This is a mistake. The cause of nine-tenths of the accidents so common at present is due entirely to the forgetfulness of the general public that trolley cars run at a much higher speed than the horse cars. The utter nonchalance with which even ladies allow the noses of car horses to graze their shoulders, proves that the many years of slow-moving transit has formed a habit much too strong to be entirely broken in a few months. Rapid transit must be *rapid* and the public will learn, perforce, that more time allowance must be made when crossing the tracks ahead of the modern trolley car. In the very nature of things there must be a limit to the *practical* length of time required to bring a rapidly-moving car to rest, and the comfort of the passengers, for whom the car is run, must not be overlooked. The education of the public in this matter is the only solution to the problem of preventing street-car accidents on trolley lines. The history of the past indicates that surface rapid transit in cities has come to stay, and in the future the public will enjoy even greater speed than is now in vogue." This is very much to the point; for while it is quite necessary to provide a swifter car with a more powerful brake, it is absurd to expect that the swifter car can be pulled up or slowed down in the same number of yards as a slower one. There is a certain amount of acceleration in starting and stopping a car, beyond which it is dangerous to the passengers to go, and the limit of this rate of change of speed is not greater for rapid transit than for ordinary transit.

Artificial Leaks on Land Lines.—In an article on "Self-induction as a Remedy for Static Discharge," in a recent issue of the *Electrical Engineer* of New York, Mr. F. W. Jones gives some particulars with regard to the use of leaks for the same purpose:—"The use of leaks was tried as early as 1870 upon the great overland circuits of the Western Union Telegraph Company extending between Chicago and San Francisco, a total distance of about £2,300 miles. The circuits were worked Morse and in sections of about 500 miles with automatic repeaters between them. Owing to the peculiarly dry nature of the vast prairies over which some portions of the circuits worked it was found that signalling was very tedious and required long and firm contacts of the sender's key to produce signals free enough from distortion by the excessive electrostatic effects to be received at either end of the line. For hundreds of miles the poles are standing in dry sand, and frequently the great expanse of sandy plain becomes highly electrified and clouds of the charged sand particles are driven by the high winds along or across the wires, which in turn become charged by contact with the electrified sand. These myriads of charges of high voltage unite into a dynamic current towards earth at each end of the particular circuit of the section invaded and on many occasions the entire suspension of business for the time is the result. This trouble is of greater frequency in very cold weather, and is then due to snowstorms instead of sand-storms. In 1883 I wrote Mr. W. B. Hibbard who had been superintendent of these circuits for several years, for information as to the value of the leaks, which consisted of high resistances placed at various convenient points along the lines to relieve the wires of their static charges. Mr. Hibbard's reply, dated Rochester, N.Y., August, 1883, is as follows:—'The high resistance leaks as a remedy for induction were tried in 1870, but proved worthless.' In some cases the resistances were strips of hard wood with a conducting line of carbon made by a lead pencil between two binding posts to which the line wire and earth were respectively connected."

Boiler Incrustations and Deposits.—At a meeting of the Junior Engineering Society, held on January 5th, an interesting lecture on "Boiler Incrustations and Deposits," was delivered by Prof. Vivian B. Lewes. The lecturer having pointed out the serious injury occasioned to boilers, and the waste of fuel due to the formation of incrustations, traced the history of various sources of water supply, and showed how the water acquired the power of forming deposits in steam generators. These deposits consist mainly of calcic carbonate, calcic sulphate, magnesic hydrate, and silica, the chemical processes which lead to their deposition in the feed-water differing in each case. Calcic carbonate, which constitutes the principal ingredient in fresh-water deposits, is thrown down in a dense form by the breaking up of soluble calcic bicarbonate under the influence of heat, and if it is nearly pure it forms a mud in the boiler, which can to a great extent be got rid of by blowing off. Calcic sulphate, however, is deposited by an entirely different action, as its solubility decreases with rise of temperature, high pressure, or great increase in the saline properties of the solution; and its wonderful power of hardening deposits and binding them together into an incrustation, which can only be removed by the use of hammer and chisel, makes it a most dangerous constituent of such deposit. This hardening power is due to the fact that it deposits from water in the form of small angular crystals, and in this form gets mixed with the calcic carbonate mud. As these crystals become heated, they lose water of crystallisation, and change their form into fine needle-shaped crystals, which bind the mass together. Magnesic hydrate, which is found in many scales, has always been supposed to be due to decomposition of magnesic chloride at a high temperature; but this is a mistake, the magnesic hydrate being produced by the interaction of magnesic chloride and calcic carbonate, which results in the formation of soluble calcic chloride, evolution of carbon dioxide and deposition of magnesic oxide, which, by combination with water, forms the hydrate. Examples were given of scales from various waters, and it was shown that fresh-water incrustations may be looked upon as consisting chiefly of impure calcic carbonate, whilst the deposit formed by the use of sea water is principally calcic sulphate. Brackish waters give incrustations consisting of nearly equal portions of these substances. The question of oily deposits on plates was next considered, and the lecturer pointed out that, according to recent researches, mere wiping of a boiler plate with a greasy rag causes a serious diminution in its power of transmitting heat, whilst with an oily deposit $\frac{1}{50}$th of an inch in thickness, plates in some cases became so overheated as to be unable to withstand the pressure upon them, and collapse of the furnace crowns sometimes ensued. The question of anti-incrustators was then dealt with, and the lecturer expressed his opinion that if manufacturers were obliged to use a hard water, the most reasonable method they could adopt was to soften it on a large scale before putting it into the boiler, as otherwise serious complications would arise in the boiler itself.

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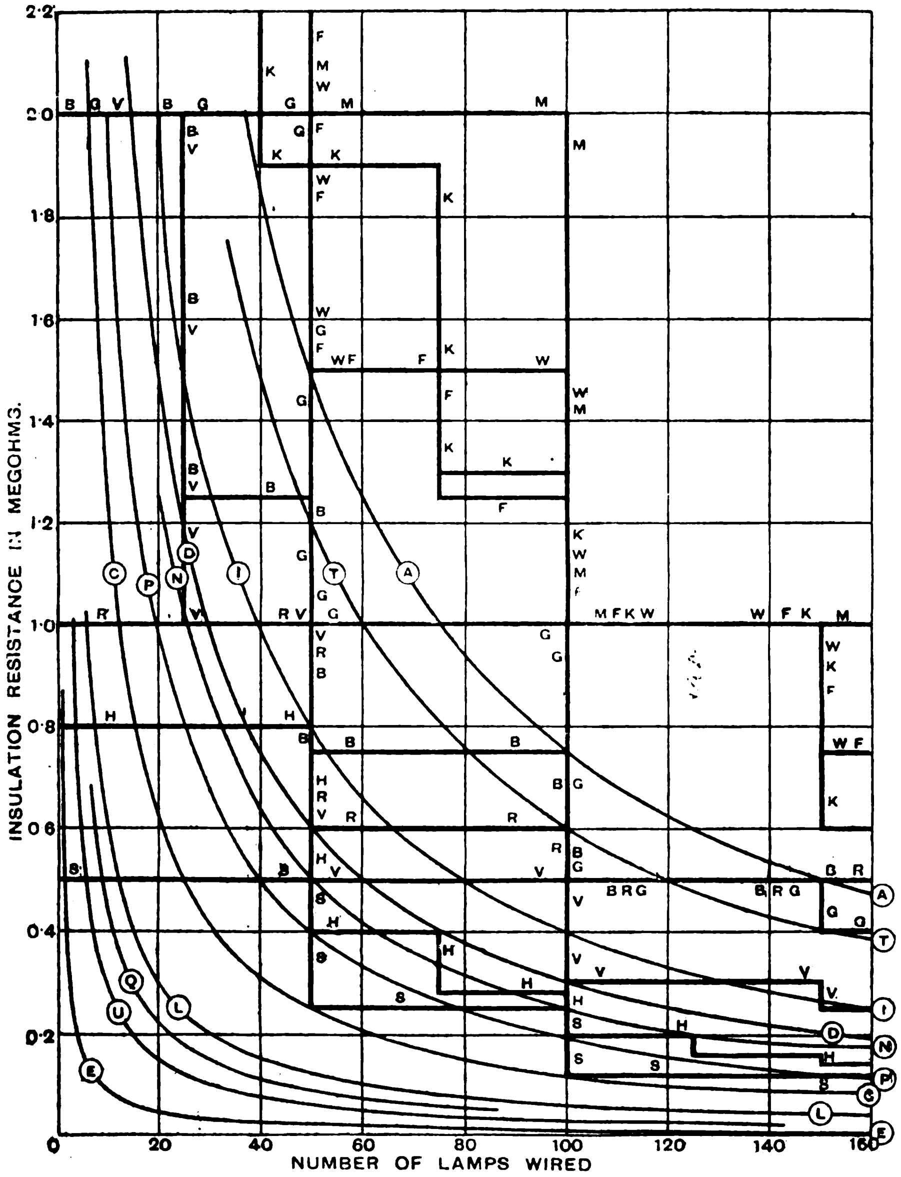
THE INSULATION RESISTANCE FOR HOUSE WIRING.

Since the publication in *The Electrician*, Vol. XXX., p. 657, of a set of curves showing the permissible variations of insulation resistance of house circuits on different systems of supply, a great many new rules have been formulated. Many of these have been published by supply companies not in existence at the time of our former article; while others are the result of the recent decisions of long-standing companies which formerly had arrived at no definite rules. Even at the present time, indeed, some of the provincial supply companies have not yet drawn up a set of rules on the subject, and are tentatively relying on the sagacity of the insurance companies. The result of a comparison of all the available insulation rules, reduced to one common standard of measurement, is given in the accompanying diagram of curves. The diagram which we published in April last gave only a few curves, and each could be clearly followed. But in attempting to make a complete collection it was evident that the diagram would be complicated, owing to their remarkable diversity as well as their occasional coincidence. The diagram thus fails to be a useful table of reference for wiring contractors, and serves rather as a symbol of the



Key to Diagram.

Index letter.	Company.	Nature of rule.
A.	City of London	75 megohms ÷ lamps.
B.	London Electric; House to House	Arbitrary insulation per lamp.
C.	Phœnix Fire Office; Liverpool Corporation; Lloyds	12·5 megohms ÷ lamps. (Doubled for alternating).
D.	Bradford Corporation	10 megohms ÷ amperes.
E.	Institution of Electrical Engineers	$\frac{1}{5000}$ part of current.
F.	Notting Hill	Arbitrary insulation per lamp.
	Kensington & Knightsbridge	do. minimum 5,000 ohms.
	Westminster	do. minimum 5,000 to earth; 75,000 wire to wire.
G.	Portsmouth Corporation	Arbitrary insulation per lamp.
H.	St. Pancras Vestry	do. minimum 5,000 ohms.
I.	Scarborough	40 megohms ÷ lamps.
K.	Chelsea	Arbitrary insulation per lamp.
L.	Leading insurance companies, including Guardian, Sun, North British, London, Liverpool and Globe, Alliance, London Assurance, Hand-in-Hand, Westminster, Royal Exchange, and others	$\frac{1}{20000}$ part of current.
M.	Charing Cross and Strand	Arbitrary insulation per lamp.
N.	Taunton Corporation	12·5 megohms ÷ 16-c.p. lamps.
P.	Brighton Corporation	20 megohms ÷ lamps.
Q.	London County Council (theatres)	$\frac{1}{15000}$ part of current; min., 5,000 megohms; max., 5 megohms.
R.	Manchester Corporation	Arbitrary insulation per lamp; min. 10,000 ohms.
S.	Whitehaven	Arbitrary insulation per lamp.
T.	Glasgow Corporation; Kelvinside	60 megohms ÷ lamps; min., 75,000 wire to wire.
U.	Chambre Syndicale des Industries Electriques	$\frac{1}{10000}$ part of current.
V.	St. James's, Pall Mall	Arbitrary insulation per lamp.
W.	Derby Corporation	Arbitrary insulation per lamp.

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prevailing chaos and a convincing argument for co-operation and the adoption of a recognised system by supply companies and Corporations.

All existing rules more or less closely follow the logarithmic law—

$$R_i = \frac{k}{n}$$

Where R_i is the insulation resistance, n is the number of lamps wired, and k is a constant about which the diversity of opinion arises. Some of the rules follow this law absolutely, giving the rectangular hyperbolæ A, I, L, U, &c., in the set of curves; others give stepped rectilinear curves which oscillate about a mean hyperbola. The choice of a constant, k, ranges from 130 down to 0·6 megohms per lamp, this latter being the rule of the Institution of Electrical Engineers. Up to date, however, no supply company or Corporation has been discovered which has put practical faith in this feeble curve, E, which clings so pathetically to its asymptotes; and the majority require a standard of insulation from twenty to one hundred times greater.

It should be observed that while the requirements of the Institution of Electrical Engineers are amply sufficient from the point of view of mere insulation to prevent danger from fire, or any serious leakage, experience has shown that a house circuit giving such a low insulation resistance cannot be sound. The rubber covering of the wires and cables is sure to be mechanically bad, liable to crack or perish, if the insulation resistance measured as a cable is less than 300 megohms per mile. This, however, hardly enters into the resultant insulation of the complete work, which depends on the quality and condition of the switches, ceiling roses, fuse boards, &c., and it is generally acknowledged that an insulation of only 6,000 ohms, that is, $\frac{1}{120}$th of a megohm, is far too low for 100 lamps.

The rules represented by the hyperbolic curves extend indefinitely in either direction, with the exception of that of the regulations for theatres of the London County Council, which very sensibly stops at a minimum of 5,000 ohms, and a maximum of 5 megohms. The hyperbolic curves in the diagram are in some cases stopped off for the sake of clearness. The stepped curves all run out indefinitely to the right hand of the diagram, but in some cases a minimum insulation is given, considerably lower than that demanded at the first test. The upper limits of some of the curves are not included in the diagram. The companies, represented by the stepped line F, viz., the Kensington and Knightsbridge, Notting Hill, and Westminster demand 2·5 megohms for 25 lamps, and 5 megohms for 12 lamps. The House to House Company and the Charing Cross and Strand Company ask for 5 megohms for 10 lamps; while the Chelsea Company expect 2·4 megohms for 40 lamps, 3·1 for 30, 4·6 for 20, and appear to be satisfied with nothing less than 8·4 megohms for 10 lamps.

For 60 lights, a good average number, the various authorities stand in the following order, and demand the following insulations:—

	Megohms.		Megohms.
Charing Cross & Strand	2	St. James & Pall Mall } Bradford .... }	0·5
Chelsea	1·9	Taunton	0·416
Notting Hill } Kensington and Knightsbridge } Westminster } Derby }	1·5	St. Pancras	0·4
		Brighton	0·33
		Whitehaven	0·25
City of London	1·25	Phœnix } Liverpool } Lloyd's }	0·21
Portsmouth } Glasgow } Kelvinside }	1		Ohms.
		Leading insurance Co.'s	100,000
London } House to House }	0·75	London County Council	70,000
		Chambre Syndicale ...	50,000
Scarborough..	0·66	Institution of Electrical Engineers	25,000
Manchester	0·6		

In the stepped curves there is exhibited considerable diversity of opinion as to the range in the number of lamps over which it is considered advisable to allow the same insulation resistance. In curve H of the St. Pancras Vestry the range is everywhere moderate, so that the quality of the work need not be affected by any consideration of the number of lamps to be wired. But in curve M of the Charing Cross and Strand Company the ranges are very large indeed, and as it is possible for a consumer with 50 lamps to get off with precisely the same insulation as the consumer with 99 lamps, there is a tendency to pass inferior workmanship and materials in the former case. Narrower limits of range of constant insulation resistance are to be recommended in the majority of these stepped curves, making the steps more numerous and less deep.

Many of the stepped curves overlap completely within th limits of the diagram, in which cases the curves are lettered wit the several index letters of the supply companies referred to a the foot of the diagram. Many, too, overlap during only a par of their length, in which cases the overlapping parts ar lettered with the index letters of the supply companies whos rules thus partially coincide. By following the course of an one index letter, the path of the corresponding curve may easil be obtained. The simple hyperbolæ are marked by letters er closed in circles, to distinguish them from the plain letter marking the stepped curves.

The majority of authorities specify the insulation accord ing to the number of lamps; one or two specify 16-c.p. lamp and a few take amperes instead of lamps. The curves ar drawn on the basis of 8-c.p. lamps, taking three to an amper and at 100 volts. The size of the lamp does not appear to u to have much to do with the insulation of the wiring. Ther seems to be no reason why a branch, with its fuse and switc for a 100-c.p. Sunbeam lamp, should have an insulation resis ance some twelve times greater than a branch carrying a 8-c.p. lamp.

One company, and one only, so far as we know, has nc deemed it advisable to adhere to any fixed scale, but prefers t leave it to the judgment of its wiring inspectors. This the Metropolitan Company, who, we understand, have exper enced no trouble in the matter; the wiring contractors hav been ready to acknowledge defects where these have been di covered, and only in rare cases has an appeal been made t insurance companies or to the owner of the property, and th with immediate and satisfactory result.

While the great diversity of the rules revealed by glance at our diagram calls loudly for some mean to whic wiring contractors can accustom themselves, the experience o so wide spreading a company as the Metropolitan compels us t consider the wisdom of binding all concerned to certain figure which even if they are the expression of a logarithmic formula are purely arbitrary. The insulation resistance of a house ci cuit, after all, has, as we have observed, little if anything to d with the quality of the cable, but is a measure of the moistur on the surface of cut-outs, lampholders, switches, and wall The effect of weather is familiar to every wiring contractor, an when the inspector is allowed no discretion for atmospheri conditions or for the length of time during which the wirin and fittings have remained unused in an unoccupied hous injustice may be done to good work, and a conscientious co tractor may suffer. We have known a very poor insulatio brought up to the mark by leaving a testing battery, givin over 100 volts, on the wires all night, before the inspector' test; and we have known switchboards to have been toaste with coke fires, a most dangerous proceeding, for the same pu pose. In cases of damp due to fogs or rain and not to ne plaster, the supply company might allow connection to b made, putting a lamp in series with each main, for a few hour before a final test.

AN ENGINE BUILDING RECORD FOR 1893.

The records of the year's work which we receive from many electrical firms consist to a great extent of accumulations of small work, and they are almost invariably confined to the manufactures and work of these particular firms; nor is it possible, even by selecting the larger items thus furnished, to obtain a record of the work of the year. Some information which we have received from Messrs. Willans and Robinson is, however, of a different character. Manufacturing no dynamos or other electrical plant themselves, a larger number of dynamos pass through their hands than is the case with any other engine builders in this country. The singularly close connection between the Thames Ditton Works and the dynamo-making industry is accounted for by the direct driving and consequent mounting of dynamos on the same bed with the engines.

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Many other engine makers rarely see the dynamos which are to be driven by their engines, and do not come into contact with the dynamo builders. We make no comparison between the business done by this firm and by other engine makers; the columns of the tables issued with our last number are sufficient to show the popularity of Messrs. Willans and Robinson's work, and their order book undoubtedly serves in large part as an index to the year's central station work.

The apparent ignorance which exists about the position attained by the Willans engine on the part of those who might be expected to know all about it is rather curious. Only last week our contemporary, the *Engineer*, lamented that up to the present no engine builder has produced an engine "capable of running with absolute steadiness with variable loads for a period of about 14 hours, during which it cannot be stopped for an instant. . . . It is not enough that the engine shall comply with the conditions for six months or a year; it must *always* do so." It might be thought that in this connection the Willans engine would be at least alluded to, but it is not, and, indeed, the references to modes of failure seem to show that the writer has open or double-acting engines only in view. The *Engineer* is even "certain that there is not one engineer in charge of a central station of any importance who will not fully endorse what we have said," and our contemporary then chides the station engineers, who "either lack the ability or the confidence to dictate to the mechanical engineer or engine builder, and take very much what the latter place before them." Now there is no doubt that station engineers have still plenty of difficulties to contend with, but we should like to hear whether engineers such as Prof. Kennedy, who has the responsibility for great stations like those of the Westminster Company, or that at Glasgow; Mr. Preece, with his years of experience with what are nothing less than large central stations for Post Office service, and his more recent experience at Bristol; Mr. Shoolbred, in respect of the large installations at Bradford and at Brighton; Prof. Henry Robinson, who can speak for such stations as St. Pancras and Norwich; Messrs. Holmes and Vaudrey, with their great experience of central-station engines at Liverpool and at Birmingham; Mr. Sydney Dobson, of the St. James's and Pall Mall Company; or the engineers of the Kensington and Knightsbridge or of the Chelsea Companies—would agree that the running of their engines ever enters into their heads as a subject of serious difficulty. In all the cases named the English single-acting engine, *i.e.*, the Willans engine, is used; the troubles and doubts which the *Engineer* gives voice to come from America or from the Continent, where they have only lately broken loose from the—in England—well-nigh obsolete plan of belt or rope driving, and where they are unacquainted with a really good single-acting engine for direct coupling, and have consequently been driven to the costly and unsatisfactory plan of making huge slow-running dynamos merely for the sake of coupling them to slow-running engines.

The works at Thames Ditton are almost wholly devoted to the making of engines for electric lighting, so much so that new works are about to be erected for the making of engines for other purposes, chiefly large engines for driving cotton and flax mills. The first point of interest, then, for the electrical engineer, is found in the rapid development shown by the following figures:—

		H.P.
Engines ordered in	1891	11,100
„ „	1892	14,300
„ „	1893	18,950

These speak well for the electrical industry in times of deep depression. It will be remembered that the firm makes very few small engines—*i.e.*, small in the sense of horse-power. There are few below 80 H.P.; in fact, the average size for the year 1893 is about 128 I.H.P.

The year's work includes the erecting and starting of engines, ordered previously, in the following stations:—

	H.P.		H.P.
Bristol	1,440	Dundee	660
Glasgow	1,210	Norwich	300
„ (Kelvinside)	270	Naples	400
City Lighting Company, Bankside Station	1,440	Hobart Tramways, Tasmania	600
Carnaby Street, London	1,060	Knightsbridge	360
		Whitehaven	240

to which a private station of the North Western Railway, at Crewe, deserves to be added, with 384 H.P.; and the very notable installation at the Small Arms Factory at Herstal, in Belgium, where a 300-H.P. Willans engine was supplied, in addition to a Corliss 500-H.P. engine, to generate current for the motors by which the whole of the shafting and machines are driven. The Corliss engine came from the famous shops of Messrs. Vanden Kerchove, of Ghent, and it is noticeable that this is one of the two firms who have since become licensees for the manufacture of the Willans engine on the Continent. The engines above enumerated amount to nearly 8,700 H.P., irrespective of a great many smaller orders carried forward from the preceding year.

The principal central-station orders received during 1893 were from, or on account of, the following:—

	H.P.		H.P.
Liverpool Company	1,920	Chelsea Company	200
Westminster Company	1,160	Nottingham Corporation	650
Brighton Corporation	720	Aberdeen Corporation	320
Birmingham Company	200	Lancaster Corporation	400
St. James's and Pall Mall Co.	550	Hampstead Vestry	860
Bradford Corporation	400	Warrington Corporation	270
St. Pancras Vestry	400	Dewsbury Corporation	400
Bristol Corporation	720	Nelson Corporation	135
Glasgow Corporation	720		

The following private stations deserve enumeration:—

	H.P.		H.P.
General Post Office	400	Royal Albert Docks	600
Lancashire and Yorkshire Railway (Victoria Station, Manchester)	300	Southampton Docks	240
		Birmingham Grand Hotel	180
		Holborn Restaurant	400

Not much has been done yet for Continental lighting stations, but the following may be named:—

	H.P.		H.P.
Rotterdam	400	Caen	270
Biarritz	180	Naples (already mentioned)	400

The above figures account for nearly 13,000 H.P. out of the (approximately) 19,000 H.P. ordered during 1893. The remainder is for minor installations, and for miscellaneous work other than electrical. Of the 13,000 H.P., over 7,000 H.P. is in the form of repeat orders from those who are already users of the Willans engine.

It will probably be agreed that there is more satisfaction in the foregoing figures, furnished by one firm of engine builders, than in the aggregated returns of many electricians, and it is additionally satisfactory to be able to add that the prospect of orders for the Spring is said to be excellent, and to promise at least as much increase over the figures of 1893 as that year showed over 1892.

Messrs. Willans and Robinson are amongst the few English engine makers who exhibited at Chicago. They put down two condensing engines, one of 360 and the other of 135 I.H.P., to drive two of the lines of shafting in the British section; the third line was driven by a horizontal engine, of about the same power as the largest Willans engine. Owing to an accident the Willans engines, for about two months, had to drive the whole of the shafting in the British section and a part of the German section, and it was officially reported that there had never, from the time of starting, been a break-down or a stoppage of either engine. It was said that this statement could scarcely be made of any other engine in the exhibition, owing, we understand, to the great quantity of water which passed through the steam pipes, and which led to many breakdowns; the Willans engines, from their position, were singularly exposed to this danger, but they escaped entirely. By permission of Messrs. Siemens Bros. and Co., Messrs. Willans and Robinson also exhibited a combined plant consisting of a fine Siemens dynamo and compound Willans engine of 300 I.H.P., being one of the sets belonging to Messrs. Siemens' own station at Woolwich. This plant was in constant use, and attracted great attention; it is unfortunate that it was not possible to compare it with American plants of similar size. We feel no doubt that, both as regards efficiency and economy, it would have given results very surprising to American engineers.

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THE CHANGES PRODUCED IN IRON BY ITS PERMANENT DEFORMATION WHEN COLD.

According to leading authorities iron exists in two allotropic states, which have been called by Osmond α-iron, or soft iron, and β-iron, or hard iron, and some recent experiments of M. Georges Charpy, recently published in the *Comptes Rendus*, tend to corroborate this theory. M. Charpy experimented upon more than 300 bars of different kinds of iron, differently tempered, annealed, or hammered. To all these samples M. Charpy applied tensile stresses by means of Col. Maillard's machine, the elongations produced being automatically registered, and he invariably obtained one or other of the two

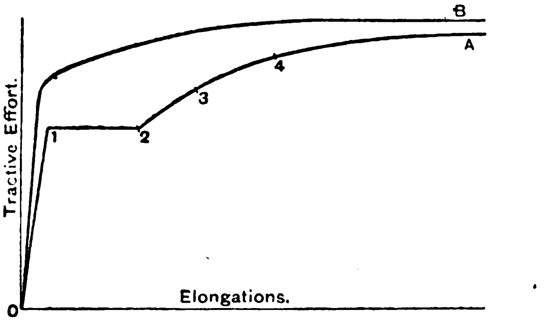

FIG. 1.

curves shown in Fig. 1. Curve A, with its well-marked step, was always obtained with, and only with, annealed iron or steel. Curve B was given by hammered or tempered steel and iron, and by other metals. The remarkable elongation which takes place in the case of the brands giving curve A leads one to suppose that it corresponds to a change in the state of metal itself, and therefore in all its properties. M. Charpy, therefore, experimented with a view to discover whether the residual magnetism curve also showed a step. Bars were submitted to tensile stresses, and at the points 1, 2, 3, and 4 the bars were taken out and magnetised, the residual magnetism being measured 24 hours afterwards by means of a ballistic

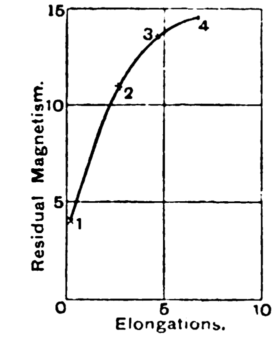

FIG. 2.

galvanometer. The following are some of the results obtained, the residual magnetism curve of series II. being shown by us in Fig. 2.

Numbers.	Tractive effort. Kg. mm^{2}.*	Permanent elongations. mm. per 10cm.	Residual magnetism (scale divisions).	Residual magnetism after annealing.
	Series I.—Soft Iron.			
1	25·20	0·0	2·5	1·0
2	25·20	1·6	4·8	1·5
3	31·10	4·3	6·5	1·2
4	33·60	6·0	6·5	1·5
	Series II.—Extra Soft Steel, 0·12 per cent. Carbon.			
1	34·2	0·2	4·0	3·5
2	34·3	2·7	11·0	3·5
3	35·5	4·7	13·5	3·5
4	41·1	6·8	14·5	3·5
	Series III.—Medium Hard Steel, 0·5 per cent. Carbon.			
1	35·5	0·0	8·0	3·5
2	38·5	1·3	14·5	4·0
3	41·0	2·9	17·0	4·0
4	52·5	4·6	17·0	3·5

* 1 kilogram per sq. mm. = 0·6 ton per sq. in.

The last column gives the results obtained by reheating pieces of the same bars up to 800°C. and remagnetising them; this latter experiment being carried out with samples taken from the bars, the absolute values obtained are not, of course, comparable. It was ascertained, moreover, that the metal, when submitted to tensile stress after annealing, again gave a stepped curve. It was possible, therefore, by a successive stretching and annealing, to make the step disappear and reappear five times in the same bar. It will be seen by Fig. 2 that the residual magnetism increases greatly during the straight part of curve A, Fig. 1.

THE PARIS CENTRAL TELEPHONE EXCHANGE.

At the present moment Paris is served, and by all accounts not very satisfactorily, by 12 telephone exchanges. The number, however, is to be ultimately reduced to four, viz., (i.) Rue Gutenberg, 6,000 subscribers; (ii.) Avenue de Wagram, 3,000 subscribers; (iii.) Rue de Belleville, 6,000 subscribers; (iv.) an exchange to be erected on the left bank of the Seine. In some articles appearing in *L'Electricien* in December last, M. Em. Dieudonné describes in great detail the large new exchange which has just been completed in the Rue Gutenberg, an exterior view of which is given in Fig. 1. The building consists of a basement, ground floor, and four stories, on each of which there is a spacious hall 215ft. long by 33ft. broad. The first floor is devoted to the apparatus connected with the inter-urban wires and the auxiliary exchange wires. The second floor is taken up by a 6,000-subscriber multiple switchboard. The third and fourth stories are still unoccupied. The building is lighted throughout by arcs and incandescents supplied with current from the municipal station at the Halles, the lighting of the operating hall being supplemented by sunlights. The entire building is ventilated and warmed on the Anthony system. In the basement a fan sucks in a supply of air from outside, which is passed over hot-water pipes to a humidifier composed of a series of rotating iron discs arranged close together on a common axle, the lower portions of the discs dipping into water. This warm, moist, purified air is then distributed under pressure to all parts of the establishment, which requires on an average over one million cubic feet of air per hour. As will be seen by the view given in Fig. 1, the front of the building contains a considerable amount of glass; to mitigate the cooling influence of this expanse of glass in wintertime a special hot-air pipe is run along each gallery close to the glass, which is thus constantly swept by a stream of warm air.

The telephone cables employed in Paris are of three kinds, viz., 100-conductor lead-covered cables, 14-conductor lead-covered cables, and Fortin-Herrmann cables, *i.e.*, cables insulated by prepared wood beads, and enclosed in a lead tube. The cables terminate in succession at hermetically-sealed boxes, called "terminal boxes." These boxes (Fig. 2) have on their faces two horizontal rows of insulated terminals, which project into the interior. To the inside ends are connected the conductors coming from the outside cables; to the outside ends are connected the wires running to the "distributor."

The terminal-boxes are not only used inside the exchange, but outside at certain points in the subways, where they play an important part in keeping up the insulation of the lines. A small pipe will be observed coming out at one end of the box (Fig. 2); into this a pipe forming part of a compressed-air system is fitted. The compressed air is taken from the Popp mains, and after having been passed through a series of boxes filled with pumice-stone or some other desiccating material it is forced into the terminal-boxes.

From the terminal-boxes the wires run to the distributor, where all the necessary rearrangements of the circuits are effected. The distributor, which is not at all unlike a wine-bin in appearance, consists of vertical and horizontal metallic pillars, terminal boards, such as the one shown in Fig. 3, being attached to them. The cables coming from the terminal-boxes pass to the terminal boards of the distributor, and thence onwards to the switchboard upstairs.

In many countries the subscribers are given magnetos to call up the exchange with; in Paris Tudor accumulators are used for that purpose. The exchange microphones are worked by block-cells, and the subscribers' by Leclanché cells.

The multiple switchboard was invented in 1880 by Messrs. Haskins and Wilson, of Chicago. How telephone exchange work was carried on before the introduction of this great improvement is graphically detailed by M. Dieudonné:—(1) The subscriber first of all rang up the exchange, and awaited the answering ring. He then gave his order and hung up his receiver. (2) The exchange operator then rang up the member asked for, and afterwards the asking member. (3) After having joined the two subscribers, the exchange operator listened to hear if conversation was commenced. (4) On the termination signal being made, the exchange operator again listened to make sure that the conversation really was over. But this was not all. All the wires running into the exchange did not terminate at one and the same

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board, sufficiently small to allow the exchange operator, without appreciable effort to connect any two subscribers together. Sometimes the annunciators of two subscribers were a long distance apart, and to connect them together consequently required long

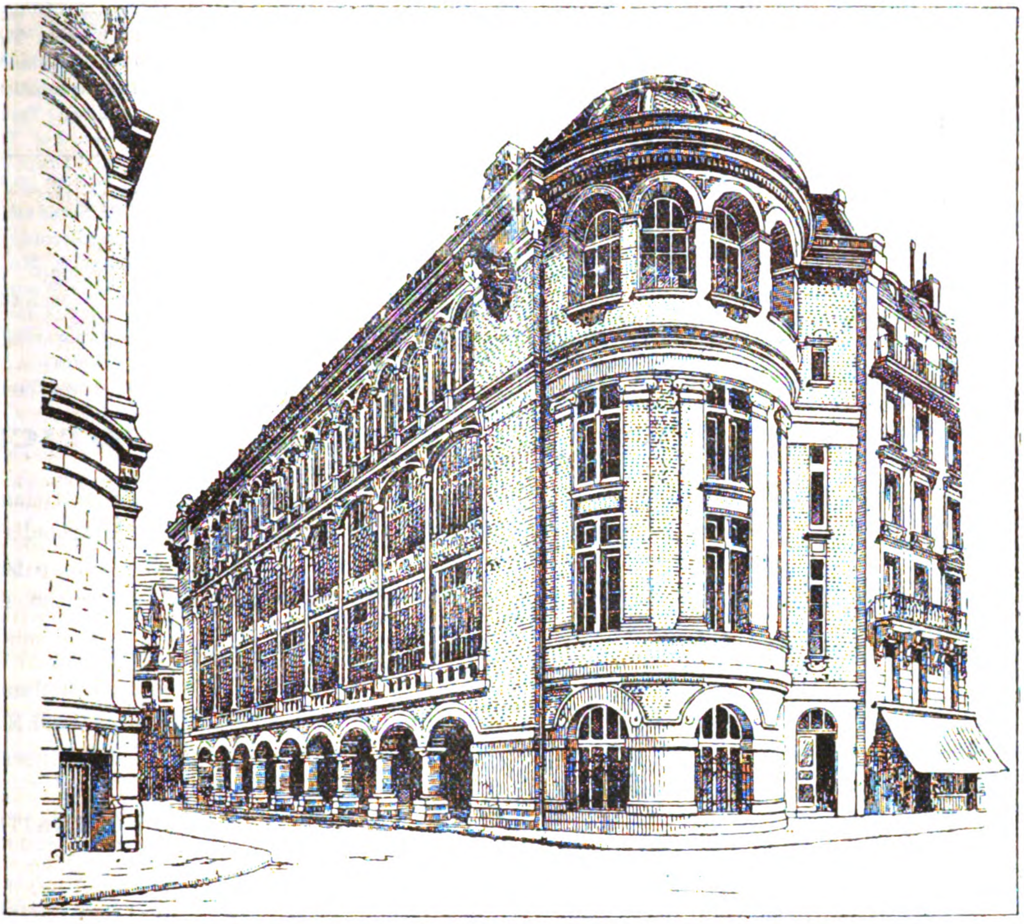

FIG. 1.—The Paris Telephone Exchange.

lengths of flexible. Subscribers attached to two different exchanges can only be joined up by means of inter-exchange wires. These inter-exchange wires ran to a special board at each exchange, the

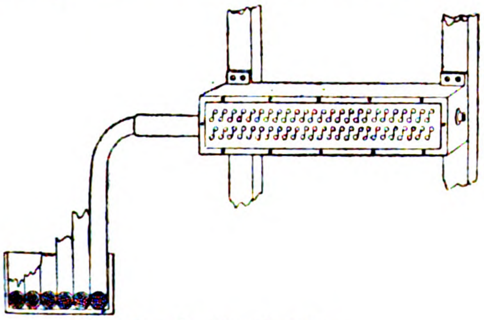

FIG. 2.—Terminal Box.

wires of the exchange subscribers being also brought to a subsidiary board. The result was that at busy times there was such a profusion of flexibles, and such a tangled network of wires, that circuits were frequently unintentionally broken, giving rise to lively

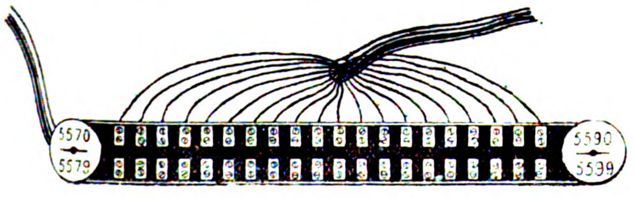

FIG. 3.—Terminal Board.

complaints. Whoever, remarks M. Dieudonné, has witnessed the spectacle, retains an indelible recollection of it; there was such a tumult of discordant noises that one almost thought one was in an aviary!

The introduction of the multiple switchboard has, however, brought peace to the land of telephony; not only has it enabled us to greatly reduce the number of our exchanges, in the majority of cases one single exchange sufficing, but it has made the connecting together of subscribers both simple and rapid. The principle of the multiple switchboard is merely to divide up the switchboard into panels of dimensions sufficiently small to enable the exchange operator to work it by means of the usual plugs and flexibles, and sufficiently large to accommodate the spring-jack terminal of *every* subscriber to the exchange. A subscriber's wire thus runs in succession to its appropriate terminal on *every* panel of the entire board, and finally to the panel containing the annunciator. Each exchange operator has, therefore, within reach the spring-jack terminals of *all* the exchange subscribers, a certain number of whom have their annunciators worked at each panel, and the operator can, therefore, without further ado, and without moving from her seat, connect up any two exchange subscribers.

The multiple switchboard in the Rue Gutenberg consists of 23 sections, 240 subscribers being allotted to each operator; there are also two sections devoted to inter-urban lines, 10 sections devoted to inter-exchange lines, and three sections devoted to suburban exchanges. The connecting-up of all these sections necessitated more than one million soldered joints.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

SATURDAY, January 13th.

ASSOCIATION FOR THE IMPROVEMENT OF GEOMETRICAL TEACHING.

11 a.m. General Meeting at University College, Gower-street.

2 p.m. Afternoon Meeting, when Papers will be read.

TUESDAY, January 16th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper will be further discussed: "The Concentration and Sizing of Crushed Minerals," by Mr. Robt. E. Commans, Assoc.M.Inst.C.E.

WEDNESDAY, January 17th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read: "White Lead Substitutes," by A. Laurie, M.A.

ROYAL METEOROLOGICAL SOCIETY.

8 15 p.m. Annual General Meeting.

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The Electrician.

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SPECIAL NOTICES.

We shall shortly issue with "The Electrician" a COLOURED MAP, showing the Streets in the Metropolis in which Mains for Private Lighting are actually laid, up to January, 1894, together with the areas allotted to the different Supply Companies.

In an early issue will be published a fine STEEL-PLATE PORTRAIT of Mr. ALEXANDER SIEMENS, President for 1894 of the Institution of Electrical Engineers.

STEEL-PLATE PORTRAITS

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TELEGRAPH STATISTICS.

Although the electric telegraph has been in existence now for half a century, and has attained to amazing proportions, the statistics of its growth are singularly meagre, and, perhaps, even more singularly complicated; not that the materials are wanting either in authenticity or detail, but they vary so much in method of collection, in data upon which the figures are based, and in diversity of usage in different countries, that any general or instructive comparisons are, as yet, beyond our reach. Such, at all events, is the case as regards overland telegraphy. With the cable lines the information, if supplied, would be of a simple and more uniform kind, one reason for which is the proprietorship being largely in the hands of one nationality and the working more nearly identical. But on land each country has not only peculiarities of its own in respect of apparatus, but also of valuing its telegrams, apportioning its receipts, and assigning its expenses. Add to this the circumstance that in some countries—notably France and Germany—the revenue, as well as the staffs, have been mixed up with those of the postal service, and it will be seen that financial comparisons can be matters only of estimate and conjecture. For the smaller matters of percentages, per head and per mile, the

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professional statistician will be able, as usual, to prove anything he pleases, according as he does or does not allow for the fulness of the land or the emptiness of the heads which he is counting up.

For what it may be worth, however, and as an instalment of something better to come, we lay before our readers this week a table of telegraph statistics which has at least the merit of novelty. It is compiled chiefly from the Official *Journal Télégraphique* of Berne, and, with due allowance for the explanatory and qualifying notes accompanying the table, may be accepted as the most trustworthy account of the facts hitherto obtainable. Without these notes the respective items would sometimes appear unaccountably conflicting. For example, the disproportionate staff of Great Britain and Ireland includes nearly 60,000 persons described as temporary *employés*, a description which can only apply to unattached agents of the service, who can only be fairly included on the supposition that the corresponding agents in other countries are also counted in—which seems unlikely. Again, as regards appliances, the telephone is in some cases included under the head of "other systems," but excluded elsewhere. The wires and instruments—possibly the offices as well—pertaining to the railways are not reckoned in some of the countries, notably the British railways, which own a tremendous property of that kind; whilst in other countries where the State owns the railways, wholly or partially, the railway telegraphs appear to be embraced in the total. The same observation applies to the telephone system, whose independence or nationalisation is still far from being uniform throughout Europe. Some clue to the closeness of the connection between the Telegraphs and other State departments, including railways, is furnished by the number of service messages, which in France reaches a prodigious total, Germany being a bad second. It is to be regretted that no figures under this head are furnished for the British telegraph; if railway messages which are sent free were treated on the same principle they would be counted as "service," and together with other departmental telegrams, including postal, would make up a total that would run that of France rather close.

Searching for details of a more practical kind, we should be inclined to single out the figures relating, first, to the "length of conductors"; second, the number of "instruments"; and lastly, the "number of telegrams." Length of line signifies very little except as indication of extent of territory covered. As a rule the conductors average three times the length of line; and we note in passing that this average has been attained even in British India, a striking testimony to its commercial development, although, of course, the number of offices, judged by population or mileage area is significantly small. In Belgium, however, a compact little country, the conductors are nearly five times the length of lines, and in Holland about four times. In the British Isles the proportion is still greater, the available wires being more than six times the length of the geographical mileage; and to this we may add a still greater carrying capacity due to the larger use made of fast speed and multiplex instruments. As regards instruments, a criterion which we take to be of more importance than the number of offices, Germany, with its population of forty-nine and a-half millions, is the only country that approaches Great Britain and Ireland, with a population fewer by ten millions. But when we examine the systems, it is found that the Morse is three times more numerous in Germany, whilst its "other systems" are almost entirely represented by telephones, whereas those of Great Britain are represented by instruments as rapid as the Continental type of Morse, and include some 600 of the fastest instruments that science or ingenuity has yet devised. It is interesting to note, however, that these high-class appliances are gaining favour on the Continent, and present quite a respectable figure in such countries even as Italy and Norway.

The gross totals of telegrams dealt with by the respective countries would furnish material for a small volume of annotations and inferences if all the varying conditions and circumstances of the several countries could be fairly taken into account and justly estimated. But the result, after all, might not be particularly edifying. For the present the facts alone concern us; the inferences may be left to those who are in need of them. How hazardous they may be on the one hand, and how attractive on the other, is shown by the column of averages under "General Information." Victoria, it seems, sends nearly twice as many telegrams per head as any European country. A good deal depends, as we said before, on the heads. They must be few in number in Victoria, and of superior quality. A more substantial fact set forth in the Table, and not resting on any averages, is, that inland telegrams number in this country about twice as many as in France, and three times as many as in Germany. Our foreign telegrams—excluding, however, those dealt with entirely by the submarine cable companies—are outnumbered by those of Germany, but exceed those of France. The same observations would seem to extend to the financial side of the account; but here so many considerations remain clouded under the official veil that we hesitate to make comparisons, much less draw conclusions. British Indian telegraphs appear to be paying their way handsomely, owing, doubtless, largely to its great transmitted traffic between west and east, and Australasia. Of European countries Switzerland seems to be the only one that is counting its telegraph as a paying concern. Possibly the same may be said of Sweden, though not of Norway. In conclusion, we have only to remark that while we are thankful for the information placed at our disposal by the Bureau International something more is expected. Particulars as regard some other countries are still wanting; and above all, the figures supplied ought to be based on one uniform method applicable to them all, and should plainly distinguish between State telegraphs as such, and telegraphs which are not of the State.

THE NEWPORT TENDERS.

Copies of the specification for the Newport municipal electric lighting plant, and a report on the tenders, have been handed to us by Mr. R. Hammond. The specification does not call for any special remarks. It relates to the complete plant for an alternate current station, with continuous-current arc lighting. Few details are given, and no promise of the surprise that was to follow in the report. The second page of this curious document contains the following passage:—"The specification throughout was drawn by me in such a manner that, though the quality and capacity of each piece of apparatus was clearly defined, there was no limitation as to type, so that no manufacturer of high-class apparatus was excluded from tendering." The obvious interpretation of this is, that had Mr. Hammond attempted to go into details, he would have described a class of plant which no manufacturer of high-class apparatus would care to touch. But perhaps he did not mean this. He then proceeds to explain the rules of an interesting game which he calls an appraisement, or system of adjusted prices.

The whole of the rules are unfortunately not given, much being left to imagination. Where a contractor has misunderstood a specification, or where deviations are made subsequent

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to its issue, adjustments of price, not of an artificial but of an actual character, are not unusual. An artificial system is carried out here through nearly every section. The method reminds us of the old method of rating and time-allowances of yachts. The length (minus three-fifths of the breadth) was multiplied by the breadth, and again by half the breadth, the product was divided by 94, and this gave the tonnage. Much more arithmetic followed, which we need not describe, but nothing was left to judgment; for the practice of making allowances for the skill of the captain and the income of the owner was never definitely adopted. Instead of simply recommending one tender in each class, with or without reasons, one tender is selected, generally without any given reason, as a standard, and then, by a succession of purely arbitrary credits and penalties, odd sums are added to or knocked off from the other tenders, until an entirely new set of prices are arrived at. These prices are not to be paid to anybody, they are only part of the game.

In the first section on boilers, the Davey-Paxman Economic is selected for the doubtful honour of acting as a standard. The first move of this pastime is to credit all Lancashire boilers with £37. 10s. "for superior accessibility and permanence as compared with" the unhappy standard. Mr. Hammond thinks that two of them have "better evaporative surface," and credits them with £15 each, and so on. The standard appears to be blamed for having long tubes, and "suffers," at least so Mr. Hammond thinks, from the position and arrangement of its tubes, and access for cleaning, &c. "Freedom from priming," as judged from the tenders by Mr. Hammond, is reckoned as worth £100 in several cases, and "means of access" as £60. Messrs. Fowler and Co., of Leeds, do not get a place in the first handicap.

The engine section reveals the full fun of Mr. Hammond's manipulation. A casual glance at these pages at first suggests that they have something to do with mechanical engineering, but closer examination only reveals more of these arbitrary and rather childish "adjustments." Bearing surface is penalised or credited at £1 per square inch, volume swept out by pistons per minute at 5s. per 1,000 cubic inches, and mechanical efficiency at £2 per annum for 1 per cent., or £30 capitalised, and so on. After all adjustments in this section, Messrs. Fowler and Co., of Leeds, come out worst, being nearly £850 higher than the lowest tender. By an odd trick of this game the standard engine, after all this nonsense, is finally recommended, as a set off, perhaps, to the boiler section, for it is that of Davey Paxman.

Section D on dynamos ought to have been interesting, but the author was wearying of the thing, and gives no details. If a bonus and penalty system had been candidly stated in the specification, as was done by Dr. J. Hopkinson for Manchester, to be decided, not by the mere off-hand assertion of Mr. Hammond, but by actual test, there would be some reason in the idea. When a consulting engineer attempts to do something more than give advice, to select, and to recommend tenders, and begins to teach manufacturers their business, or, as in the case of Prof. Forbes, to take it out of their hands and to do it for them, he is likely to attract criticism, and his critics will be men who have spent their lives in practical work in different departments. Adjustments such as those pretended in the Newport report would not be without interest if they were based upon experimental data, but to make them on sundry items in the tenders, when no hint of such adjustments was given in the specification is simply throwing dust in the eyes of the Newport Corporation. The specification having invited all kinds of alternators, and containing nothing whereby any "manufacturer of high-class apparatus was excluded," the report proceeds to disparage all alternators with revolving fields, and this is the reason. "As regards the point of mechanical strength, it is obvious that the class of machines in which the armature rotates can, on account of the lightness of their moving parts, safely be made much lighter and more cheaply than those in which the magnets form the rotating part. For the same reason they can be run at a higher speed with equal safety." So Mr. Hammond seems to like a light, cheap, fast-running machine! We are almost compelled to reconsider our views about that sentence on the second page. To support this choice, which was not hinted at in the specification, lists of towns using the two kinds of alternators are given. No figures of merit are appended to these towns. Brighton is one; one of Mr. Hammond's pioneer stations. It might have been marked "goodwill, £5,000; plant *nil*." Whether the adjustments in this section take account of the colour of the paint or the weight of the oil cups we do not know. Messrs. Fowler and Co. come in first this time. Tenders for continuous-current arc lighters were invited, and for lamps to suit the arc lighters. Two pages are devoted to discussion of Messrs. Ferranti and Co.'s rectifying apparatus, and at the end, *apropos* of nothing in particular, it is announced that Messrs. Fowler and Co. have won again. This firm's tender for a switchboard is more than twice that of Messrs. Crompton and Co., who, however, are not in the running; perhaps there were no ornamental corners on their tracing. Siemens and Co. are close to Fowlers; "between these two boards, however, I must leave the Committee to judge, as I am naturally somewhat prejudiced in favour of the switchboard of which I have had such satisfactory experience over so many years." This is admirable candour, but why deal with the switchboard alone in this manner? Why not apply the same briefly and in a straightforward manner to the whole job? The section on arc lamps finds Crompton and Co. lowest after the "adjustment" business has been done, but the specification is thrown over, for "the first step, however, is to write to each tenderer asking him the cost, if any, of the substitution of an alternating-current lamp for a continuous-current lamp." Messrs. Crompton and Co. are recommended for culverts, but not without some sneers about the field being new to them, and the information that the pattern of one of the iron boxes "is one which I had a hand in designing some years ago."

After all this tedious business a general summary is given, not of the lowest, or "adjusted," or recommended tenders, but of "the prices at which good apparatus can be obtained under each section." The total comes to £22,564. The totals of the four firms who tender for all sections stand thus:—

Fowler	£24,480
Brush	24,203
Siemens	23,886
Crompton	20,789

The game is not over. There is one move more. It is all on the last page. "It is interesting to compare this figure with the price at which four of the tenderers have expressed their willingness to undertake the whole contract, viz.:—

Brush	£24,203
Siemens	23,500
Fowler	23,384
Crompton	20,780
Average	£22,966"

With a rather unpleasant remark, Messrs. Crompton and Co. are bowled out, and the rest of this extraordinary report

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considers "the policy of giving out the whole of the contract to one firm," and "the many advantages accruing to this plan." The result of the whole thing is that at a special meeting of the Corporation on Tuesday last the Electric Lighting Committee recommended that the tender of Messrs. JOHN FOWLER and Co. be accepted, but it was decided by 21 to 11 votes to refer the matter back, and to hear Messrs. CROMPTON and Co. as to the details of their tender. If the report had consisted of the last page alone, Mr. HAMMOND would have had an excellent reason for recommending Messrs. FOWLER and Co., on the grounds given in the switchboard section, to which we have alluded.

OBITUARY.

HEINRICH HERTZ.

Not a student of physical science on the planet but will realise and lament the sad loss conveyed by the message, "Hertz is dead." After thirty years of study and preparation, he achieved his great discovery in the comparative quiet and isolation of Karlsruhe, and now, only a few years later, his work for the human race is over, and he has entered on a new career.

Ever since he went to Bonn he has been ailing; he was never strong, apparently, as a child, and his friends have long been anxious about him. A little time ago he seemed to be mending, and we heard better accounts; but since the serious winter began he grew worse, and with the incoming of the new year he passed out of our ken, not yet thirty-seven years of age.

It is not the time to attempt a critical estimate of his work. The greater part of his short life was spent in thorough equipment of himself for the successful quest of the unknown among the most solid and difficult branches of science. Up to the age of twenty-one he studied as an engineer—an admirable training for a physicist, as many can testify. Then he graduated at Berlin, and became assistant to von Helmholtz. Here the writer first made his acquaintance thirteen years ago, when, on calling upon the distinguished professor of physics at the University of Berlin, Hertz did the honours of the laboratory.

During the years at Berlin he published many investigations and theses of a weighty, not to say ponderous, order, and became known in strictly scientific circles as a learned and rising physicist of whom much might reasonably be expected. In 1885 he became Professor at the Technical College of Karlsruhe, and in 1889 he received his call to succeed Clausius in the University of Bonn. But it was during an investigation begun in 1887, at the instance of Prof. von Helmholtz, on some obscure phenomena occurring in induction coil circuits that led him to that brilliant series of experiments which have immortalised his name, and may even be said to have created an epoch in science. July, 1888, saw the publication of the most striking memoir of that series, and at the Bath meeting of the British Association in that same year all the world was apprised of the discovery by Fitzgerald, then President of Section A.

Had it not been for the preparedness of British physicists in this matter Hertz's discovery might have been left to leak out gradually, and be more or less misunderstood for the course of ten or twenty years, as usual. Continental science was in fact by no means ripe for a clear appreciation of these experiments, and even now it is surprising that a continental philosopher should have thus reaped the fruits of the theoretical seed sown in England. However, so it was; Hertz stepped in before the English physicists, and brilliantly carried off the prize. He was naturally and unaffectedly pleased with the reception of his discovery in England, and his speech on the occasion of the bestowal of the Rumford medal by the Royal Society will long be remembered by those who heard it for its simple-hearted enthusiasm and good-feeling. His letters are full of the same sentiment, and there is no doubt that, in addition to being a capable and well-armed investigator, he was also a modest and courteous gentleman. We hoped many times to see him at one of the meetings of the British Association, where he would have been sure of a cordial welcome, but every year he had to excuse himself—once on the ground of military service demanded of him at some autumn manœuvres. It is strange to remember that such a man, with his rare combination of experimental facility with high mathematical equipment, was regarded by his nation, not only in the light of a University teacher, but also as a locomotive unit capable of emitting and receiving bullets. However, this compulsory military service may have conferred upon him some needful relaxation and change of thought, if the discipline was not too trying for his state of health.

In addition to his physical investigations it may not be generally known that Hertz was also genuinely though not obtrusively or actively interested in certain modern discoveries in experimental psychology, and he was a corresponding member of the Society for Psychical Research. Some experiences of his in this connexion had made a distinct impression upon him, and he was prepared to examine into the possible truth of phenomena such as a short time ago would have been by most men in his position scouted as hopelessly improbable or absurd.

It would be a mistake to suppose that his best known research is all we owe to him. He made experiments on the time of contact of elastic bodies of certain shapes before they rebounded, and a minor or collateral discovery of his concerning the curious effect of ultra-violet light in promoting electrical discharge has led to a long series of experiments, and seems likely to afford important assistance in the difficult task of disentangling the relations between electricity and matter—the most promising and suggestive branch of modern physical chemistry.

But the writer does not intend to be drawn into a comment on Hertz's scientific work; he feels too keenly the serious blow which the loss of so young and capable a man entails upon all workers in the same regions of science.

We have lost the skill and power of work, the trained judgment, the patience and store of learning with which he was endowed; and those that are left must close up the ranks and advance as best they can without the aid of that able and friendly co-worker. O. J. L.

REVIEWS.

Recent Researches in Electricity and Magnetism. By J. J. THOMSON, F.R.S. (Clarendon Press.)

This work is intended as a sequel to the great "Treatise on Electricity and Magnetism," first published by Clerk Maxwell twenty years ago. The supreme influence of Maxwell's views in moulding the progress of electrical science since that date is now acknowledged everywhere, and it has been the endeavour of the author of this book to give an account of the more recent electrical researches, both experimental and theoretical, which have been most important in confirming, or in developing, the theory as set forth by Maxwell. It would be too much to expect anyone, even Prof. J. J. Thomson, to succeed in this endeavour to everybody's satisfaction. Only a large committee of experts could possess sufficient authority to decide on the researches which should or should not be included, and it is certain that the limits of a single volume would be too narrow for the purpose. In this book no attempt is made to simplify or explain Maxwell's theory. The reader is supposed to be familiar with Maxwell's treatise, and the equations of the electromagnetic field given in the ninth chapter of the second volume of that work are assumed, and used throughout the present one.

The book consists of seven chapters, three of which—the first, second, and fifth—form comparatively light reading, while the others are highly mathematical. It contains a considerable proportion of purely experimental matter, much of which is now published for the first time in an easily accessible

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form. The analytical portions of the book consist for the most part of original mathematical work.

The first chapter, entitled "Electric Displacement and Faraday Tubes of Force," is concerned with a physical method of regarding the electric field, which, although not exactly new, has as yet received very little attention. In the science of magnetism, especially when considered from a practical point of view, the use of lines of force to represent the state of the magnetic field is not only important, it seems a necessity. But in electrostatics the corresponding electric lines, or Faraday tubes, are rarely used to denote the state of the medium. Instead of these, the charges on the conductors are considered, and the state of the medium is represented by the variation of a mathematical quantity called the potential. This quantity is a tangible thing in current electricity, because instruments can be made, and are used, to measure it. But in ordinary electrostatics potential is a rather abstract conception, since even the most delicate electrostatic instrument in existence, the quadrant electrometer, is not sufficiently sensitive to measure the potential at a point in the air without altering the thing it is supposed to measure. It thus happens that in electrostatics potential is nearly always considered as a mathematical quantity, and is a conception which an ordinary student has generally much difficulty in properly grasping. To avoid this difficulty Prof. J. J. Thomson suggests the use of Faraday tubes, and says that "this method has all the advantages in vividness which arise from the use of concrete quantities instead of abstract symbols to represent the state of the electric field; it is more easily wielded, and is thus more suitable for obtaining rapidly the main features of any problem; when, however, the problem has to be worked out in all its details, the analytical method is necessary." These statements are no doubt true in the main, but it will depend a great deal on the particular problem considered whether the new method is easier to use than the old. Lines of force are very convenient to consider when their path is pretty well known, as, for instance, in the magnetic circuit of a dynamo or transformer, but when, as in most electrostatic problems, we have only a general idea of where they are, they can rarely be used to give more than a rough notion of the character of the phenomena which occur. Prof. Thomson has been led to the study of these tubes from considering the subject of the passage of electricity through liquids and gases. All the evidence in this connection goes to show that molecular structure is closely allied with electrical charges and the accompanying electrostatic tubes. The tubes of magnetic induction, so familiar to us in the commercial applications of magnetism, under the name of lines of force, do not seem here to have any direct bearing on the phenomena, and are rather neglected by the author during the first half of this book, dealing as it does with a subject to which Prof. Thomson has specially devoted himself, viz., the passage of electricity through gases.

Prof. Thomson commences by defining what he calls the "polarisation" of the dielectric. This is a vector quantity, and means nothing more nor less than the density of the electrostatic lines of force in the field. It corresponds exactly with induction density, which we familiarly represent by B in the science of magnetism, and it is a great pity that Prof. Thomson has chosen the word polarisation, overburdened as it is already with many vague meanings, to represent an exact quantity of this kind. Several mathematical theorems with regard to the motion of electrostatic tubes, and to consequent changes in the components of the polarisation follow; and it is shown that such motion is accompanied by (1) a magnetic force perpendicular both to the tubes and to the direction of motion; (2) a momentum perpendicular to the tubes and to the magnetic induction; and (3) an electromotive force perpendicular to the line of motion and to the magnetic induction. Students of the writings of Oliver Heaviside will be familiar with the perfect analogy which he has drawn between the laws of electricity and magnetism, and with the fact that he has shown that the ordinary law of the generation of electromotive forces by the movement of magnetic lines has an exact analogue in the induction of magnetic forces by the motion of electric lines. Just as an induced electromotive force in any piece of wire is measured by the rate at which magnetic lines of force cut the wire, so the magnetic force induced in any direction by the motion of electric lines is measured by the rate at which these lines cut a unit length measured in that direction. It is not necessary to abandon one of these laws to adopt the other. They are mutually consistent, and each may be shown to involve the other. For a particular class of problems it may however be much more convenient to use only one of these laws. In nearly all cases hitherto considered it has been found preferable to use the former, and to regard electromotive force as being generated by the motion of magnetic lines. This law is accordingly well known, while the view that magnetic force is caused by the motion of electric lines has been altogether neglected. Prof. Thomson finds that the latter law is much the more useful of the two in dealing with the subjects to which the first half of his book is devoted, and proceeds to illustrate this method of regarding electrical phenomena by applying it mathematically and otherwise to the consideration of several cases. The uniform motion of an electrically-charged sphere is first investigated. The magnetic forces in the field, the momentum generated in the dielectric, and the mechanical forces acting on the sphere, are fully worked out, and the author passes on to discuss the theory of rotating electrified plates which have been used by Rowland and others for the experimental investigation of questions which are of the first importance in connection with the electromagnetic theory of light. A detailed examination is then made of the case of a steady magnetic field. The difficulty met with here is to account for the field of a permanent magnet by the motion electrostatic lines of force, in spite of the fact that there are no electrical forces acting in the medium. This difficulty is met in an ingenious manner by supposing the medium to be filled with both positive and negative electrostatic lines, the density of the former being always equal to that of the latter at each part of the field. These lines are supposed to be moving in opposite directions, so that the magnetic forces so generated conspire, while the electric forces oppose and neutralise each other everywhere. The actual motion of these tubes in certain simple cases of magnetised bodies is next discussed, and the more familiar cases of the induction of currents by changes in the magnetic field, or by the motion of the circuit, are considered from the new point of view. The induction of a current in a secondary coil by the variation of current in a primary, can, in this way, be explained without referring to the properties of magnetic lines of force, and the theory of the action is really simpler than that ordinarily given in terms of such lines. The theory of the discharge of a Leyden jar is fully illustrated by means of a number of diagrams, most of which are taken from a former Paper of the author's printed some time ago in the *Philosophical Magazine*. The first chapter concludes with an attempt to use these Faraday tubes to form a mental picture of the processes which accompany the propagation of light according to the electromagnet theory.

The second chapter treats of the discharge of electricity through gases, and occupies nearly two hundred pages of the book. This chapter is one of great value, and forms an excellent summary of the work which has been done on the subject. A large amount of experimental matter is included, and a great number of illustrations are introduced. It is specially rich in references to German researches. Prof. Thomson is to be congratulated on his success in presenting a connected and readable account of such a large number of investigations. The fault of most attempts of this kind is that too little criticism is brought to bear on the description. This defect is not to be found in the present instance, as a very fair amount of critical matter is introduced. Space does not permit our mentioning all the subjects dealt with in this chapter. Some of the chief ones are as follows:—The electrical properties of hot gases, and flames. The phenomena connected with ultra-violet light. The disintegration of charged surfaces and the discharge of electricity by glowing bodies. The researches of Baille, Liebig, Peace, Paschen, and many others, on the phenomena of the spark discharge, and the electric strength of gases. The influence of pressure on the dielectric strength of gases. The discharge of electricity

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through vacuum tubes and through rarefied gases. The influence of magnets on these phenomena. The effect of electrodes. The velocity of discharge. Crookes's radiant matter. The distribution of potential along the path of the discharge. The arc discharge.

The matter of this chapter is well chosen, and the description very full. When describing the experiments which have been made to find the connection between spark length and potential difference, it would, however, have been an improvement if the experiments made at Messrs. Siemens Bros.' works, and described before the Institution of Electrical Engineers, had been referred to. These experiments were made with commercial apparatus, and with large amounts of power at disposal. They merit attention on this account, as those given in the book were carried out under very different circumstances. The description of the phenomena of the arc discharge is meagre and unsatisfactory, and the matter comprised in §§ 179-193 does not seem of sufficient importance to merit a place in a work of this kind. The theory of the electric discharge given at the end of the chapter is also of too speculative a nature for it to be of much value at present. But these are only small defects in a chapter of great value.

The third chapter on Conjugate Functions is exclusively mathematical, and belongs, moreover, to that part of mathematical physics which should, we think, merely be regarded simply as a section of applied mathematics. It does not help in the least towards explaining any physical phenomenon. No new principles are involved, and the calculations with which the chapter is concerned are confined entirely to such problems as the capacity of conductors of given geometrical shapes. Such calculations are of value when the absolute measurement of some electrical quantity has to be experimentally found; but they do not help to elucidate any physical problem. The chapter possesses the greatest value from a mathematical standpoint, and it forms a full sequel to the corresponding chapter in Maxwell's original work. But, like that chapter, we consider it out of place in a book which is supposed to be devoted to the theory of electricity rather than to mathematical problems connected with the subject.

The fourth chapter is also highly mathematical, but is very different in character from the one which precedes it. It deals with the theory of electrical waves and oscillations, and is, therefore, of immediate use in the explanation of the valuable experiments on electromagnetic waves, which have been made during the last few years by Hertz and his followers. The notation used throughout the chapter is taken without any alteration from Maxwell, and students of the mathematical writings of Mr. Heaviside will be sorry to find that the author makes no criticism of, or reference to, the somewhat simplified system of equations introduced by that writer. We also notice that the very useful word *impedance* suggested by Mr. Heaviside, and now universally adopted, is used by the author of this work in quite a wrong sense. The impedance of a conductor for alternating currents is the ratio of the voltage impressed upon it to the current in amperes flowing through it, thus, if

$$V = R\,C + L\frac{dC}{dt}$$

where V = volts, C = amperes, R = resistance, and L = self-induction, then

$$\text{impedance} = \sqrt{R^2 + 4\,\pi^2\,n^2\,L^2},$$

where n is the number of complete periods per second. But on page 293, and in several other places throughout the book, Prof. Thomson calls R the *impedance* of the circuit, and states that "this term is preferable to resistance, as it enables the latter to be used exclusively for steady currents." Prof. Thomson discusses many new problems in this chapter, and also reproduces from the *Proceedings* of the Mathematical Societies other problems of interest in connection with the subject of electrical oscillations. The chapter comprises close on 140 pages, and forms a valuable work of reference.

The fifth chapter is almost entirely experimental, and forms a very full summary of the researches of Hertz, and of the more recent experiments made in continuation of his important work. A summary of this kind has been much wanted owing to the great amount of experimental matter in connection with the subject, which is to be found scattered among the Proceedings of the various European scientific societies. A great deal of obscurity still surrounds the explanation of many of the phenomena of these oscillations. Prof. Thomson attempts to explain some of them by means of his Faraday tubes. The conception of these tubes proves very useful in certain cases, as, for instance, in the explanation of the fact that the vibrations of the oscillator generally die away much more quickly than those of the resonator. The phenomenon of resonance is, however, not easily explained by these means, and in other respects the Faraday-tube method of explanation leaves much to be desired.

A portion of the chapter is mathematical, dealing with the theory of reflection of electromagnetic waves from walls, metal plates, and wires; the reflection of light from metals, and from gratings; on the scattering or diffusion of electric waves by wires and metal spheres. The chief part of the chapter is, however, devoted to an account of the experiments of Hertz, Trouton, Sarasin and De la Rive, Rubens, Paalzow Ritter and Arons, Lecher, Blondlot, and others, on electrical waves. A fairly full account is also given of the various determinations of specific inductive capacity by means of methods involving the use of electromagnetic waves.

The sixth chapter, on the distribution of rapidly alternating currents, is useful for purposes of reference, but contains very little that is new. The calculations merely relate to combinations of inductive conductors in series or in parallel. The mode of distribution of alternating currents in a single conductor conveying alternating currents is not referred to although a case of some practical importance. The analogous problem of the distribution of lines of force in the iron core of a transformer is, however, treated fully in Chapter IV., and as the problems are identical from a mathematical point of view, the mathematical student will find no difficulty in solving one by referring to the other.

The book concludes with a chapter on the theory of the electromotive intensity in moving bodies, and an appendix referring to the author's experimental work on steam.

Prof. Thomson is to be congratulated on being the author of a book which is well worthy of being called a sequel to Maxwell's great treatise. This volume is certainly the most important electrical book which has been written since the issue of Maxwell's work. W. E. S.

"Clarke's Pocket-Book." For Plumbers, Architects, Sanitary Engineers, &c., &c. By J. W. Clarke and W. Hibbert. (London: Bush and Co. 1893.)

This little pocket-book, with pages no larger than those of Thompson-Thomas's Electrical Tables, contains a large amount of information for plumbers, architects, and sanitary engineers. Fifty-three pages out of two hundred and sixty-six are said to be devoted to electrical tables and memoranda. These are intended either for "plumbers, architects, and sanitary engineers," or perhaps only for the use of the "&c., &c." This part, contributed by Mr. Hibbert, is excellent as a text-book in miniature, and would be very useful to vestrymen, judges, and others who are occasionally called upon to decide important questions of electrical engineering or science, and who have no time for studying long and difficult treatises. It begins with these words: "Nobody knows what electricity is. Its behaviour is, however, well understood, and the line between good and bad work is clearly marked." This is eminently sensible, but why should it be stated in a tiny book into which much useful information should be carefully compressed? There are, in fact, only three, or perhaps four tables in this section, one called a wiring table, in which no account is taken of fall of volts; a fuse table in which the length of the wires is ignored; and a list of the casings of a certain timber merchant. This is followed by another casing list, but it seems to form the beginning of the advertisements. The first part of the book, with which we are not concerned, seems to be full of valuable memoranda.

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TELEGRAPH STATISTICS FOR 1892.

COUNTRY	Great Britain and Ireland.	France.	Germany.	Italy.	Norway.	Sweden	Belgium.	Holland.	Switzerland.	Denmark.	British India.	Victoria.
System.												
a. Length of line of the entire system in miles ..	33,689	59,597	73,080	21,846	4,875	5,398	4,448	3,390	4,509	2,853	41,203	4,062
b. Length of conductors in miles	207,231	187,319	259,210	91,527	9,640	14,742	21,495	12,070	11,970	7,993	126,219	9,118
Offices.	**8,537**	**10,720**	**18,739**	**4,360**	**378**	**1,062**	**965**	**797**	**1,439**	**389**	**3,424**	**783**
Instruments.												
Morse	5,423	11,622	15,269	4,343	275	504	1,486	521	1,991	397	6,538	495
Hughes	57	749	492	125	...	...	79	63	47	...	...	...
Other	19,960	4,665	11,049	94	69	24	224	371	183	142	14	179
Totals	**25,440**	**17,036**	**26,810**	**4,562**	**344**	**528**	**1,789**	**955**	**2,221**	**539**	**6,552**	**674**
Staff.	**131,459**	**28,459**	...	**5,719**	**649**	**844**	**3,160**	**1,976**	**2,046**	**784**	**6,704**	**1,961**
Telegrams.												
a. Internal service. No. of paid telegrams	62,672,745	31,396,150	20,649,217	6,757,690	1,062,844	1,156,746	2,647,227	2,215,506	1,913,133	623,910	3,441,637	2,277,410
a. Internal service. No. of telegrams free	1,791,151	2,043,797	1,106,430	586,136	...	...	3,665	...	...	12,668	2,536	92,152
Totals	64,463,896	33,439,947	21,755,647	7,343,826	1,062,844	1,156,746	2,650,892	2,215,506	1,913,133	636,578	3,444,173	2,369,562
b. International service. No. of telegrams sent abroad	3,761,329	2,701,666	3,744,073	698,501	271,620	320,801	966,509	752,770	605,517	281,895	168,826	18,103
b. International service. No. of Telegrams received from abroad	3,257,190	2,604,671	4,208,524	793,323	315,050	357,430	1,054,821	945,856	631,475	323,740	150,213	18,684
b. International service. No. of telegrams transmitted from one frontier to the other	820,141	1,571,168	969,210	130,261	30	190,492	577,046	388,846	480,479	407,426	220,735	338,190
Totals	7,838,660	6,877,505	8,921,807	1,622,090	586,700	868,723	2,598,376	2,087,472	1,717,471	1,013,061	539,774	374,982
c. Number of service telegrams	...	5,011,436	497,646	308,082	10,826	84,386	129,121	40,461	135,550	36,067	384,405	...
Grand Total number of telegrams	**72,302,556**	**45,328,888**	**31,175,100**	**9,273,998**	**1,660,370**	**2,109,855**	**5,378,389**	**4,343,439**	**3,766,154**	**1,685,706**	**4,368,352**	**2,744,544**
Receipts.	£	£	£	£	£	£	£	£	£	£	£	£
a. Net revenue from internal correspondence	1,949,357	763,761	...	472,184	42,308	38,026	61,121	58,228	51,525	19,804	256,469	76,289
b. Net revenue from international do.	314,297	442,759	...	101,480	21,842	40,677	76,702	50,703	53,437	27,755	105,396	37,496
c. Sundry receipts	223,137	206,286	...	31,934	1,679	2,164	20,443	5,085	5,864	1,049	113,882	22
Totals	**2,486,791**	**1,412,806**	...	**605,598**	**65,829**	**80,867**	**158,266**	**114,015**	**110,826**	**48,608**	**475,747**	**113,807**
Expenses.												
a. **Extraordinary Budget.** Cost of establishment of the system	£ 96,969	£ ...	£ ...	£ ...	£ 9,930	£ 3,611	£ 287,856	£ 7,343	£ 7,194	£ 2,686	£ 135,689	£ ...
b. Ordinary Budget. Staff	1,976,049	...	...	351,025	52,191	57,914	119,760	123,819	73,500	45,331	262,390	...
b. Ordinary Budget. Cost of working and repairing of lines and offices	494,790	...	...	77,564	14,929	15,359	61,648	34,630	25,490	12,535	61,145	...
Total expenses of ordinary budget	**2,470,839**	...	...	**428,589**	**67,120**	**73,273**	**181,408**	**158,449**	**98,990**	**57,866**	**323,535**	
General Information.												
a. Population of the State according to census	38,379,276	38,343,192	49,428,470	30,158,408	2,001,000	4,806,865	6,069,321	4,669,576	2,917,819	2,172,380	287,000,000	1,100,000
b. Area of the State in square miles	120,943	203,183	207,374	113,906	123,979	169,953	11,323	12,712	15,921	14,723	1,449,561	87,496
c. No. of *paid inland* telegrams sent per head	1·632	0·818	0·437	0·224	0·531	0·240	0·436	0·474	0·655	0·287	0·012	2·070
d. No. of square miles per office	14·1	19	11·1	26·3	326	160	11·7	16	11·1	33	423	112

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TELEGRAPH STATISTICS FOR 1892.

The accompanying table and remarks are based upon some elaborate statistics recently published in the *Journal Télégraphique* of Berne:—

England.—The figure given for length of line includes 22,787 miles of private wires, but does not comprise pneumatic tubes nor wires belonging to the Railway Companies. The number of offices does not include those of the Submarine Cable Companies. The number of Hughes instruments includes 46 used on the cables between England and the Continent. Of the "other instruments" 498 are Wheatstone automatics, 129 translators, 78 quadruplex, and 34 Delany multiplex. The total number of instruments includes those used upon private lines. The *personnel* includes the whole postal force as well. The number of paid telegrams includes 20,077 messages at reduced rates sent for account of the Railway Companies. The total number of telegrams includes messages exchanged direct by the Cable Companies without having passed over Government lines. The maximum number of telegrams sent in any one week during 1892 was 1,677,094. The average number of *words* transmitted every week for the press was 12,865,026. The receipts include £120,299 for press telegrams, and £414 for messages at reduced rates sent for the Railway Companies. The revenue from international correspondence includes £56,814 for the rent of special wires leased by the Cable Companies as well as the proportion of the revenue from telephonic communications between London and Paris due to the Government. The "various receipts" include £93,893 for the rent of private wires and £13,447 for wires leased to newspapers. The figure given for cost of establishment is the amount expended during the year 1892 only, and is in addition to the capital sum of £10,130,820 previously spent on this account.

France.—The figures given for the *personnel* are said to be those of the postal and telegraphic services together, owing to the fusion of which also the telegraphic expenses cannot be given separately, but the total number seems far too small to be correct.

Germany.—The "other systems" of apparatus include 10,764 sets of telephone and 50 Estienne instruments. In regard to the *personnel*, the postal and telegraphic services being amalgamated, the number of the staff engaged in the telegraphic service alone cannot be given. The number of unpaid telegrams includes 406,807 railway service messages. The number of telegrams sent abroad does not include 52,844 international service telegrams. The amalgamation of the postal and telegraphic services makes it impossible to ascertain the amounts of receipts and expenses exclusively belonging to the telegraphs.

Italy.—The "other systems" of instruments comprise 17 Wheatstone automatics, 68 Wheatstone receivers, and 9 Baudot. The service messages include messages free of charge from the Royal House to the Holy See, the Presidents of the two Chambers and the Ministers, as well as the ordinary correspondence of the Government, which is not admitted free, but does not include 10,939 messages sent for the railways. The "various receipts" include £8,270, in the shape of *contributions* from the telephone companies.

Norway.—The "other instruments" comprise 13 duplex, 10 quadruplex, 5 Wheatstone automatics, and 41 telephones.

Sweden.—The number of paid messages includes 158,646 messages sent over the railway lines.

Belgium.—The length of lines and conductors does not include 239 miles of line comprising 1,281 miles of conductors laid under water. The number of instruments does not include 105 telephones used for telegraphic transmission. The number given for the *personnel* does not include 3,244 railway servants, &c., who assist in telegraphic work, nor the large number of persons who deliver telegrams without making this service their exclusive occupation.

Holland.—The "other instruments" comprise 2 Estienne, and 369 Bell-Blake, Paul-Bert, d'Arsonval, Theiler, Van Rysselberghe and Berliner telephones.

Switzerland.—The cost of working and maintenance includes £2,022 interest on, and sinking fund of, the cost of establishing the system.

Denmark.—The "other systems" of instruments comprise 7 Wheatstones and 135 telephones. The service telegrams do not include 14,207 international meteorological messages.

India (*British*).—In the number of service telegrams given 85,777 related to the postal service.

RESISTANCE TO ALTERNATE CURRENTS.*

BY E. HOSPITALIER.

In 1886 Lord Rayleigh† published some formulæ enabling us to calculate the effective resistance of a circular conductor through which periodic currents of a given frequency were flowing. Unfortunately the series which give these values becomes so divergent as the diameter and frequency increase that it is practically only applicable within narrow limits. In his Presidential address to the Institution of Electrical Engineers in 1889, Sir William Thomson gave a table for certain diameters, and a frequency of 80, which enables us to greatly extend these limits. It has occurred to me that from the practical point of view it would be convenient to have a simple and concise table which could be used quickly for all diameters and all frequencies, and, assisted by M. A. Potier, I have converted the data given by Sir William Thomson into a simple table, which will greatly simplify and facilitate calculations.

If we denote by R_A the resistance of a circular conductor to alternate currents, and by R_C its resistance to continuous currents, we have the general expression—

$$R_A = k\,R_C \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

k being a numerical coefficient depending both on the frequency 1/T and on the diameter d of the wire. It follows from Sir William Thomson's investigation that for a wire of a given kind this factor k is the same for all values of the product $d^2 \times 1/T$. We can, therefore, draw up a table giving the values of k for each corresponding value of the product of the diameter squared into the frequency. In the following table the diameters are expressed in centimetres, the frequency in periods per second, and the resistivity of copper is taken at 1,597 C.G.S. units. To determine the multiplication factor of the resistance, R_C, of a conductor of d centimetres diameter, we need only multiply the square of this diameter by the frequency in periods per second, and look in the table for the nearest corresponding value of k, and then apply equation (1).

Values for k, the Coefficient of Increased Resistance.

$\frac{d^2}{T}$	k	$\frac{d^2}{T}$	k
0	1·0000	1,620	1·8628
20	1·0000	2,000	2·0430
80	1·0001	2,420	2·2190
180	1·0258	2,880	2·3937
320	1·0805	5,120	3·0956
500	1·1747	8,000	3·7940
720	1·3180	18,000	5·5732
980	1·4920	32,000	7·3250
1,280	1·6778		

For instance, what will be the effective resistance of a copper conductor 2cm. in diameter, traversed by an alternating current of a frequency (1/T) of 80 periods a second, its electrical resistance measured on the Wheatstone Bridge being 3 ohms? We have $d = 2$; $d^2 = 4$; $1/T = 80$; $\frac{d^2}{T} = 320$. We see by the table that the corresponding value of k is 1·0805. Hence

$$R_A = R_C \times k = 3 \times 1{\cdot}0805 = 3{\cdot}2415 \text{ ohms.}$$

If the product d^2/T is not to be found in the table, we can interpolate or make use of the next highest value, in which case we commit an error of excess. The above table is wide enough to determine R_A far beyond the needs of practice. In fact, for the frequency of 150, which is never exceeded in practice, the table gives values of k up to $d = 15$cm., a feature much greater than that which occurs in commercial conductors.

When the quotient d^2/T exceeds 32,000, we shall obtain the effective resistance with great precision by calculating the resistance of the solid conductor as equal to that of a tubular conductor of the same external diameter and thickness equal to $6{\cdot}38\sqrt{T}$ centimetres. All these results relate to pure copper of resistivity 1,597 C.G.S. units. For a metal of resistivity ρ different to that of pure copper and of unit magnetic permeability (which excludes iron,

* From *L'Industrie Électrique*. † *Phil. Mag.*, May, 1886.

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steel, &c.), the factor d^2/T which enables us to find the corresponding value of k in the table, should be multiplied by the ratio of the resistivity of copper to that of the metal under consideration, that is to say, by $1,597/\rho$, ρ being expressed in C.G.S. units. It is unnecessary to say that these formulæ do not take capacity or mutual induction into account.

I think that this table will be of use to electricians by enabling them to quickly determine whether under stated conditions the factor k is or is not negligible in the conductors they are using.

LEGAL INTELLIGENCE.

The Medical Battery Company (Limited).

C. B. Harness, Director of the Medical Battery Company, J. M. M'Cully, and C. B. Hollier, again surrendered before Mr. Hannay, at Marlborough-street, on Wednesday last, to answer the charge of having conspired together to obtain money by false pretences.

WILLIAM JOHN CLARKE MILLER, registrar and secretary of the General Medical Council, produced the medical registers from 1887 to 1894. He had examined them, and the names of C. B. Harness and C. B. Hollier were not on them. The name of J. M. M'Cully was on the register up to November, 1887, when it was struck off.

Cross-examined by Mr. AVORY: The Medical Council struck persons off the register of their own accord. No appeal from the decision of the Council had ever succeeded. A person struck off the register could not sign a death certificate, could not recover his fees in a court of law, but could practise his profession.

Re-examined: The powers of the Medical Council were regulated by Act of Parliament.

W. R. SELLMAN, otherwise Dudley Towers, who till recently was one of the defendants in the case, further cross-examined by Mr. AVORY, said that the condition of his being released by the prosecution was that he should sign an undertaking (copy produced) not to bring an action against the prosecutors. He only signed the document as a means of escape from the position in which he was placed.

Cross-examined by M'CULLY: He had never known any injury to be done to patients by the use of statical electricity. With the statical chair he should say it would not be possible to hurt a persons finger or shoulder-joint.

This concluded the case for the prosecution.

Mr. AVORY, for the defence, submitted that the prosecution had failed to establish any criminal offence. He used the word "criminal" advisedly, because he very much doubted whether the persons who had put forward the prosecution had appreciated the broad line of distinction between conduct which could give rise to a civil liability and that which could give rise to a criminal prosecution. This was not a *bonâ fide* prosecution at the instance of aggrieved parties, but only part and parcel of the newspaper agitation which for a long time had been going on against the defendant Harness and the establishment at 52, Oxford-street. Civil proceedings were first taken, and when it was found that they were not likely to succeed well then a criminal prosecution was begun, and magistrates and judges had always set their faces against such a course. He could not help thinking that if the true facts of the case had been disclosed process would never have been granted. There were only three possible grounds on which the case could have been held to be a criminal one. The first and only substantial ground on which the case could be supported was that the defendants had been guilty of false representation. The second was the allegation that large sums of money had been obtained from persons by pretending to cure them of complaints from which they were suffering. The third was the allegation that certain persons had complained of having suffered from the treatment they received. As to the first, he submitted that none of the witnesses had proved that any criminal offence had been committed in the eyes of the law. Mr. Terrell, in his opening speech, said that he relied on the advertisements that had appeared, and the statement that Mr. Harness was an eminent electrician, and that the belts he sold were electrical appliances. The application of the term "an eminent electrician" was, however, purely a matter of opinion, and, as a matter of fact, Mr. Harness had patented several electrical appliances. The subject of the belts was the crux of the whole case. On the question of their right to the term "electrical appliance" he would simply refer to the evidence of Dr. Lewis Jones and Mr. Gatehouse, and he would accept as a definition of an electrical appliance that it was something which would generate electricity. Did not the whole evidence of those gentlemen show that the belts, whether connected or unconnected, generated electricity when worn on the human body? The question of quantity was quite another matter, and did not enter into the case. It was obvious when the evidence was looked at that the whole matter was a question between the medical profession and 52, Oxford-street, as to what was the minimum dose of electricity that would produce therapeutic effects. Was that a proper question to submit to a criminal court? The only false pretence alleged was the representation to Mr. Burbage that he was suffering with spine disease, but the evidence of Sellman showed that it was quite another complaint. The prosecution had contrasted the cost of the manufacture of the belts with the price at which they were sold. He could not suppose that they seriously put forward the suggestion that it was a criminal offence to sell an article for five guineas which had only cost 3s. 6d. If they did, the answer would be that every tradesman throughout the country was liable to be indicted, for it did not matter whether the difference between the cost price and the selling price was £5 or £500 or 5d. The fact that money had been obtained from persons that went to the place to be cured could not be put forward as obtaining money under false pretences. In every instance in which money was paid a printed receipt was given, on which was a notice to the effect that the Company declined to guarantee any expectations which might be anticipated from the treatment. It could not be constituted a criminal offence because the defendants sometimes failed. With regard to the third ground of complaint, it was alleged that some injury had been done to persons by the treatment and the wearing of the belts. That did not constitute a criminal offence. It might be the result of unskilfulness or ignorance, but as the law stood it was no criminal offence for a person to undertake to cure a disease, although not a qualified medical man, or to fail when having undertaken to effect a cure. It was only in the case of death that the law could come into action to prosecute. He could show that many cures had resulted from the treatment administered at Oxford-street, and numerous testimonials had been received from grateful patients. There was another matter that he should like to refer to. There were only three persons charged; why were not the other doctors and assistants that were employed in the place charged? Were not they just as much implicated as the three defendants? He thought he should be able to show that the defendants had a *bonâ-fide* belief that the treatment might do good, and, if so, then there was no case against them.

The further hearing of the case was then adjourned for seven days.

Jude and West v. Watson.

This was an action tried before Judge Baylis at Liverpool, in which the plaintiffs, a firm of chartered accountants, sought to recover from Malcolm Walker and Adam West Watson £250 for damages for breach of contract in respect to operations for an attempt to float a company to be called the Walker Electric Lighting and Engineering Company (Limited). Plaintiffs alleged that the defendants engaged their services for floating the proposed Company, which was to include not only the defendants' business but a similar business belonging to a Mr. Hall. After hearing the evidence, the jury found for the plaintiffs against Walker for £5 in addition to £5 paid into Court, and Watson was found not liable. Verdict accordingly.

CORRESPONDENCE.

ELECTRIC TRACTION AND THE BOARD OF TRADE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We should like to be permitted to deprecate your censure on our last week's letter, which we cannot but think unduly severe. The technical press have before now discussed Board of Trade rules with advantage to the profession, and this particular question having been referred to the Council of the Institution of Electrical Engineers, a purely technical body, is surely peculiarly one which may be so discussed. Besides, the technical press reported and commented on the proceedings of the joint committee last June, and cannot now reasonably taboo discussion arising out of those proceedings. We admit that we were not aware that anything was being done by the London Chamber of Commerce, our *Electrician*, to which we naturally look for information on such matters, having been silent on the point. But we are glad to learn the fact now, and trust success will attend the efforts made.

With regard to our "unwarranted insinuation," we look at the matter from a practical, not a sentimental point of view. It appears to us illogical, if not positively indecent, that experts who were advocates last June before the Joint Committee should now be constituted judges of the issue they disputed then, which is what the reference to the Council of the Institution amounts to. It is not necessary to, and we do not, impute unworthy bias, but the experts in question have been accustomed to regard the question from one point of view. They got-up the case for the Telephone Company to the best of their ability, and they doubtless believe themselves right. So, apart from the influence of retainers, they are, and must be, so many advocates against traction. To be otherwise now would be to confess that they pushed their advocacy before the Committee too far last June. We are glad to see that you agree with us that the Board of Trade draft rules are at variance with the Committee's report. That is *the* question. We reiterate that the interests of traction for many years to come are threatened seriously by this proposed stultification of the Committee's report, and that it behoves the profession to see that it comes to nought.—Yours, &c.,

BENNETT AND DRUCE.

44, Fishergate, Preston, January 8, 1894.

[Our correspondents, who admit that they were not aware that anything was being done by the London Chamber of

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Commerce in connection with the draft Board of Trade rules for electric traction, are not, perhaps, members of the Electrical Trades Section, or being members, are, perhaps, not known to take an active interest in electric traction. The matter has up to the present been discussed by a committee. As soon as this committee has anything to publish, or as soon as they report to a general meeting of the section, it will be time enough to discuss details. Useful work can be, and has been, done by such committees, and a report on their deliberations is no more necessary than on that of the committee of the Institution of Electrical Engineers. The over-head wire rules and other Board of Trade rules have been discussed in our columns after this preliminary stage had been passed.—Ed. E.].

THE PAST YEAR'S WORK.

Brush Electrical Engineering Company.—All classes of electric lighting contracts have been secured by this Company during the past year, which has kept the works fairly employed. This applies particularly to plant for central electric lighting stations, for which the Company have received many important orders. The plant for the lighting of the City of London is nearing completion; and the Bankside station, in addition to the plant originally put down, has received during the year six sets of Raworth-Mordey combined alternating plant, with an aggregate output of 2,500 kilowatts, and the equipment of the various transformer stations is now nearly complete. The original contract for lighting the town of Huddersfield has now been completed, and orders for considerable extensions have been received. Additional plant has been supplied for the central stations at Sheffield, Bournemouth, Hastings, and Woking. Among other central station contracts secured may be mentioned those of Leicester, Lancaster, Dover, Canterbury, Fleetwood, Coatbridge, and the supply of alternators and arc-lighting plant to the Great Northern Railway Company, Holloway, and to Hastings and Blackpool for lighting the promenades on the sea front; alternators, exciters, and transformers to the Bolton Corporation; the complete equipment of the transformer sub-stations for Bristol; and the supply of alternate-current plant for the station at Rugby School. The Company's contracts for exhibition lighting have included this year the supply of the whole of the electrical plant at the Horticultural Exhibition, Earl's Court; and orders for isolated installations have been secured for the lighting of Arundel Castle, Southill Park, Bracknell, Battenhall Mount, Worcester, High Trees Mansion, Redhill, and the supply of arc-lighting plant includes a contract for the Midland Railway Company's station at Leicester. The installation work on shipboard, completed by the Company during the year, includes plant for two vessels belonging to the Pacific Steam Navigation Company; two cruisers for the Argentine Government, &c. Having perfected a system of alternate current-distribution the Company have been giving attention to the further development of their continuous-current plant. With this object in view they have acquired the sole rights for manufacture in this country of the Brush-Desroziers dynamo, and have also begun the manufacture of several classes of two-pole dynamos of high efficiency and moderate price. Important improvements have been made during the year in the Company's Transformers, alternate-current arc lamps and lamp posts, at the same time particular prominence is being given to the supply of plain fittings, switches, and lampholders. The Brush Company made extensive preparations to resume their former position in the incandescent lamp-making branch of the electrical industry. The Brush glow lamps have met with a ready sale. In other departments the Company continues to be occupied fully with large orders, to an extent that taxes their resources to the utmost, notwitstanding the enlargement of their works and the increase of their staff.

Corlett Electrical Engineering Company (Limited).—This firm are the northern agents for Messrs. Crompton and Co., and have carried out a large number of light and power installations in various parts of the country during 1893. A pumping contract has been supplied to the Consett Iron Company (Limited), Durham, in which the power is transmitted from the blast furnaces to the workings of the mine, a distance of nearly two miles. The fact that a plentiful supply of steam was raised from the gases of the blast furnaces determined the position of the generating plant. The first pumping set consists of a series-wound motor, driving by a belt a three-throw ram pump, which delivers water through about 1,000 yards of piping against a vertical head of 110ft. Two other pumping sets consist of motors direct coupled to centrifugal pumps, and deal with large volumes of water at a comparatively small head. The Corlett Company have also supplied a similar pumping plant on the same lines to a colliery in North Wales, where the vertical head is 500ft. A complete lighting plant has been supplied to the Garswood Coal and Iron Company, of Wigan, the generating plant for which is on the surface. The whole of the surface and underground arrangements are included in the lighting scheme. Several similar plants have been supplied to other collieries. A 1,000-light contract was secured for Messrs. McConnel and Co., of Manchester, and several other cotton mill installations have been carried out. The United Alkali Company, at Fleetwood, have placed with the firm an order for a very complete lighting plant for their new works, and the Ince Wagon and Iron Works at Wigan have also been fitted throughout for the electric light, Crompton-Pochin arc lamps being used. The firm have some important contracts in hand approaching completion.

Messrs. Doulton and Co.—In addition to their usual large trade in telegraph and telephone insulators, and pottery parts for electrical apparatus, Messrs. Doulton and Co. have received numerous orders for their patent stoneware conduits for underground cables, which have been supplied to several London and provincial companies. A description of this conduit was given in a recent issue of *The Electrician*. The firm have gratifying proof of its growing popularity from the receipt of several large orders from important works shortly coming on. Another specialty for which the firm is well known is their vitrified stone insulators for bare copper mains, for which they have designed special manufacturing plant. Recent contracts for these insulators include Oldham, Aberdeen, &c.

Messrs. Paterson and Cooper.—This firm have during the past year been fairly well employed, and they have fitted a number of vessels with complete outfits of electric lighting plant, including the "Matin," "Princess Beatrice," "Laurentian," "Empress," "Zaize," and "Noir-el-bahr," in addition to supplying complete direct-driving sets for the s.s. "Premier," of the Canadian Pacific Service, and for other vessels. A large number of installations have also been carried out. During the year Admiralty contracts of considerable size have been executed, and Messrs. Paterson and Cooper have introduced their new patent 5-ampere lamp, which has met with a favourable reception, as have also their improved electrical measuring instruments. Several important contracts are in hand for the New Year, which, however, does not, in the opinion of the firm, offer any very promising prospects.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1894 Edition of "'The Electrician' Electrical Trades' Directory and Handbook" is in preparation, and will shortly be published. *New names, alterations of addresses, &c., should be sent in at once.* Full printed particulars can be obtained, post free, from "The Publisher," *Electrician* Office.

"Electromagnetic Theory," by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application to the Publisher.

"Electrical Engineering Formulæ," a pocket-book, by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.) Prospectus on application to the Publisher.

"Drum Armatures and Commutators."—This book, written by Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

Tenders Invited.—The County Borough of Hanley invite tenders for the electric light wiring and fittings for the various Corporation buildings, of which particulars are given in our advertisement columns, and also for electricity meters, switches, testing, and measuring instruments, &c. Separate tenders must be sent in to Mr. Joseph Lobley, the borough engineer, not later than Monday, the 29th inst.

———— The Corporation of Edinburgh invite tenders for work in connection with contracts Nos. 1, 2, 3, and 4 for their electric lighting station in Torphichen-street, Edinburgh. Copies of any of the specifications can be obtained from Prof. A. B. W. Kennedy, 14, Old Queen-street, Westminster, S.W., and tenders, addressed to Mr. W. Skinner, Town Clerk, City Chambers, Edinburgh, must be in not later than the 30th inst. It is a condition with these contracts that tenders will only be considered from firms who are actual manufacturers of the whole or an important part of the work for which they estimate. Further particulars will be found in our advertisement columns.

———— The Corporation of Cheltenham invite tenders for supplying and erecting engines, dynamos, and boilers at their electric light station. Tenders must be in by Tuesday, the 23rd instant.

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TENDERS ACCEPTED.—The tender of Mr. J. S. Brown, of Oxford-street, Swansea, has been accepted for lighting the Swansea Docks, for the sum of £649, the contract to last for five years. A large number of tenders were received, the highest being £927.

——— The Town Council of Halifax have confirmed the various contracts for the electric lighting works recommended for their acceptance by the Electric Lighting Committee, which will be found in our issue of December 15th. and have in addition accepted the tenders of Messrs. Pollit and Wigzell (Limited) for condensers at £225, of Messrs. Robey and Co. (Limited) for two horizontal engines for exciters at £327, and of Messrs. H. Jenkinson and Co., Halifax, for sub-stations, at £79. 15s. 8d.

APPOINTMENTS VACANT.—The Wolverhampton Corporation require a draughtsman and assistant at their electric light and power works. Applications must be sent in to Mr. F. Harman Lewis, borough electrical engineer, Town Hall, Wolverhampton, not later than January 27th. The Corporation also require an outdoor foreman and linesman, for which post applications must be sent in not later than the 27th inst. Further particulars will be found in our advertisement columns.

DISSOLUTIONS OF PARTNERSHIP.—Mr. Fulwell has retired from the firm of the Coventry Electrical Engineering Company, and the business is now carried on by Messrs. Eaves and Butlin.

——— The firm of King, Brown and Co., electrical engineers, has been dissolved by mutual consent, Messrs. A. B. and D. G. Brown retiring. The business will be carried on under the name of King and Co., the partners being Messrs. W. F. King, A. Ogilvie, and A. Wilson.

MESSRS. DAVEY, PAXMAN AND CO.—Mr. James Paxman, who has for many years been the sole proprietor of Messrs. Davey, Paxman and Co., engineers, Standard Ironworks, Colchester, has taken into partnership his son, Mr. William Paxman, from January 1st. The title of the firm will remain unchanged.

MESSRS. WHEATLEY KIRK, PRICE AND GOULTY.—From January 1st Mr. Sherley Sherley-Price, son of Mr. H. Sherley-Price, has been admitted as a partner in the firm.

EXTENSION OF PREMISES.—The Electrical Installation Company (Limited) have, owing to the increase of business, found it necessary to extend their premises, and are moving into additional offices at 66, Victoria-street, S.W., which will be the address for all general office communications. The Company have started new works in Pimlico.

GOVERNMENTS AND THE TELEPHONE.—In our summary of electrical events for 1893 we omitted to place on record the purchase by the Austrian Government of the rights, &c., of the Telephone Company of Austria, which were taken over by the Government as from January 1, 1893.

MAGNETIC DECLINATION.—We have received from the *Colliery Guardian* a map, well got up, varnished, and mounted on rollers, showing lines of equal magnetic declination or variation of the compass corrected to the beginning of the new year—that is, to January 1, 1894. The lines, which are shown in red on the map, depend, as in several past years, on the magnetic survey of the kingdom undertaken by Profs. Rücker and Thorpe. The rate of annual decrease at Greenwich is thus about 7 minutes yearly, and it is much the same over the area covered by the map, as mentioned in the note thereto attached.

CORRECTION.—We last week notified that the contract for lighting the new premises of the Bank of Scotland had been secured by Messrs. Rashleigh Phipps and Dawson ; the name should have been Messrs. Rashleigh Phipps and Co.

ALUMINIUM.—The Cowles (Aluminium) Syndicate Company (Limited) send us their latest circulars giving prices and particulars of their aluminium bronze sheets, rods, ingots, castings, forgings, &c. These circulars can be obtained on application to the Company at Milton.

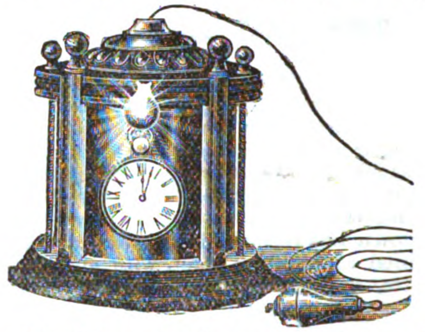
THE CONSOLIDATED TELEPHONE COMPANY.—This Company are issuing revised circulars relating to their Gower-Bell Telephones, and accompanying the illustrated printed particulars are valuable testimonials, one of which is from Spain, which speaks very highly of the Gower-Bell telephones erected nearly 13 years ago, and which, after continual service during this long period, still give every satisfaction. These telephones, too, were the first to be used in Spain, and were those with which brilliant tests were made at great distances.

MESSRS. MATHER AND PLATT'S CATALOGUE.—We have received from Messrs. Mather and Platt illustrated price lists of their Edison-Hopkinson dynamo, Edison-Hopkinson motor, "Manchester" dynamo, "Manchester" motor, and of their alternator. Several improvements have recently been made in these well-known machines.

MR. E. R. DOLBY, C.E.—Under the superintendence of Mr. Dolby, acting as consulting electrician, the electric light has recently been installed at Harrington-gardens, for Mr. S. V. Morgan, Messrs. G. Trollope and Sons being the contractors (137 lights) ; at the Economic Life Assurance Society's office, for which Messrs. Baily and Grundy were the contractors (80 lights) ; and Messrs. Strode and Co. are the contractors for the lighting of "Saratoga," Forest Hill, for the complete installation of 104 lights, including a Crossley gas engine, Mather and Platt' dynamo, and E.P.S. cells.

SMOKE ABATEMENT.—Reference has recently been made in our columns to a smoke and fumes annihilator, invented by Mr. Samuel Elliott, of Newbury, Berks., of which a successful demonstration was given at the Birmingham Mint a week or two ago. Negotiations are in hand for the sale of the American patents, for which a tempting offer has, we learn, been made.

ELECTRICAL NOVELTIES.—An electrical novelty is introduced out by Messrs. Robertson and Co., of 234, Sauchiehall-street, Glasgow, who have on sale an electric night-light, made of best quality nickel plate, with walnut top and base. These night-lights are fitted with three dry cells, with a fairy glow lamp in front, and



are supplied with 12 feet of silk-covered wire cord. The fairy lights are guaranteed for three months. They are supplied with a recess for a watch, over which the glow lamp throws its rays. The illustration shows the novelty complete.

TIME CHECKS.—The illustration below shows the Bristol electric time check (Miles' patent), of which Messrs. King, Mendham and Co., Bristol, are the makers. The time check is specially designed for use in factories and workshops for checking workmen's time, and is the only apparatus of the kind actuated and controlled by electricity. The men are provided with checks, which, at appointed times, are dropped into the slots in the apparatus, which checks are subsequently removed, the numbers registered, and the checks placed upon a board ready for the men to take when next leaving work. The slot in case is electrically opened at appointed times, the time of opening being governed by a clock specially fitted with adjustable contacts, and directly the circuit is broken the slot is closed. If the workmen are in time the checks fall into the proper

receptacle at the base of the apparatus, or through a specially-made opening into the offices behind. If the workman is late, the check falls into a drawer in front of the case, and he then learns that he is late. As the time approaches at which, by the rule of the works, he is re-admitted, the next slot opens and his check is received. The time check is fitted in a polished wood case, and can be provided with as many slots as are found to be necessary. Usually two slots only are required, marked "Early" and "Late," as shown in the illustration. The apparatus is supplied in a portable form, and can be used either occasionally or regularly. It is claimed that there is no special clockwork and no complicated parts ; that no fixing is required; that one clock can be fitted to work as many time checks as are necessary, and that any ordinary clock can be adapted for use for the apparatus.

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THE ENGLISH ELECTRIC CARBON COMPANY.—It is a matter for regret that all the carbons used in England for arc-lighting have hitherto been imported from abroad. The best quality, which must be used to attain the best results in this system of lighting, come from the Continent, while the inferior quality used with much less satisfactory results are an American product. Under the title of the English Electric Carbon Company (Limited), a company has been formed to enter commercially into the manufacture of electric light carbons. The chairman of the Company is Mr. John H. Darby, the Managing-Director of the Brymbo Steel Company (Limited), and amongst the Directors are Sir H. B. Robertson and Mr. J. C. Edwards, of Ruabon. The secretary and manager is Mr. T. Graham Littleboy. The factory has been erected at Brymbo in North Wales, on the most modern lines, equipped with special machinery and appliances, and is now in full operation. The Company have secured the rights to all the trade secrets and methods of manufacture of one of the best carbon makers on the Continent. A laboratory and testing room are provided, and the utmost care is used in the selection and treatment of materials and the testing of the carbons. Sizes from 8mm. to 20mm. are quoted in this Company's list.

THE "ENGINEERING MAGAZINE."—A special issue of this magazine is made for January, and is entitled "The World's Fair in Retrospect." The number is crowded with photographic views of the World's Fair, interior and exterior views of the various buildings, and the chief exhibits; and, in addition, contains the usual critical notices on architecture, civil engineering, railways, electricity, &c. Altogether, the number is, probably, the handsomest production of the kind ever published. The photographs and the printing are alike excellent throughout.

MACHINERY AND HARDWARE CATALOGUE.—Messrs. J. H. Hackworth and Co., successors of the Machinery and Hardware Company, forward us their new catalogue of machinery by the principal makers. A large variety of machines and apparatus are illustrated, and very complete particulars are given as to prices, sizes, &c.

ELECTRO-HARMONIC SOCIETY.—A smoking concert will be held on Friday, the 26th inst., at the St. James's Hall Restaurant, Regent-street, W., at eight o'clock. A varied and excellent programme is provided.

ENGINEERING AND MACHINERY DIARY, 1894.—This is the title of a new diary, compiled by Mr. J. S. Jeans, and published by Messrs. Straker and Sons, London. The contents include a variety of formulæ, tables, &c., and other information of use to the engineering trades.

NEW YEAR CALENDARS.—The Direct Spanish Telegraph Company send us a highly-illuminated hanging pad calendar, in which an improvement is shown over the ordinary issues of this kind by the figures being printed in very bold type, which can be seen at a distance. It is printed in Spanish.——A useful calendar, paper weight and pen brush combined, is sent by the Western Union Telegraph Company.——Messrs. Willcox and Co. send us their useful hanging pad calendar, which, in addition to the usual information, contains illustrations of a variety of specialties for which the firm are well known.——New Year's greetings come from the staff of the Commercial Cable Company in the shape of an ornamental card, on which the famous yacht "Vigilant" forms the centre piece, with horse-shoe mount.——The Indo-European Telegraph Company also issue a pad calendar, upon the back of which is printed an exhaustive tabular sheet of tariffs by the Company's cables.——Messrs. Clarke, Chapman and Co. is another firm of electrical engineers who adopt the hanging-pad calendar, upon which effective announcements are printed.

BATTERSEA.—A motion made at the last meeting of the Vestry to appoint a new special committee to inquire into the electric lighting question was adopted, and the committee was appointed.

BERMONDSEY (LONDON).—The desirability of lighting the Public Baths, Town Hall, and Free Library by electricity has recently been discussed by the Vestry, but the subject has to be shelved owing to the absence of funds.

BIRMINGHAM.—A *conversazione* of the Birmingham and Midland Institute was held on Tuesday evening last, at which there was an exhibition of machinery, models, and electrical appliances by the Birmingham Electric Supply Company (Limited), who supplied current for working the same from the street mains. The arrangements were carried out by Mr. J. C. Vaudrey, the Company's engineer. Amongst the exhibitors were Messrs. Evered and Co., Messrs. F. and C. Osler, the Callender Company, Messrs. Ferranti, and Messrs. Chamberlain and Hookham. Included in the exhibition were a number of stands where machinery in motion, driven electrically, formed a great attraction. Electric cooking and heating were shown, and the exhibition, which closes to-night (Friday), has attracted much attention and has been very popular.

BLACKPOOL.—A discussion took place at the last meeting of the Town Council, and the recommendation of the Electric Lighting and Tramways Committee that Mr. R. Hammond should be asked to advise the Corporation upon some extensions that were in contemplation, was approved. It is contemplated that about £20,000 will be required for the extensions which will be undertaken.

BRAY.—The Electric Light Committee have advised the Township Commissioners to enter into negotiations with the electric-light contractors for the purchase of their plant, &c.

BRISTOL.—A letter has been received by the Sanitary Committee of the Corporation from Mr. George White, secretary to the Tramways and Carriage Company, recommending the use of the Overhead system on the proposed extension of the tramways from St. George to Kingswood. We understand the Committee have the matter under consideration, and are likely to visit Walsall, Darlaston, and Wednesbury in order to inspect the tramways systems there, where about 8½ miles in all are worked by electricity.

BURY.—A proposal by Mr. Bentley at the last meeting of the Town Council, that it was desirable that the Electric Lighting Committee should include in their scheme the introduction of a refuse utilizer, was seconded and carried.

CHESTER.—Some time back the Town Council proposed the selection of the Hop-Pole Paddock as the site for the electric-lighting station for the borough, but the Dean and Chapter of Chester Cathedral recently memorialised the Council against the proposal. It was pointed out at the meeting that the Council had some time back purchased the land from the Dean and Chapter, and it would be necessary now for the Council to pay £3,000 or £4,000 for ground suitable for a site. An expert was to be engaged by the Council to report upon the site and its suitability.

CHICHESTER.—The electric lighting committee of the Town Council have passed a resolution, which has been confirmed, instructing Messrs. Kincaid, Waller and Manville to report to the Council on an electric lighting scheme for the city.

CHURCH LIGHTING.—The Notting Hill Electric Lighting Company have received a very favourable report from the Trustees of Denbigh-road Wesleyan Chapel, Bayswater, where the electric light has been recently installed. The Trustees say that the electric light has proved a great improvement upon the previous lighting arrangements, and that they are about to extend the installation to the Sunday school rooms.

DORCHESTER.—A report has been received by the Town Council from Mr. Newton, of Taunton, who was commissioned to prepare a scheme for the public lighting of the town by electricity. He estimates that the capital outlay would be £6,000, and the annual upkeep about £1,300. In the scheme it is proposed to utilise water-power to some extent. After discussing the matter the Council unanimously decided that it was not, for financial reasons, at present advisable to proceed with the scheme.

DUBLIN.—At the Gaiety Theatre (Dublin) the pantomime of "Little Red Riding Hood" has been successfully produced. One of the scenes is the Glow Worm Glen, and quite a realistic effect is brought about by the introduction of electric glow lamps. Among the ferns and undergrowth about the roots of the trees in the scene numerous tiny incandescent lamps are fixed. These light up and darken alternately in imitation of the glow worm, and in the trees above some small lamps are so fixed as to give the idea of fireflies. This part of the work, which is charmingly effective, has been carried out by Messrs. Porte, Syke and Co.

ELECTRIC ORGANS.—Messrs. Brook and Co., of Glasgow, are erecting in the Dixon Hall, Govan Hill, a large organ to be worked by electricity.

GLASGOW.—The Trustees of the Clyde Navigation Trust have been asked by their Committee of Works to adopt a scheme of electric lighting for Cessnock Dock, and designs and tenders may be invited for an electric power installation for working nine electric cranes, three for each of the berths on the south quay. If the electric cranes prove successful additions will be promptly made, so that the remaining quays may be furnished. At the meeting of the Trust, where these proposals were discussed, after deferring the consideration of that portion of the report dealing with crane appliances, the minutes were confirmed.

GUILDFORD.—At the last meeting of the Town Council the question of opposing the electric lighting Order of the Holloway Electricity Supply Company (Limited) was discussed, and the matter was ultimately referred to the Electric Lighting Committee to be "dealt with."

HALIFAX.—After considerable difficulty a suitable site for the new electricity works has been found, and the purchase was confirmed on Wednesday last by a special meeting of the Town Council. The area is over 4,700 yards, and is so favourably situated that coal can be shot direct into the furnaces from the railway siding, and water is plentiful. The site is known as the Park Mills, situate nearly 400 yards from the site originally selected in Cripplegate.

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HEYSHAM.—A meeting of the ratepayers of the newly-formed district of Sandylands, near Morecambe, was recently held, and the estimate of the Morecambe Gas and Morecambe Electric Light Companies were compared. After discussing the matter it was unanimously decided to adopt the electric light. The installation is expected to be completed in about two months.

LEEDS.—It seemed the general opinion of the members of the City Council at their last meeting that it was advisable to copy the plan adopted by the Edinburgh Corporation in transferring the working of the Leeds Tramway system to a private company under guarantees. Opinion was divided as to whether electricity or cable haulage should be adopted.

MILDENHALL.—The extensive Lark Roller Flour Mills, Mildenhall, have been installed throughout with the electric light, the plant including two "Hercules" turbines in place of the old water wheels. The contract has been carried out by Messrs. W. J. Crampton and Co., of Cambridge.

MONMOUTH.—As mentioned in our last issue, the estimates for the electric lighting and drainage scheme have been separated, and in round figures, £8,000 is the sum required under the electric lighting tenders. A discussion ensued at the last meeting of the Town Council as to the practicability of using the water of the river Wye, and it was ultimately decided to obtain the services of an independent hydraulic engineer to report to the Board upon the working of turbines before putting the work in hand, for which a Provisional Order has been applied for by the Council.

RADCLIFFE.—A sub-committee of the Local Board have reported that the result of their visit to the electric lighting works at Morecambe, Blackpool, Bradford, and Leeds induced them to strongly advise the adoption of the electric light for the district; but, before taking further steps, they recommended the Board to consult an electrical expert as to the system most likely to suit the requirements. The report of the Committee was adopted, and the matter is, we understand, to be energetically proceeded with.

ST. PAUL'S CATHEDRAL (LONDON).—The subject of lighting this cathedral by electricity is engaging the serious attention of the Dean and Chapter. The gas lighting is pronounced fairly satisfactory, but the process of lighting the many burners fitted in the cathedral is a very tedious one, and this and other advantages of the electric light will doubtless ultimately induce the Dean and Chapter to decide upon the latter illuminant.

SALFORD.—Tenders have been accepted for work in connection with the electric lighting scheme. Mains are first to be laid in those thoroughfares from which the largest number of applications for the light have been received.

STIRLING.—At an important conference of business men, held recently, it was resolved to ask the Town Council to abandon its resolution opposing the application of the Caledonian Electric Supply Company for an electric lighting Provisional Order. It was stated that the Company intend, if the Council withdrew their opposition, to make Stirling the centre for supplying the electric light to Bridge of Allan, Alloa, Alva, and other places in the district. The Town Council have, by the casting vote of the Chairman, resolved not to grant the application of the Caledonian Electric Supply Company for a Provisional Order to supply the district with the electric light. The Company will, we learn, proceed with their application, which has received considerable support.

TREHARRIS.—The gas supply in this town is the subject of much complaint, and at a recent meeting of tradesmen it was suggested that the Ocean Coal Company should be asked to supply the district with the electric light.

WAKEFIELD.—Mr. Robert Hammond has presented his report to the Corporation of Wakefield upon the proposed establishment of municipal electricity works in the city. After pointing out the extensive undertakings carried out by many of the local authorities in the country, Mr. Hammond sets out in detail statistics which will be found of service to all authorities contemplating the introduction of the electric light, both for public and private use. He recommends that the Kirkgate site, which the Corporation propose to adopt for their electric lighting station, be substituted for a more eligible position, where ample room for extension is available. He points out that the Corporation have two such positions to select from—one at the proposed sewage works, and the other at the sanitary depot. His estimate of the ultimate cost is based upon the establishment of the works upon the sewage site. Mr. Hammond recommends the high-tension system of supply on the 3-wire system.

WALSALL.—A proposal was before the Town Council on Monday last that a portion of the old Wolverhampton-street Gasworks, including the old boiler, retort and purifying houses and chimney stack, should be set apart for the proposed electric lighting station, and it was further proposed to increase the amount to be borrowed for the electric lighting scheme from £19,650 to £21,900, to cover the additional cost of land and buildings to be taken over.

WEDNESBURY.—Complaint is made of the proposed increase in the price of gas for public lighting, and also of its quality, and suggestions are made that the Town Council should consider the subject of introducing the electric light.

WHITEHAVEN.—At the last meeting of the Harbour Trust the Chairman said that the generating plant had proved sufficient for applications for the electric light received to the present time, but there was no doubt additional plant would shortly have to be put down. They had already applications on hand for anadditional 480 lamps, and the plant was now nearly running to its utmost capacity. The accounts to be presented in March would be so satisfactory as to justify the trustees in duplicating their plant. The private demand for the light had considerably exceeded all expectations.

WIGAN.—A circular has been sent round to tradesmen in the town quoting the terms on which the Corporation are prepared to supply electric current, and asking what support the recipients were willing to give the scheme if carried out by the Corporation.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

December 28, 1893.

24,926. W. BRIERLEY. Halifax. Improvements in the method of, and means employed for, completing electric circuits. (P. Weber and J. Heinrich, Germany.)*

24,946. F. S. RANDALL, E. PACKARD, J. ROBINSON, and W. J. CHANINEL. London. Improvements in coverings for electric wires.*

24,948. E. C. DE SEGUNDO and W. DERHAM. London. A time electric switch.*

24,951. F. H. NALDER, H. NALDER, C. W. T. CRAWLEY, and A. SOAMES. London. Improvements in electrical measuring instruments.

24,966. R. J. LATIMER. London. Improvements in, or relating to, the production of electrotype plates for printing purposes.

December 29, 1893.

24,979. W. THOMSON (Baron Kelvin). Glasgow. Improvements in instruments for measuring and recording electric pressures and currents.

25,009. F. W. SCHINDER. London. Electric heater, and its application to electric cigar lighters.

25,013. F. HALLOWS and F. J. BEAUMONT. London. Improvements in or connected with apparatus for feeding carbons in electric arc lamps.

25,016. H. H. LAKE. London. An improved rosette for electric wires. (W. B. Rand, United States).*

December 30, 1893.

25,056. F. LYST. London. Improvements in incandescent electric lamps.

25,082. J. W. T. CADETT. London. Improved means for arranging and intensifying the magnetic fields of dynamo-electric machinery.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d. each.

1892.

23,460. BARNETT. Electromotors.

23,774. NIEWERTH. Electric arc for lighting.

1893.

601. HUGHES. Electric incandescent lamps.

775. CONRADY. Electric arc lamps.

1,661. ANDREOLI. Electrolytic apparatus.

1,683. LOTT. Electric arc lamps.

2,272. HOLT. Electric light hangers.

3,118. EDMUNDS. Electrical conductors.

3,119. EDMUNDS. Forming solid ends on electrical conductors, &c.

3,152. BEAL. Electrical pendulum indicator.

7,600. SALOMONS. Electrical heating apparatus.

16,226. EGGER and others. Electric cars.

180,64. EDISON and SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED) and BELL. Electric switches.

18,990. THOMPSON. (Coffin.) Electrically heating or working metal.

20,408. KINNIBURGH. Ear pieces for telephone receivers.

20,715. RUCKERT. Electrical heating apparatus.

21,324. DE FERRANTI. Electric cables.

21,628. DELANY. Telegraphy.

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COMPANIES' MEETINGS AND REPORTS.

Fowler-Waring Cables Company (Limited).

The Directors' report, to be presented to the shareholders at the fifth ordinary general meeting, to be held at the offices, 32, Victoria-street, London, S.W., to-day (Friday), at twelve, contains the following :—

The Directors have passed their fees for this year to the credit of this account, which thus shows a net profit of £1,990. 5s. 3d. Out of this profit the Board proposes to write £1,329 off the value of shares in other companies, which now stands in the balance-sheet at £2,115, thus reducing this item for next year to £786, at which price they may safely be left for the present, and to carry forward the balance of £661. 5s. 3d. to the credit of next year. The shares in other companies were taken in part payment of contracts, and practically represent the profit on cables supplied. The Directors believe that they will earn dividends, and become saleable at par or over in due course ; but in the meantime they deem it desirable to reduce the estimated value. On turning to the balance-sheet, shareholders will notice that the Directors have placed the whole of the fees, hitherto credited, but not drawn by them, to the credit of that account, and they have thus been able to strike out the balance of loss as it appeared in last year's balance-sheet, and to write off £1,209 4s. 10d. from the preliminary expenses. No allowance has been made for depreciation of plant and machinery, but all has been fully maintained and repaired from revenue. The stock has been taken with great care, and valued throughout at or below cost.

The Company's business has continued to increase, the sales being considerably in excess of last year, whilst the gross profits have, on the whole, and notwithstanding severe competition, been well maintained. The Directors recently made a temporary issue of £10,000 in Five per Cent. Debentures, repayable in September, 1894. With the exception of £1,000 taken by one shareholder, the whole of this amount was either subscribed or guaranteed by Directors. In view of the immediate necessity of providing additional capital to meet the growing business of the Company, and to pay off the debenture debt, the Directors are negotiating for a fresh issue of £25,000, on Debentures to be secured against the general assets of the Company, which in the meantime have largely increased, and afford, in the opinion of the Board, ample security for such an issue. Meanwhile, the Directors are still confident that, with sufficient capital and ordinary fortune, the Company's affairs must continue to improve.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, pages 320-348, *&c., &c.*]

ELECTRIC EXPLOITATION COMPANY (LIMITED).—This Company was registered on January 4th, with a capital of £25,000, in £1 shares, to carry into effect an agreement with Max Sussmann for the acquisition of certain existing inventions relating to manufacture, and to deal in, secondary battery plates, secondary battery lamps and dry electrolyte for secondary batteries, and other inventions relating to the generation, storage, distribution and employment of electricity, and to carry on the business of an electric light, heat and power supply company in all or any of its branches, electrical and mechanical engineers, lamp manufacturers, metal and wood workers, metallurgists, &c. The subscribers, with one share each, are :— A. H. Tredwen, H. T. Godrich, E. J. D. Hewitt, W. Wood, J. A. Buchanan, V. C. Doubleday, and P. C. Atkins. The first Directors are :—John A. Buchanan and V. C. Doubleday.

PORT BEIRA PIER, TRAMWAY, AND TELEGRAPH COMPANY (LIMITED). This Company was registered on January 6, 1894, with a capital of £150,000, in £1 shares, to carry into effect an agreement between Joan R. Davies and Herbert Edwards, to acquire telegraphs, telephones, electric lighting, heating, and power works, &c. The subscribers, with one share each, are :—O. Heindorf, A. C. Heindorf, W. H. Talbot, G. F. Rooper, R. W. Elder, Ernest Roney, and H. Bowles. The first Directors are :—R. Bensusan, Count de Mendia, C. Algernon Moreing, and (after allotment) R. G. Webster M.P.

RUGBY SCHOOL ELECTRIC LIGHTING COMPANY (LIMITED.)—The statutory return of this undertaking, made up to November 28th, has been filed. 70 shares out of a nominal capital of £5,500 in £50 shares have been taken up, upon which a call of £25 per share has been made, and £1,750 paid in respect thereof. The shareholders are the Head Master and Assistant Masters of Rugby School, no outsiders being admitted.

SALT LAKE AND OGDEN GAS AND ELECTRIC LIGHT COMPANY (LTD.).— Evidently the intended purchase of the business of an American company of a similar name has not yet been completed, as, at the time of making up the statutory return recently only the seven signatories' shares had been subscribed for, no calls having been made.

TELEGRAPH IMPROVEMENT COMPANY (LIMITED).—The annual return of this Company, made up to December 22nd, has been filed. 15,006 shares out of a nominal capital of £100,000 in £1 shares have been taken up, 15,000 of which were issued as fully paid, while the full amount has been called and paid on the remainder.

CITY NOTES, &c.

CITY AND SOUTH LONDON RAILWAY.—The traffic returns of this Company for the week ended January 7th, were £990, as against £998 for the corresponding period of last year, being a decrease of £8. The total receipts for the half-year amount to £990, as against £998 for the corresponding period of 1893, a decrease of £8.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend of 3s. per share (free of income-tax), being at the rate of 3 per cent. per annum, for the quarter ended December 31st last (such dividend to be payable on and after the 24th inst.), carrying forward £3,080. 10s. 10d.

DOVER.—The *Dover Express* states that there was a fair demand for the Dover Electric Light Company's shares, and that although all were not applied for, sufficient capital was forthcoming to justify the Company in proceeding with the works.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY (LIMITED).—This Company announce the payment on February 1st next of the interest due January 31st on the Company's Four per Cent. Mortgage Debenture Stock. The register will be closed from the 27th to the 31st inst., both days inclusive.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company for December, 1893, amounted to £20,800, and from January 1 to December 31, 1893, to £269,200. In the corresponding months of 1891 and 1892 the amounts were £282,600 and £266,400 respectively.

PORT BEIRA PIER, TRAMWAY, AND TELEGRAPH COMPANY (LIMITED). The prospectus has been issued of a company bearing the above title, with a share capital of £150,000, in £1 shares. The Company is formed for the purpose of acquiring and working privileges and concessions granted by the Mozambique Company for the construction of piers and landing stages, tramways, telegraphs, and telephones in the port and town of Beira on the East Coast of Africa.

SALT LAKE AND OGDEN GAS AND ELECTRIC LIGHT COMPANY (LIMITED).—It is stated by the *Financial News* that on January 2nd interest was paid on the bonds of this Company, which was organised in 1893 to take over the gas and electric light works of the cities of Salt Lake and Ogden, in Utah, U.S.A. (See also paragraph under "Statutory Declarations.")

WESTERN UNION TELEGRAPH COMPANY.—The following is the report of this Company for the quarter ended December 31st last :—The condition of the Company at the close of the quarter ended September 30th last is as under :—

Surplus July 1, 1893, as per last quarterly report, ……		\$6,888,457 66
Of which (on account of sundry fractional and other items aggregating $16\frac{38}{100}$ shares) there has since been capitalised by the issue of additional capital stock, for the purpose of equalisation, and that the outstanding capital stock issued shall be exactly \$94,820,000, …		1,638 00
Less which leaves ……		6,886,819 66
Net revenues, quarter ended September 30, 1893 ……		1,749,615 22
		\$8,636,434 88.
From which, deducting for dividend of 1¼ per cent. paid October 15th ……	\$1,184,992 50	
Interest on bonded debt ……	223,262 25	
Sinking funds ……	20,000 00	
		\$1,428,254 75
Left a surplus October 1, 1893, of ……		\$7,208,180 13
Surplus October 1st, as above ……		\$7,208,180 13
The net revenues of the quarter ended December 31st instant, based upon nearly completed returns for October, partial returns for November, and estimating the business for December, will be about …		1,550,000 00
		\$8,758,180 13
From which, appropriating for interest on bonds ……	\$223,262 25	
Sinking funds ……	20,000 00	
		243,262 25
		\$8,514,917 88
It requires for a dividend of 1¼ per cent. on the capital stock issued ……		\$1,185,000 00
Deducting which leaves a surplus, after paying dividend, of ……		\$7,329,917 88

In view of the preceding statements, the Committee recommend the adoption by the Board of the following :—*Resolved*, That a dividend of 1¼ per cent. on the capital stock of this Company be hereby declared payable on and after January 15th next, to stockholders of record at the close of the transfer books on December 20th instant. *Resolved*, That for the purpose of such dividend the stock books of the Company be closed at three o'clock on the afternoon of December 20th instant, and be reopened on the morning of January 2nd next. (The dividend order, when properly filled in, may be collected through any bank on or after January 15th).

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WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the week ended January 5th (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £3,037.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the two weeks ended December 31st were £2,563, as compared with £2,706 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Jan. 3.		Price Wednesday, Jan. 10.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Jan. 10.	
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,134,640	Stock	12/6	Anglo-American	43	45	42	44	6 5 0	Jan., Apr., July, Oct.	..	..
£2,932,680	Stock	25/0	Do. Preferred	81	82	79½	80½	6 16 8	" "	81⅝	80½
£2,932,680	Stock	5/0	Do. Deferred	7½	8	7	7½	..	..	7½	..
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer) xd	99	102	99	102	3 18 5	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	11¾	12¼	11½	12	5 8 4	Mar., June, Oct., Dec.	11⅝	11 9/16
£18,700	£100	5%	Do. 5 per Cent. Bonds	101	104	101	104	4 16 2	January and July ..	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906) xd	107	111	107	111	4 10 1	June and December	..	–
10,000,000	$100	7%	Commercial Cable Capital Stock	130	140	130	140	5 0 0	Jan., Apr., July, Oct.	–	–
16,000	10	8/0	Cuba Submarine	11½	12½	11½	12½	6 8 0	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	18	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October ..	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	..	..
60,710	20	3/6	Direct United States Cable, 1877	11⅝	11⅞	11⅝	11⅞	6 3 4	Jan., Apr., July, Oct.	11¼	11 1/16
400,000	10	2/6	Eastern	15	15½	15	15½	4 5 3	" "	15¼	15
70,000	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16¼	3 13 10	" "	16 1/16	15⅞
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	116¼	114
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	108	111	108	111	4 10 1	February & August	..	..
250,000	10	2/6	Eastern Extension	15⅝	15⅞	15⅝	15⅞	4 8 2	Jan., Apr., July, Oct.	15¾	15⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	114	117	115	118	3 7 10	February & August	116¾	116
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900 xd	101	104	101	104	4 16 2	January and July ..	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900 xd	101	104	101	104	4 16 2	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103	106	103	106	3 15 6	February & August	..	..
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	106%	109%	106%	109%	3 13 5	May and November	107¾	..
180,227	10	1/6	Globe Telegraph and Trust	8⅝	8⅞	8½	8¾	5 2 10	Jan., Apr., July, Oct.	8 11/16	8⅝
180,042	10	6%	Do. 6 per Cent. Preference	15⅛	15⅝	15⅜	15⅝	3 16 10	" "	15 9/16	15 1/16
150,000	10	5/0	Great Northern xd	20	20½	19¾	20¼	4 4 2	Jan., April, and July	20⅛	20
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 14 4	March & September	..	..
17,000	25	12/6	Indo-European	41	44	41	44	5 13 7	May and November	43	42½
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	3 6 8	" "	..	–
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	105	108	5 11 1	March & September	105	–
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red" 1942 xd	100	103	100	103	3 17 8	..	..	..
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October ..	..	..
3,381	£100 Cert.	35/0	Submarine Cables Trust 6 per Cent.	114	119	114	119	5 0 10	" "	115	..
15,609	10	5/0	West African Telegraph	5½	6½	5½	6½	7 13 10	January and July ..	..	..
£249,900	100	5%	Do. 5 per Cent. Debentures	99	102	99	102	4 18 0	March & September	..	..
30,000	10	2/0	West Coast of America	2	3	1½	2½	..	January and July ..	2	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902 xd	97	101	97	101	7 18 5	June and December	..	..
88,321	10	1/0	West India and Panama	1	1½	1	1½	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10¼	9¾	10¼	5 17 1	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917 xd	105	108	105	108	4 12 7	June and December	..	..
64,242	15	4/6	Western and Brazilian	6	6½	6	6½	3 9 4	May and November	6¼	6 1/16
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5¼	5¾	5¼	5¾	..	..	5⅝	5½
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¼	1¾	1¼	1¾	..	..	..	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	104	107	104	107	5 12 2	February & August	..	..
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	104	107	104	107	5 12 2	" "	..	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	105	102	106	5 13 2	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	–	..	–
224,850	10/0	3¼d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
220,000	£1	4·76d.	Oriental Telephone and Electric (11s. paid)	¼	⅜	¼	⅜	5 6 5	Yearly	..	..
484,597	5	2/6	National	4⅝	4⅞	4⅝	4⅞	5 2 7	June and December	4⅞	4½
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	13½	14½	14	15	4 0 0	" "	14¾	–
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	13½	14½	13½	14½	4 2 9	" "	14½	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅛	5⅝	5¼	5½	4 10 11	..	5⅝	5 5/16
925,017	£100	4½%	Do. Deb. Stk. 4½% xd	111	113	112	114	3 18 11	January and July ..	113	112⅛
58,000	5	1/0	United River Plate	2	2½	1½	2		" "	1½	–
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock xd	90	100	90	100	5 0 0	" "	..	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11¼	11¾	11¼	11¾	–	..	11⅝	..
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	13	13½	13	13½	..	–	13 7/16	13¼
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	–	–
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	–	..	–
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	–	–
8,322	£5	..	House to House Electric	..		..		..	–	–	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		..	–	..	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July ..	..	–
30,000	£5	1/9	Liverpool Electric Supply (£3 10s. paid)	4½	4¾	4½	4¾	..	–	..	–
15,000	£5	2/6	Do. (fully paid)	6¼	6¾	6¼	6¾	..	–	..	–
111,000	5	..	London Electric Supply	¼	¾	¼	¾	..	..	..	..
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	7¾	8¼	8	8½	2 7 1	..	8¼	7 15/16
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	103	106	104	108	4 12 7	June and December	105½	..
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½		–	..	..
19,980	£5	9½%	St. James' and Pall Mall	5¼	6	5¾	6¼		–	6⅛	5⅞
20,000	£5	7%	Do. 7 per Cent. Preference	7¾	8¼	8	8½	4 2 4	–	8 1/16	8⅛
59,900	5	1/6	Westminster Electric Supply (fully paid)	5	5½	5	5½	3 3 8	–	5¼	5 3/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	8	2/1	Brush Electrical Engineering	2⅜	2⅝	2⅜	2⅝	6 17 1	–	2 9/16	2⅜
90,000	2	6%	Do. 6 per Cent. Preference Non-Cumulative.	2	2¼	2	2¼	5 6 8		2⅜	2 1/16
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	105	107	104	106	4 4 11	March & September	104	..
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	4	4½	4	4½	..	January and July ..	..	..
12,139	5	..	Edison and Swan United			–		–	–	..	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		–	–	..	..
120,000	2	..	Electric Construction	½	1	½	1	..		..	..
12,845	2	..	Do. 7% Cumulative Pref.	..		1	1½	..	..	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜		–	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½		–	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	21½	22½	22	23	5 8 8	February & August	22⅝	22½
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	–	..	..
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	–	–
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/0	4/0	3/16	5/16	..	..	–	..
78,949	5	3/6	Swan United (£3. 10s. paid) xd	2¼	2¾	2¼	2¾	..	May and November	2⅝	..
37,350	12	12/0	Telegraph Construction and Maintenance	36	38	36	38	4 9 1	March and July	37½	36
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894 xd	103	106	103	106	4 14 4	January and July	–	–
37,514	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		–	–	–	–
41,098	£5	..	Do. Preference (fully paid)	..		..		–	–	–	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	¾%	City and South London Railway	28	33	28	33	2 5 5	May and November	..	–
87,500	£10	..	Liverpool Overhead Railway	5	5¼	4¾	5⅛	–	–	–	–

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THE ELECTRICIAN:

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NOTES.

The practice of allowing a coroner's jury to append riders to their verdicts often gives opportunity for the expression of sensible opinions, but it is not without serious danger. The inquiry into the death of a man at the Blackfriars transformer station resulted in a verdict which calls for no remark, but was accompanied by the recommendation of the use of rubber gloves. We hope that any harmful result of this well-meaning but mistaken idea may be over-ruled by a simple and effective regulation by the Board of Trade. On this occasion the supply company has not made the smallest attempt to shelter itself behind a pair of rubber gloves, and is ready to condemn the false security offered by this cheap but ineffectual precaution. We threw out a suggestion that barriers or doors in such stations might be interlocked with the switches; but this may be difficult to arrange in practice. Major Cardew's proposal for a red pilot lamp on each transformer seems excellent at first sight; but it must be remembered that if the small transformer for the lamp, or the fuse, or the filament of the lamp, fails, the attendant would think that the current had been shut off, and that there was no danger. Any device of this kind must be absolutely trustworthy. We understand that none of the men put in charge of the London Corporation's sub-stations have been in their service for less than four years, and that the man who was killed had been with them for six years. It is estimated that he had changed-over sets of transformers on about one thousand occasions before the accident. Under these circumstances, what would be the use of a printed card, "Danger! Please see that the switches," &c., &c.

The consideration of the voltage in the insulation rules, which we discussed last week, has not been entirely left out of consideration, as Mr. Human suggests in his letter to us on the subject. Nearly half of the rules state that the test is to be made at 100 volts. We have prepared a diagram to illustrate Mr. Human's proposed rules, and have printed it with his letter. The curves are plotted in the same way as our diagram last week, but on a smaller scale. It is noteworthy that the insurance companies have hitherto been content with much lower insulation than the average demanded by supply companies. Mr. Human's proposal, simple and practical as it is, can hardly be said to be the average of modern practice; it appears to be about double. Half the volts divided by the number of lamps, or half the insulation suggested by Mr. Human, may be represented by a curve exactly between curve I and curve T in our diagram on p. 265 of our last issue. Three formulæ may be given for this curve. Half the volts divided by the number of lamps, or 50 megohms divided by the lamps, or, $\frac{1}{10500000}$th part of the whole current. The last form is convenient enough when only $\frac{1}{5000}$ part is specified, but becomes unwieldly in the present case.

With an enterprise worthy of the position which it holds among London newspapers, the *Pall Mall Gazette* is the first large London daily to put down electric motors for driving its presses. Two 40-H.P. "Manchester" motors have been supplied by Messrs. Mather and Platt. They take their current from the outer conductors of the Charing Cross and Strand Company, at 200 volts. The motors run at 800 revolutions, and the main line of shafting at 175. Want of space prevented direct-driving, and a countershaft running at 300 is therefore used. Jaw clutches allow either or both motors to drive. We had the privilege of seeing the plant started for the fourth edition yesterday afternoon. The ammeters showed no appreciable current when running the shafting on light load. A Hoe double-insetting supplement press, folding, cutting, pasting, and arranging in quires, was started by striking gear, and the ammeters showed about 75 amperes each, the speed of the motors hardly varying at all. The supply company thus improve their day load with but little interference with their lighting.

We publish in another column a Paper read by M. Claude before the Société Internationale des Électriciens, describing some striking results obtainable with alternating current circuits. The object of the writer was to devise some means for diminishing the danger of touching one of a pair of high-potential mains traversed by alternating currents. This danger cannot be got rid of by insulating each main from the earth, since in many cases it is due to the capacity which each main has between it and the ground. But M. Claude shows that, by actually connecting each main to the earth, through a choking coil of *low* resistance, and possessing a suitable amount of self-induction, the mains behave as if there were no capacity effect to earth, and can, under these circumstances, be touched without harm, provided that the mains are not connected to earth through a leak having no appreciable self-induction in it. The mains, in fact, behave like a Leyden

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jar, which, although very highly charged, may, nevertheless, be touched with impunity, provided it is insulated from earth. It does not, however, seem very probable that high-potential mains will be kept permanently connected to earth through choking coils in the manner suggested. The expense of well-insulated coils of the description needed would be very great if the chance of a breakdown were properly ensured against. Moreover, the result mentioned by the writer, that he has managed, by means of the use of a suitable choking coil, to reduce the condenser current from the mains to earth to only 4 per cent. of its value when no choking coil was used, is one which cannot be attained at all easily in practice.

There have been, so far as we remember, only three attempts to apply simple reciprocating motion, instead of rotary movement round an axis, to the armature of a dynamo. The first of these was the "thunder-pump," a magneto device used for ringing-up in the early days of telegraphy. Perhaps this instrument ought not to be classed as a dynamo, but it was a practical success in its day. As much cannot be said for the Edison tuning-fork dynamo. Electrically, this second attempt was reasonable, but it was mechanically impossible and absurd. The third reciprocating dynamo is that of Nikola Tesla. This was first shown in a lecture delivered by the inventor before the Chicago Congress, and is illustrated and described elsewhere in our present issue. The account, for which we are indebted to the *Electrical Engineer* of New York does not allude to the principal object in view in designing this machine. We understand, from the reports of the lecture, that high frequency was Mr. Tesla's aim. In the *Electrical Engineer* of New York, for August 30, 1893, we find that a mass of about 20lb. was kept in vibration with a stroke of ⅞in. at a frequency of about 80 per second, "but by shortening the stroke the weight could be vibrated many hundred times, and has been in other experiments." This result seems hardly sufficient to justify so complete a departure from ordinary practice, but on looking up the subject we found some more figures in the *Electrical World* of New York, for September 2, 1893. "The piston is operated by compressed air at 60lb. per square inch. . . . The compression reaches as much as 16 tons. . . . The number of oscillations used at the lecture was from 50 to 90 per second, although from 5,000 to 10,000 per second have been obtained, and as many more as desirable"!

"The principle underlying" Mr. Hammond's method of coping with the examination of sixty tenders is set forth in our Correspondence columns for the instruction of those who failed to understand our explanation of it last week. These figures are a mere show, they mean nothing; they have this in common with other "business methods." We defy Mr. Hammond to explain how a credit of £37. 10s. is intelligently arrived at as the value of the credit "for superior accessibility and permanence" of one class of boilers over another. We say this the more of the £1 per sq. in. of bearing surface. The bearing surface of an engine may be sufficient, deficient, or excessive. Engine bearings either give no trouble, or they give trouble. The nuisance, the thoughtlessness, and the danger of permitting an engine to be used of which the bearings are considered to be improperly designed are so great that it is impossible to assign even an approximate money value to the fault; to do so may be a "business method," but it is one which we are glad to think is altogether unknown in engineering. It should be observed that, if Messrs. Yates and Thom had been credited with an excess of exactly 17½ sq. ft. of bearing surface over the 84 sq. in. of Messrs. Davey, Paxman and Co., the value of their engine, £2,520, would have been exactly doubled by the "allowance," calculated on Mr. Hammond's system. Any student at a technical college can give Mr. Hammond reasons for providing something less than 17½ sq. ft. bearing surface. The "volume swept by the pistons per minute," the steam consumption, and the mechanical efficiency, are all parts of one and the same quantity. To separate them in this case is to confuse them. A bonus and fine, included in the specification and decided by steam trial, as in the Admiralty tests, is an excellent system, but calculation from the guaranteed, or in some cases not guaranteed, figures of the makers is useless. The object is confessedly not to alter the actual price, but to show the Newport Corporation "the nature of the choice that lay before them." What if the figures were found after all to be wrong? Mr. Hammond asks if any of our readers "can suggest a sounder method of dealing with such tenders," and says that he would be glad to know of it through our columns. It is really asking a good deal of our readers to expect them to instruct Mr. Hammond in the branch of the profession which he has so recently joined.

With regard to the letter from the Secretary of the Brighton and Hove Company, the names of the makers of the plant of that Company are quite sufficient to attest its value as good machinery, and we had no intention of depreciating it, and regret that the words used have been taken to bear such an interpretation. We referred, of course, to the offer made by the Brighton Corporation, which has been accepted by the Company. This offer, as our readers will remember, was as follows:—The Corporation to purchase the Company's undertaking for the sum of £5,000, one-half of which sum to be paid on September 30, 1894, and the other half to be paid within one month of it being certified to the Corporation that the overhead wires, posts and apparatus belonging to the Company have been removed to the satisfaction of the Borough Surveyor; the Company to continue to supply their own customers until September 30th, bearing all the expense and receiving all the revenue.

Mr. Henniker Heaton, having scored less than nothing by his intrusive importunities respecting colonial postage and telegraphs, is now asserting himself in regions nearer home. He wants to reduce the rate for telegrams between France and England to 1d. per word, or, more correctly, to forestall such reduction and take credit for it if it should occur. His information on this point, however, like much else that he is in the habit of parading with oracular confidence, turns out to have no

foundation. There is no condition attaching to the Anglo-French telegraphic agreement of 1889 that the rates should be revised in 1894. Mr. HEATON argues that, in the event of a revision, 1d. per word would suffice, that being the sum of the inland rates of the two countries. The POSTMASTER-GENERAL declined to see it in that light, remembering probably that France, though one of the nearest, is not the only foreign country with which we are connected by cable, and that international barriers, as well as the cost of cables, count for something in the framing of tariffs. That Jersey benefits by the English inland rate, while France does not, is an anomaly for which Mr. HEATON will find plenty of precedents if he will turn his attention to the rates prevailing between towns on opposite sides of continental frontiers, however near those towns may be.

THE chief alteration in the coloured map which forms the supplement to this issue, as compared with our map of last year, is the extension of the City mains. The Chelsea Company has run down the King's-road, but the London Company has followed it, and is in active competition. The Metropolitan Company and St. Pancras Vestry have thrown out a branch or two, but the additions to the mains have, on the whole, been made by "drawing in" additional conductors rather than by advance into new streets.

Dublin.—The Local Government Board have sanctioned the loan of £24,400 for the extension of the electric lighting system.

Electrical Standardising, Testing, and Training Institution.—Mr. James Swinburne is now giving a course of lectures in "Dynamo and Transformer Construction" to the students of this Institution.

The Srinagar-Gilghit Telegraph Line.—The telegraph line to Gilghit, says the *Indian Engineer*, though not completed on a permanent basis, continues to work satisfactorily in spite of the snowfall on the Kashmir passes.

The Telegraph on the West Coast of Africa.—The telegraph system on the West Coast of Africa is being gradually extended. This week it has been notified that a station has been opened at Lomé, in Logoland (German territory), the place being reached by land line from Accra. The line is to be extended shortly from Lomé to Little Popo.

Lighthouse Communication.—The last of the difficulties which have stood in the way of the completion of the arrangements for the telephonic connection of the Goodwin lightships with the shore are now removed, the Ramsgate Corporation having granted the necessary permission for carrying the wires through to the town post-office. The connection will be direct between the North Sand-head lightship and the Ramsgate post-office.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
Lagos-Brass	Dec. 4th, 1893	Jan. 11, 1894
Cayenne-Paramaribo	Oct. 25th, 1893	—
Cayenne-Vizeu	Nov. 25th, 1893	—
Haiphong-Hongkong	Dec. 11th, 1893	—
Garachico-Santa Cruz de Palma	Dec. 27th, 1893	—
Penang-Medan	Jan. 14th, 1894	—
Bonny-Cameroons	Jan. 15th, 1894	—
Foochow-Shanghai	Jan. 15th, 1894	—

Standardising Electrical Instruments.—We are informed that the Owens College Physical Laboratory is prepared to test a limited number of electrical instruments free of charge. The testing will be carried out with all due precautions by qualified assistants, under the superintendence of the Director of the Physical Laboratory. The electrical standards of the laboratory will be compared from time to time with the standards of the Board of Trade, and every effort will be made to ensure accuracy. All inquiries should be addressed to Professor Arthur Schuster, Owens College, and headed "Physical Laboratory Testing Department."

Electric Traction at Hartlepool.—We understand that a syndicate has been formed which has purchased the Hartlepool tramways for the purposes of equipping them with the overhead system. The promoters appeared before the Works Committee of both West Hartlepool and Hartlepool Corporations on Thursday the 11th inst., and after having explained their intentions, the Committee decided to report in favour of the proposition to the Council. We learn that the system is to be considerably extended.

Premiums and Pupils at the Bristol Municipal Electric Light Station.—The question as to whether the engineer to the Bristol Corporation shall be allowed to employ improvers at the Corporation Electrical Works has at length been determined. There has been considerable contention on the matter, and various proposals have been made from time to time. The arrangement come to is that Mr. Faraday Proctor shall be allowed to take two pupils for a period of two years, at a premium of £100 each. Mr. Proctor's share of the £100 will be £15, and the remainder will be placed to the credit of the city.

Newport.—The Parliamentary Committee of the Newport Corporation met on Tuesday to consider the electric lighting report, which was referred back to them for reconsideration by the Council. There was a large attendance. Mr. Hammond, the consulting electrical engineer, was present. Mr. Crompton was granted an audience with the Committee. The discussion upon the question of the alleged "shelving" of Messrs. Crompton's contract occupied a considerable amount of time, and we understand that the *pros* and *cons* of the case were debated at some length by Messrs. Crompton and Hammond. However, no decision was come to in the matter, the consideration of the question being adjourned.

The Government and the Telephones.—Mr. Provand has set down for next session, notice of motion that a Select Committee be appointed to inquire into and report on the proposed arrangement between the Post Office and the National Telephone Company, and generally on the future policy of the Post Office with reference to the extension of the telephone service. We understand, says the *Pall Mall Gazette*, that although the terms of the agreement between the Post Office and the National Telephone Company have not yet been submitted to Parliament they have been practically settled, subject to ratification by the department after the House of Commons has had the promised opportunity of discussing them.

The Halifax-Bermudas Cable.—Strong pressure, says a *Times* correspondent, is being brought to bear upon the Canadian Government by business men in Canada to induce it to grant the extension of the Halifax-Bermudas cable to Jamaica. The leading shippers have been interviewed on the subject, and they hold the extension of the cable to Jamaica and other islands to be absolutely essential to the development of Canadian trade. Four steamers a month are now running from this port to those islands, but business is very much restricted by the high telegraph rates charged, and by the fact that the daily quotations of prices published in the West Indian newspapers come from New York. The extension of the Bermudas cable would make it possible for the Canadian market prices to be published in the West Indies side by side with the American quotations; and with the advantage of cheaper cable rates Canadian trade would be largely increased.

Proposed Adoption of Electric Traction at Bristol.—The Bristol Tramways Company are seeking powers to extend their line to Kingswood, and to work the section by means of electricity. The Directors have decided upon the overhead trolley system. At their invitation the members and officials of the Kingswood and St. George Local Boards inspected the South Staffordshire system on Friday last. At the inevitable dinner, the Mayor of Walsall, said that their system of electric traction had been eminently satisfactory to the town of Walsall; and he had never heard a single inhabitant say a word against it. The ex-Mayor (Mr. Job Wheway) followed,

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and said that the steam trams were a very great nuisance, but there had been no cause to regret the introduction of electric traction. On the contrary, the local authorities were very thankful for it, and it had been the means of bringing Walsall a bit to the front. It was quite a pleasure to travel on the electric cars, and they felt proud in Walsall that they were wise enough to adopt the system which the deputation had inspected that day. He was one who originally did not believe in the system of electric traction, and he opposed it because he thought it would be a failure. He looked at the posts on paper and thought what hideous things they would be. But he was prepared that day to say that he was penitent, that he recognised his past sinfulness, and that he recognised the advantages they now enjoyed through the system.

Car Brakes.—The following is from the *Electrical Engineer* of New York:—"The recent animated discussion in our pages on the desirability of some better method of car control has received a noteworthy contribution in an accident that occurred at Troy, N.Y., on December 28th. It appears that a car on the Troy City line got away from the motor man. Brakes were applied, but although the wheels ceased their revolution they skidded and the car went on with increasing momentum. The sand-box was freely used and other sand thrown on the track, but to no avail. There was nothing left for the passengers but to jump out. One lady in doing so broke her leg. The motorman stuck bravely to his post on the car, which, after knocking over a fire alarm pole and breaking off at its base a telephone pole, plunged headlong against a building which it shook violently and with a great noise. The car was smashed to pieces, and the motorman was so badly injured that he may not recover. Had not the car butted the building at the foot of the hill it would have committed suicide in the Hudson just beyond. It would seem that this was a casualty that might have been avoided. It should have been possible to reverse the motor instantly, and run up the hill. This was not done, probably because it could not be done with the brakes jammed. As a rule, the brakes on street cars are none too good; but even when they are at their best such accidents happen. That better, or additional, means of control are needed is obvious."

Electricity and Steam Power in Switzerland.—Our contemporary, the *Engineer*, publishes an extract from a recent report of the United States Consul at Chemnitz, Saxony, which it rightly remarks will be of interest to those engaged in applying the waters of Niagara, &c., to the electrical transmission of power to the United States mills and shops. The following table, published at Chemnitz, shows what 50, 300, and 500 H.P. costs per horse-power per annum in Bohemia, England, Germany, and Switzerland:—

Country.	Up to 50 H.P.	Up to 300 H.P.	Up to 500 H.P.
	£ s. d.	£ s. d.	£ s. d.
Bohemia	5 14 7	3 1 6½	2 14 2½
England	5 1 0¼	2 12 6	2 1 4
Germany	6 1 9	3 4 9	2 16 3½
Switzerland	9 15 3	6 3 5¾	5 6 4½

Compared with the preceding the cost of the same amount of horse-power produced by electricity and transmitted 3⅕ miles by an air line in Switzerland, according to results published in connection with the foregoing table, is:—50 H.P., £6 6s. 10d.; 300 H.P., £3. 10s. 10d.; 500 H.P., £2. 12s. 4d. Adding to this the cost of transmission, the total cost will be:—50 H.P., £12. 0s. 5½d.; 300 H.P., £6. 10s. 4d.; 500 H.P., £5. 6s. 3d. It is only by building a large plant—500 H.P. at the very least—that electricity begins to show any profit that would commend it as a substitute for steam.

Adiathermanous Glass.—In *Dingler's Polytechnisches Journal*, 1893, Vol. 287, numbers 1, 3, and 5, there is an interesting Paper by Mr. Richard Zsigmondy, Vienna, on "Glass Transparent to Light, but Opaque to Heat." What is wanted is an absorption-band in the infra-red part of the spectrum. After a series of experiments with alumina, attention was directed to the use of iron salts. A sheet of glass 0·4in. thick, containing 2·8 per cent. of iron as ferrous chloride, allowed only 4·06 per cent. of radiant heat to pass through, while one containing the same quantity of iron as ferric chloride allowed 11·2 per cent. to pass, thus acting little better than water. Next, samples of glass were prepared, one containing 1 per cent. of iron oxide, the second 2, and the third 4 per cent. All were reduced, as far as possible, so as to bring the iron to the ferrous condition. This appeared to have succeeded in the first of the three. The colour was a faint blue, something like a weak copper oxide blue; the other two were bottle-greenish. It seems, therefore, that pure ferrous silicate, without ferric, gives a very pale, pure colour, different from the ordinary colour produced by iron in glass. The spectrum was not materially affected by this glass in layers 0·32in. thick; the violet was slightly weakened, and there was some absorption in the red, about the Frauenhofer line C, but otherwise the spectrum came through pure and bright. The dark absorption-band produced by this glass was in the invisible heat-region of the spectrum. This glass, in layers 0·332in. thick, allowed only 0·4 per cent. of the heat from a batswing burner, 0·72 per cent. of that from an argand burner, or 0·73 per cent. of that from a lime light, to pass through it; but it let through about 12 per cent. of the heat of sun light, while ordinary glass let through 86 per cent. The new glass can thus be used for lamp shades, &c. Its faint blue tint is not unpleasant; but it ought to be possible to make it colourless.

The Blackfriars Accident.—The inquiry was resumed on Tuesday afternoon, before Mr. A. C. Langham, at Guy's Hospital, as to the death, in September last, of Frederick William Ball, aged 34, who was killed by electricity at the Blackfriars-road sub-station of the London Electric Supply Corporation. The inquiry had been adjourned from October for the attendance of Ernest Meech, who was injured at the time, and was now present, and stated that he was still in the employment of the London Electric Supply Corporation. On September 12th he was at the Blackfriars-road station with Ball. It was Ball's duty to turn off the current about six o'clock each evening, and to obtain a fresh supply from Deptford. It was then witness's work, after the current had been switched off, to "clean down." On the night in question he asked Ball, as usual, if it was safe to begin the work, and received a reply in the affirmative. He began to dust down, and on coming to transformer 42 he caught the terminal between the thumb and finger of the left hand. He was standing on the ground at the time, and fell into the pit in an insensible condition. On recovering consciousness he shook Ball, and, receiving no answer to his questions, he concluded he was dead. He then crawled on his hands and knees to the door. By the Coroner: He had then been a fortnight in the employment of the Corporation, and had only been instructed in his duties by Ball. He quite understood that it was dangerous to go near the transformer when the plug was on. The Coroner: Can you account for Ball telling you it was safe?—Witness: I cannot.—The Coroner: Did you wear boots?—Witness: No; but Ball did. We had no gloves on at the time.—A juryman: Did you know the plug was in the transformer?—No. The Coroner said he thought they could come to no other conclusion than that Ball's death was due to an accident; but in returning their verdict he thought the jury might suggest a remedy which might prevent accidents in the future. He thought that india-rubber gloves might be worn with advantage. He was sorry Major Cardew, of the Board of Trade, had been unable to be present. On the last occasion Major Cardew had suggested to him that when the current was on the electric light should be fixed over the place where the contact was made, so that if the current was on it would be lighted by it, and would be seen by those at work. Major Cardew thought the glass globes ought to be coloured red, so that when the workmen went to dust they would at once see the light. He thought that was a very practical suggestion. The jury returned a verdict of "Accidental death," and added, "We are of opinion that had the men been provided with gloves the danger might have been averted. We also think that the rules and regulations at the station should be printed, and that the second man (Meech) should have been more competent before undertaking the work."

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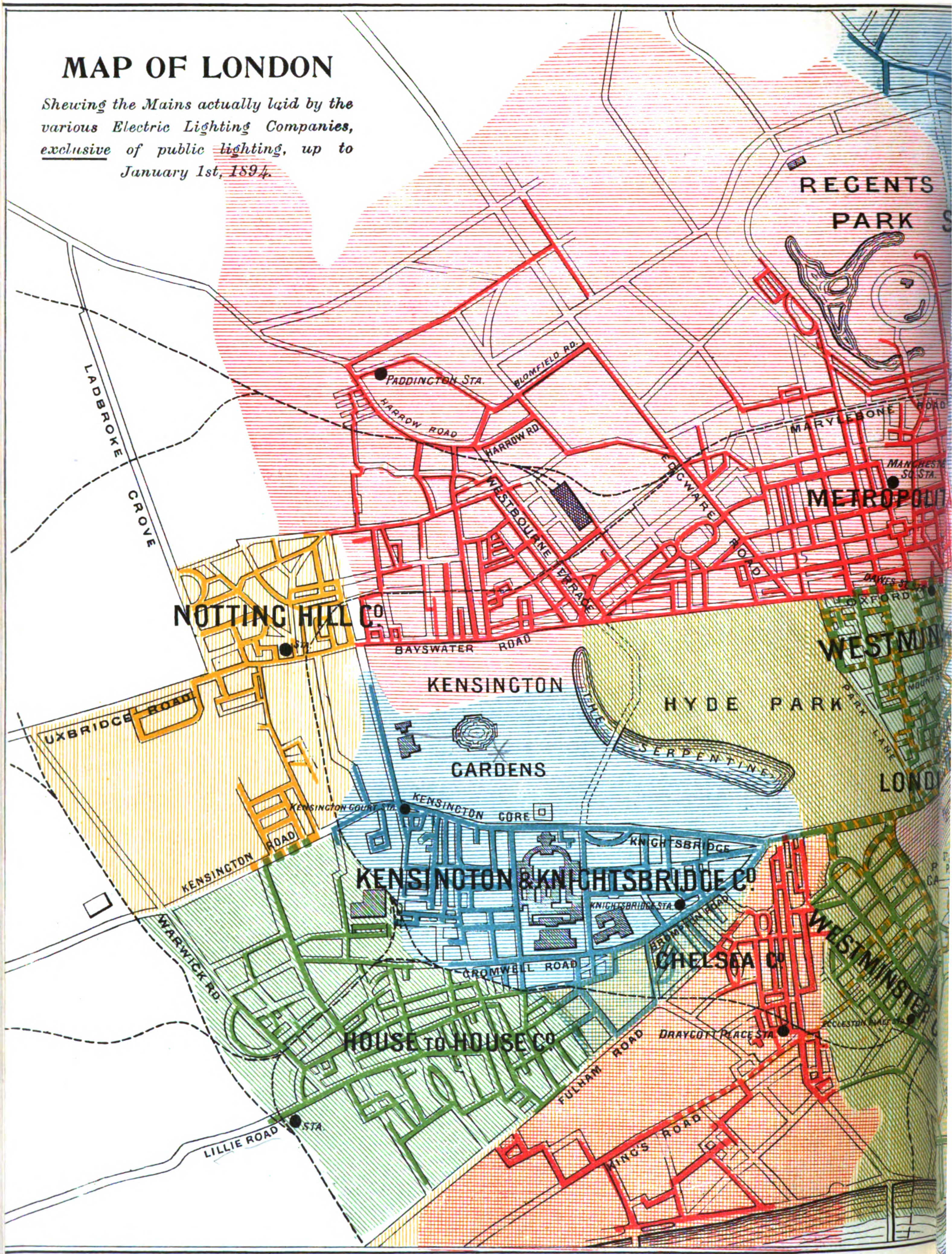
MAP OF LONDON

Shewing the Mains actually laid by the various Electric Lighting Companies, exclusive of public lighting, up to January 1st, 1894.



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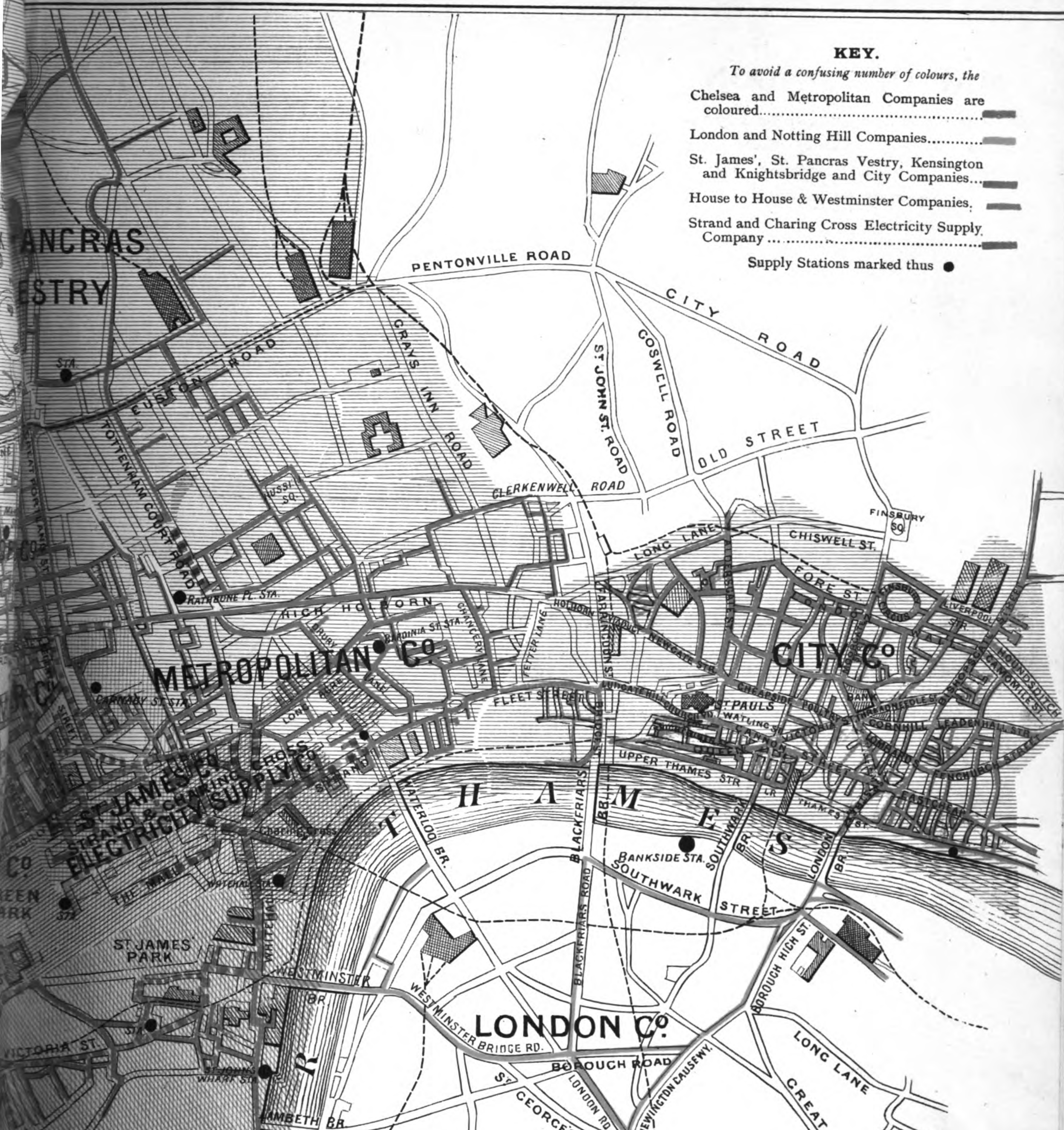

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MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(Continued from page 136.)

The Factor of Underloading.—This coefficient differs from the factor of idleness in not including any estimate of the time during which the plant is not doing any work. From the definition of this quantity it will be evident that if we multiply this factor into the total horse-power of the station or plant, the product will be equal to the average horse-power below the full horse-power at which the station or plant works during the time over which the coefficient is measured. Thus, if the factor of underloading of a 1,000-H.P. station is found to be 0·3, the average power will be equal to 1,000, less 300 H.P., or 700 H.P.; or, to put the matter in another way, if an engine at this station has a rated power of 100 H.P., and a factor of underloading of 0·2, its load factor will be 0·8, and its equivalent average power will be 80 H.P. This 100-H.P. engine is not more effective than an 80-H.P. engine running at full load for the same total time. Besides the idea of idleness here involved, there is another important idea, namely, the idea for which this coefficient has been specially invented. This is, the idea of efficiency of working at reduced loads. Not only will the 100-H.P. engine do no more work than the 80-H.P. one, while costing more to build, but—and this is the point for inquiry—it may happen that the large underloaded engine will take more energy to do the same amount of useful work as the small fully-loaded one, a point which can only be settled by study of each special type of engine. From an economic point of view this coefficient affects the revenue, not so much on the score of prime cost as on account of working costs; and it will be important to know its relation to the efficiency of the engine as indicating the extent to which the working expenses of the plant may be expected to be modified by any variation of the load diagram, or of the distribution of load among the engines which compose that plant. In regard to the main problem this factor will guide the engineer in deciding upon the size and number of the engines as well as, in certain cases, upon the adoption of some auxiliary engine details.

Character of Power-Station Load Diagrams.—The ideal conditions of a power station with factors of idleness and underloading equal to zero are difficult, if not impossible to obtain. This partly arises from the imperfections of the plant and its management, and partly from the intrinsic character of the load diagram. The imperfections in the construction and management of the plant will make it necessary to have a certain amount of *reserve plant*, or excess of engine power over and above the total possible load. The need for this arises from the liability of any unit of plant to become disabled from failure of any part, and from the necessity for laying up each unit of plant from time to time in order to effect cleaning, overhauling and repairs. In a power station which has to be prepared for rapid and considerable extension of the demand for power, it is also necessary to have a certain amount of reserve plant to meet any increase of demand which may arise. The proportion of this reserve to the total plant will be dealt with in a later section. The second cause of underloading and idleness is the imperfect form of the load diagram. We may consider the two principal cases:—(1) A power station for electric lighting and power supply for private consumers, and (2) a power station for electric traction for railways or tramways. In the former there is a long-period variation, the periodic time being a whole day; and the load suffers few but very large variations during that time. There is also a period of longer variation still, for throughout the year the form of the load diagram changes gradually. In the latter there are a great number of rapid and enormous variations at frequent intervals, which are superposed upon a small and gradual variation from hour to hour as the number of cars or passengers varies. The rapid and large changes in the load on the station are caused by the extra power required in starting a car, in taking it up a steep gradient, and in getting it round a sharp curve. Where a very abnormal rise in power occurs it may be due to two or more cars starting at the same time, or to their starting on a steep up-gradient. Apart from these rapid and almost momentary changes in load, the load is practically constant for many hours together, and is not liable to any sudden or unexpected variation. Where the cars are run to scheduled time, it is easy to pre-determine the character of the load diagram. It is not so easy, however, to pre-determine the character of the diagram for an electric supply station. Here, every indeterminate addition or removal of lamps or motors, by hundreds of consumers using power and light for a hundred purposes, will instantly tell upon the total load on the station, and will modify the diagram; while the incidents of dull weather, fogs, and the variations of season, have also their modifying effects. Still, every neighbourhood has its electro-moral character, as it were—a habit of life which is statistically indicated by the load diagrams throughout the year. Where there are theatres, shops and clubs supplied, the character will differ from where the station supplies only private houses; and, while the country station will have all its lights out long before midnight, the city station will be hard at work into the small hours of the morning. The average character of the load diagram of any proposed station may therefore be inferred, either from the known character of the diagrams of another station in a similar district, or from the ascertained variation of load on the mains of the gas supply. This having been done, all necessary allowances must be made for the limits, above and below this average, within which the diagram may be expected to vary. The average load factor of English electric light stations, over a period of a whole year, is not more than 10 or 12 per cent.; the average for the winter months may rise to 25 or 30 per cent., while the summer months may attain an average of less than 5 per cent. In America, where power stations are as much or more employed during the day in running motors, as during the night in running lamps, a station load factor of as high a figure as 50 or 60 per cent. is not uncommon.

Analysis.—Summarising the foregoing discussion of the chief points presented by the problem of the adaptation of motive power and gearing to electrical machinery, we shall find it convenient to dissect the complete problem into the following parts, which analysis will form the basis of subsequent sections:—

(1) The principles of the various types of motive power.

(2) The characteristics of the forms of energy utilised by each type of motive power.

(3) The structure of the engines and of their accessory parts.

(4) The normal, or full load, functions of the engines, and their details.

(5) The influence of varying conditions of load, &c., upon these functions.

(6) The construction and action of gearing.

(7) The relative merits of various forms of gearing.

(8) The economic aspects of gearing and of non-gearing (direct coupling).

(9) The relative merits of the various systems of motive power and gearing from an economic point of view.

(To be continued.)

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THE HOURS OF LIGHTING.

In our last issue we gave a striking example of the complication and disorder which arose when a number of different authorities made independent rules for insulation resistance. To-day we give an instance of one of the most regular laws of nature, and of the wonderful unanimity with which it is voluntarily obeyed by hundreds of different individuals. Nearly ten years ago we published in these columns a diagram from which the time of lighting up at any part of the year might be found. and total number of hours in the year, during which light is needed, under given conditions. The correspondent who furnished this diagram, based it upon information obtained from the South Kensington museum. It appeared to be the custom to turn on the electric light from a quarter of an hour to half

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an hour before sunset. The time at which the light was turned on, depended on two things, each peculiar to the special case. The one, the nature and amount of light wanted for the place,

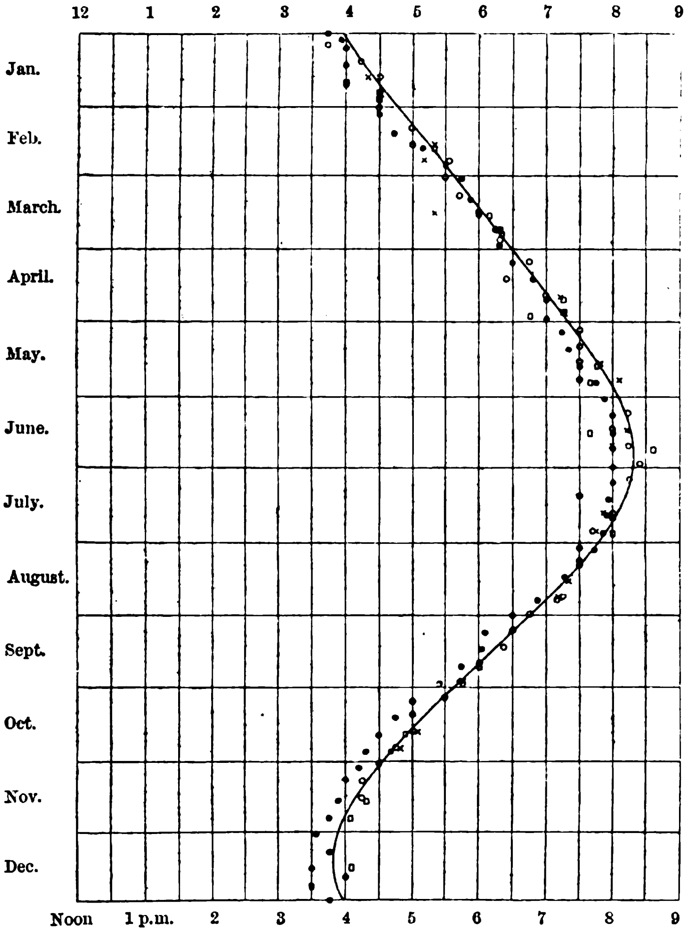


Fig. 1.

Black dots represent	readings	for	1892 St. James and Pall Mall Co.	
Circles	„	„	1893 „	„
Squares	„	„	1892 Westminster Co.	
Crosses	„	„	1893	„

and the other, the judgment of one individual as to the extent to which daylight might diminish before artificial lighting became necessary. The first step towards a more general knowledge of the time during which artificial light is required, is to average a number of different cases, such as shops, private houses, &c., and the next step is to get the opinion of a considerable number of people instead of that of one man. Inspection of the load curve of a supply station enables us to supply both of these needs. It will be remembered that a load curve begins to rise slowly in the afternoon, then more rapidly, as more lights are turned on, and when full load is approached, the rate of increase diminishes, and the curve becomes less steep. The steepest part of the curve evidently extends over that period of time during which the lights are being turned on at the greatest rate. Unless the load curve be of an unusual shape, it may be assumed, without appreciable error, that the middle point of the steepest part is the "average time of lighting up" for that district on that day. We are greatly indebted to the Westminster Electric Supply Corporation and to the St. James and Pall Mall Electric Light

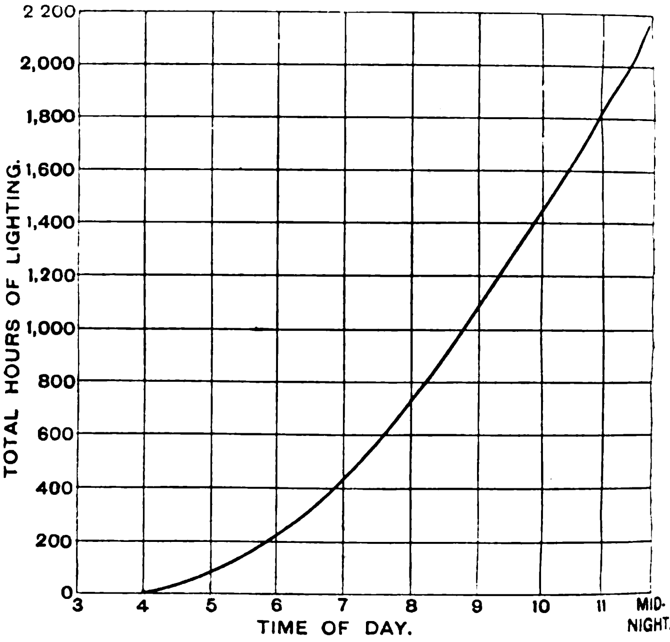


Fig. 3.

Company for the trouble which has been taken at our request to furnish information on this subject. The diagram (Fig. 1) shows a number of points, determined, as we have described, from the middle of the steepest part of the load curves. We expected to find, as in the curve of the Museum lighting, that the average time of lighting up would be a little before sunset, and that the difference would be greater in winter. The curve drawn among the points is the sunset curve, and the uniformity with which the points lie along it is rather striking. Each point is, as it were, the mean result of hundreds of independent voters, each of whom

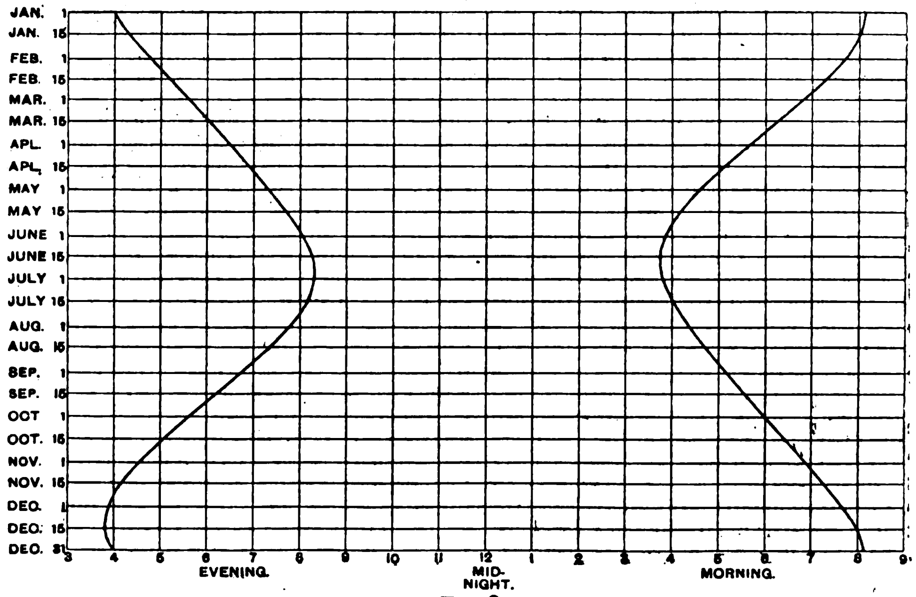


Fig. 2.

in turning on his switch, whether in shops or dwelling-houses, basements or attics, unconsciously influenced the general result. The average time of lighting up seems to be a few minutes before sunset, and the difference in the winter months is only just perceptible. The St. James and Pall Mall Company have sent us some observations for foggy days, but these are hardly sufficient to enable any definite result to be deduced. The curve sent by our correspondent in 1884 was laboriously corrected to include all the fogs during the three years which were averaged. The number and duration of fogs to shift the mean curve a quarter of an hour for, say, two months, would be very considerable, and ought to be averaged over six or eight years.

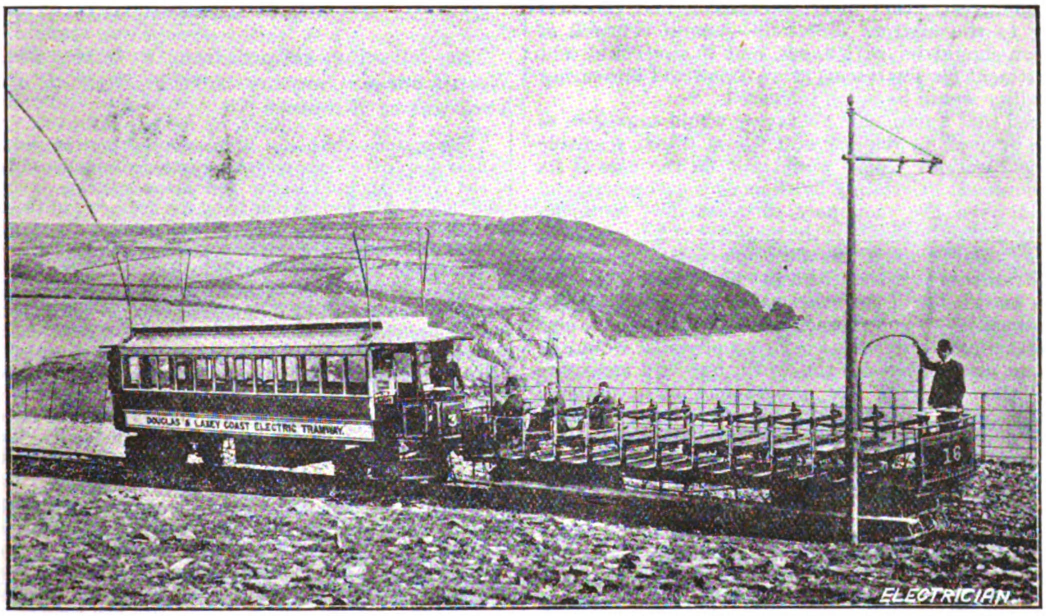
In estimating the total duration of artificial light throughout a year, under any given conditions, the time of sunset and sunrise may be taken as the average time of lighting up. In Fig. 2 the curves are shown together, as in the diagram published long ago; but they have now been plotted with greater care. The space between the curved lines represents the time during which light is required. The horizontal lines show the months of the year. The vertical lines show the hours. From the sunset curve the curve in Fig. 3 has been calculated. This curve shows the total hours of lighting in a year, from dusk to any given time, and from this curve the following table has been compiled :—

Table showing Hours of Lighting.

Hours of Lighting.	Period of the year during which light is required at these hours.	Total number of hours of lighting per annum.
		HOURS.
6 a.m. till daylight	—	250
Dusk „ 5:0 p.m.	Oct. 18 to Feb. 8	83
„ „ 6:0 „	Sept. 21 „ „ 14	226
„ „ 6:30 „	„ 8 „ April 1	320
„ „ 7:0 „	Aug. 25 „ „ 19	430
„ „ 7:30 „	„ 10 „ May 7	560
„ „ 8:0 „	July 23 „ „ 28	730
„ „ 8:30 „	All the year	900
„ „ 9:0 „	„ „ „	1,090
„ „ 10:0 „	„ „ „	1,455
„ „ 11:0 „	„ „ „	1,820
„ „ midnight	„ „ „	2,185
„ „ 2:15 a.m.	„ „ „	3,000
All night	„ „ „	4,380

THE DOUGLAS-LAXEY ELECTRIC TRAMWAY.

The accompanying illustration is a view of a section of the Douglas-Grondle Glen Electric Tramway, which was opened to the public last season, and will, it is hoped, be extended, with double track throughout, before next summer to Laxey, a distance of seven miles from Douglas. The electrical plant of the line has been designed by Dr. E. Hopkinson, of Messrs. Mather and Platt, who are the contractors for the machinery and rolling stock. The bridges, earthworks, and embankments (including some heavy sea-works) are being executed by the promoters of the line, to whom Mr. F. Saunderson, of Douglas, Isle of Man, is engineer.



Motor Car and "Trailer" on the Douglas-Laxey Electric Tramway.

The Douglas-Grondle Glen section is 2⅓ miles long, with 5 per cent. and 2 per cent. gradients, no part of the line being level. As will be seen from the illustration, there are two collecting bars on each motor car, which run along the underside of the overhead conductors. These bars are 26ft. apart, so that when passing a pole one bar is always in touch with the overhead conductors.

NATIONAL LABORATORIES.*

BY CH. ED. GUILLEAUME.

If industry owes its immense development in some measure to the application on a large scale of scientific methods, science, on the other hand, could with advantage assimilate industrial methods, by which I mean not merely make use of the material means with which modern industry has endowed the investigator, but rather imitating the organisation and economy of industry. I am speaking of the future, since although this path has been taken it cannot be denied that the greater part of the work remains to be done.

* From *L'Industrie Électrique.*

The tools of the scientist, and more especially of the physicist, are becoming more and more expensive. Experiments are now-a-days carried out on a large scale, and require complicated apparatus. Measurements of precision, researches on high pressures, the obtaining of very low or of very high temperatures, demand very diverse apparatus, each in its way imposing; and a university laboratory, the funds of which are never too plentiful, has either to limit its work to a special line of research or to give up altogether that research work which has made us penetrate so far into the secrets of nature.

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In many cases the work of a laboratory is decided beforehand; military establishments, for instance, have a very definite object, and a sphere of research which is clearly limited. In others, by choice or by necessity, a single question is attacked, and the physical specialist is created; a profession which is not as yet to be found in any directory, and is, up to the present, but very little understood by the public. No one contests the utility of an astronomer; his science, the most ancient of all, is for many wrapped in a veil of mystery which they are not so indiscreet as to lift. The chemist, even, is no longer questioned; people understand, or think they understand, why it is a man puts on a blouse and heats crucibles, for chemistry has given us a number of products of which no one is ignorant; moreover, a big fortune can be made that way sometimes, which in itself is an irrefutable argument of the utility of chemistry. On the other hand, however, it is difficult to conceive why a sensible man should devote himself to physical research, unless he be a professor or an acquaintance of Robert Houdin. I will not so far insult my readers as to break a lance on behalf of the professional physicist, and will only assert that by the force of things he is every day being brought into existence.

The necessity for concentration of apparatus, for directing scattered effort upon a single well-defined point, and, above all, for filling up the lacunæ of physical science, has brought the question of national laboratories to the front at the same time in several different places. The matter is being considered in England. The influential British Association discusses the proposal at every meeting. In Germany such a laboratory is an accomplished fact: the Reichsanstalt at Charlottenburg, Physico-Technical Institute of the German Empire, presided over by Von Helmholtz, is a national laboratory that has already rendered services, and will, before long, be of priceless value to science and to German industry.

The advantage of a national laboratory is easily understood the moment one thinks of the kind of work it could perform. First of all, it should be the custodian of standards of all sorts, and as such it should be in possession of the best possible appliances for comparing them, a trained staff being specially charged with this work, and with the investigation of all theoretical and practical questions relating to the matter. Secondly, general research of the utmost precision should be carried out, and if one could add an industrial department for the testing of materials and measuring instruments, its utility would be much increased.

It might be feared that a national laboratory would aggregate to itself all the funds devoted to science, and would injure scientific work by over-concentration. Such would not be the case if its object be well understood. Certainly by their very nature national laboratories would have the monopoly of researches requiring apparatus too costly and too special for the majority of laboratories; but, before all, they would come to the aid of physicists by supplying them with instruments to assist them in their researches. At a given moment a knowledge of the exact value of a physical constant becomes a necessity. Who will undertake the long and tedious work which its determination demands? Every physicist would be glad to see someone else undertake the work, but let a managing committee insert the work in the programme of a national laboratory, and the work will be carried out. In university laboratories people could carry out investigations after their own heart without any constraint; whilst at the national laboratory part of the work would be carried out to order and in accordance with an annual programme.

A few instances will show the advantages of such an organisation. When, in view of the 1884 Electrical Conference, people set to work on all sides to determine the value of the true ohm, some physicists constructed everything connected with their mercury standards of resistance, whilst others procured commercial standards of which the makers guaranteed the value. On the one hand there was great labour, and on the other an enormous uncertainty, as was evidenced by the results which the members of the Conference brought together from all countries. The construction and accurate determination of a mercury copy does not demand one twentieth of the work involved in the construction of a primary standard. A central laboratory would have made the latter, and would have distributed exact copies. The work would thus have been greatly diminished, and we should have arrived at the truth far more rapidly. In this way a national laboratory would in no way have interfered with the work; on the contrary, it would have greatly assisted it.

The same would be the case whenever a physicist required an auxiliary instrument in a research, the national laboratory would lend him an electrodynamometer, a resistance box, a thermometer, a divided rule, or a set of weights. The efficiency of scientific workers would in this way be greatly increased, and even the funds of university laboratories would be virtually augmented, since on payment of a reasonable sum they could dispense with the purchase of costly standard apparatus and need no longer pass months in masstering their use. In another direction it may be said that precise determinations of the mechanical equivalent of heat have no meaning so long as we do not define the thermometric scale employed, the numerical value of the intensity of gravity, and lastly, the normal temperature at which we consider the specific heat of water to be equal to unity. Up to the present no physicist who has undertaken this determination has first of all exhaustively investigated these three factors. Thermometry has been the object of special work, the measurement of g has been confided to geodetic establishments for the most part military, finally the specific heat of water has cost MM. Bartoli and Staciati nine years' work. To-day we are fairly clear on this point, but a national laboratory would have done it all for us much more quickly.

In a national laboratory part of the work could be done by a subordinate staff carefully recruited, and finding in their position advantages similar to those offered by commerce, industry, or any other State employment. The practical work of these labourers of science is often very skilled and better than that of scientists themselves, and in any case the work would be done with less waste.

The elements of a national laboratory exist in many countries. In the case of France we need only mention an important department of the Conservatoire des Arts et Métiers, if not the entire establishment; the Laboratoire Central d'Électricité, the Bureau des Alcoolmètres, and other institutions, which would all gain by being united under one management. Certain branches would have to be developed, such as the mechanical laboratory so loudly called for by engineers. The whole should be granted ample funds and given a good staff, and in the end I have no doubt it would be found economical. The realisation of such a scheme would certainly encounter great difficulties. But if we set aside personal questions, delicate matters in every country, must we not admit that in no country would the establishment of a national laboratory be so easy as in France.

THE WESTINGHOUSE PLANS FOR THE NIAGARA CONTRACT.

The following extract from a letter addressed by the Westinghouse Company to the *Electrical Engineer* of New York will be of interest:—

"The system which has been adopted for the installation at Niagara Falls is simply the Tesla polyphase system as developed by the technical staff of the Westinghouse Electric and Manufacturing Company. It has not been modified in any particular by the engineers of the Cataract Construction Company or of the Niagara Falls Power Company. It is fully described in publications of this company and was demonstrated on a large scale by one of our exhibits in the Electricity Building at the recent Columbian Exposition in Chicago. In developing and perfecting the system, we have not only been guided by a wide experience in the design, manufacture and use of electrical machinery, but we have carried out a large amount of experimental work, much of it on an extensive scale, and have made a careful, theoretical and practical study of the subject. Prof. Forbes' views, as stated in his paper, are naturally in accord with ours upon many points. In others, his paper fails to fully state the facts as we see them, and, in others still, we think his views are incorrect. We cannot, therefore, in justice to our company, consent to the assumption that his paper be accepted as a 'fair representation' of our views.

"Some of the technical journals have apparently received the impression that the generator described in Prof. Forbes' paper under the heading 'General Description of a 5000-H.P. Alternator' is that which has been adopted by the Cataract Construction Company. This is not the case. The drawings and specifications of the generator, which Prof. Forbes describes, were laid before us in August last, and were fully explained by Dr. Coleman Sellars and Prof. Forbes. After careful consideration, we accepted the general mechanical features of the construction proposed as excellent, but, in the opinion of our electricians and engineers, the electrical features—the method of winding, the insulation, etc.—were impracticable, and realising that we could not undertake the construction of such a machine with credit to our Company, we declined to submit proposals. We were thereupon requested by the officers of the Cataract Construction Company to submit our own plans and specifications, and this was done early in August. We followed closely the mechanical features approved by Dr. Sellars, but the electrical features are wholly our own. These plans were accepted by the Cataract Construction Company and are those under which the generators for Niagara are now being constructed.

"Prof. Forbes is undoubtedly qualified to speak with authority as to the assumptions and reasoning which have led him to agree with other engineers of the Cataract Construction Company in recommending to his Board of Directors the adoption of the system which has been selected, but the premises and the reasoning which guided the engineers of the Westinghouse Electric and Manufacturing Company in the development of the Tesla polyphase system, as it will be used at Niagara, differ widely in some respects from those which are set forth in the paper to which your editorial refers.

"We trust that you will give to this explanation suitable prominence, as we are unwilling, for the reasons stated, to have Prof. Forbes' paper accepted by your readers as a statement of our views."

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NOTE ON GUTTA-PERCHA.*

BY J. LAGARDE.

I have lately been able to procure a sample of copper covered with gutta-percha extracted from the leaves of the isonandra by M. Serulla's process. The insulation seemed very high, but I was unable to measure it, the length of the sample being only 1 metre; I was therefore obliged to confine myself to analysing the gutta-percha, the analysis giving the following results :—

Water	Nil.
Impurities	0·8 per cent.
Resins	16·0 " "
Gutta-percha	83·2 " "
	100·0 per cent.

I separated out the resins and found them to be as below :—

Fluavil	1·72 per cent.
Alban	14·28 " "
	16·00 per cent.

The large amount of alban as compared with fluavil, and especially the absence of water, are sufficient to account for the high specific insulation attributed to this dielectric, notwithstanding the large proportion of pure gutta. I am, moreover, inclined to think that by reason of the absence of water this gutta-percha will oxidise less easily than those brands which have hitherto been used, and consequently that it will last longer.

As the facilities that have been afforded me for investigating the properties of gutta-percha are about to fail me I am, to my great regret, obliged to relinquish the study of this question as well as that of many matters affecting telegraphy. Nevertheless what I have published on this subject seems to me sufficient to show what are the effects of water and resins on gutta-percha. Water diminishes its insulating power, and facilitates its oxidation; the resins, especially alban, increase its insulating power, but, at the same time, are a source of deterioration. Two submarine or subterranean cables, covered with very different gutta-perchas, may, at a given moment, show the same insulation; but that, the gutta-percha of which contains less water and resin, will remain sound for the longer time. Analysis, therefore, presents itself as the only means of discovering whether the gutta-percha on a cable is of good or bad quality, and it is because analyses were not carried out a few years ago, that is to say, previous to my investigations, that some submarine and subterranean cables of bad quality were accepted, which, nevertheless, fulfilled the specified electrical conditions. The cores of the submarine cables deteriorated so much after a few months' sojourn under water that it was impossible to use them. As to the subterranean cables, the insulation of several lengths appreciably decreased before they were put into use, and some could not even be employed at all. Moreover, at the time when the interurban underground network was being laid down, it sometimes happened that on soldering up two cable ends in somewhat cold weather the gutta-percha cracked. This must have been caused by the large quantity of alban contained by the gutta-percha, and not as I suggested when consulted at the time.

It would be a useful termination to my investigations on gutta-percha if I could answer the following question :—Has pure gutta-percha coming from different sources identical electrical qualities? To solve this question it would seem a natural thing to do to cover copper wires of the same diameter with the same thickness of dielectric, and then to measure the insulation and capacity. But to do this it would be necessary to raise the gutta-percha to a somewhat high temperature at which it might oxidise. So that it would seem to me better to reduce the gutta-percha to very fine sheets of the same thickness, and to make condensers instead of cores, and I employed this method some little time ago when testing two samples of pure gutta-percha, one of which came from a very good and the other from a very bad source; I was not, however, able to obtain any results owing to the small amounts of gutta-percha at my disposal, and the test must be renewed. The numerous experiments that I have carried out, only a few of which have been published in the *Annales Télégraphiques*, had to do with gutta-percha of all kinds coming from seven different factories. The results were always similar, which leads me to believe that the various pure gutta-perchas the samples contained had the same electrical qualities. I cannot, however, assert this. If, on the other hand, this is not the case, my conclusions as to the influence of water and the resins, and as to the necessity of determining the amounts of these substances that are contained in the gutta-percha of a cable, would in no way be affected; indeed, analysis would be all the more necessary, since electrical tests would tell us less about the value of the gutta-percha employed than they would if all kinds of pure gutta-percha possessed the same qualities.

In conclusion, I will repeat that I consider tolerably good gutta-percha to be that which contains at least 55 per cent. of pure gutta, and at the most 5 per cent. of water and 1 per cent. of foreign substances, and in which the amounts of alban and fluavil are equal. Good gutta-percha should contain at least 60 per cent. of pure gutta, and at the most 5 per cent. of water and 0·8 per cent. of foreign substances, the amounts of alban and fluavil being equal. Finally, gutta-percha of very good quality should contain at least 65 per cent. of pure gutta, and not more than 3 per cent. of water, 0·5 per cent. of foreign substances, and 12 per cent. of alban.

* From the *Annales Télégraphiques*, Vol. XX.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, January 19th.

INSTITUTION OF CIVIL ENGINEERS.

7 30 p.m. Students' Meeting at 25, Gt. George-street, S.W. The following Paper will be read: "Discharging and Storing Grain," by Mr. William G. Wales, Stud.Inst. E.C.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting at 28, Victoria-street, S.W. The following Paper will be read: "Multiphase Currents and their Applications," by C. V. Drysdale, Student.

SATURDAY, January 20th.

JUNIOR ENGINEERING SOCIETY.

8 p.m. Visit to the Engineering Laboratories and Workshops of the Battersea Polytechnic Institute, Battersea Park-road, S.W.

MONDAY, January 22nd.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture. "The Detection and Measurement of Inflammable Gas and Vapour in the Air," by Frank Clowes, D.Sc.

TUESDAY, January 23rd.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "Locomotion and Fixation in Plants and Animals," by Prof. Charles Stewart, M.R.C.S.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper will be read: "The Tunnels of the Dore and Chinley Railway," by the late Percy Rickard, M.Inst.C.E.

WEDNESDAY, January 24th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read: "American Carriages," by G. Herbert Thrupp.

THURSDAY, January 25th.

INSTITUTION OF CIVIL ENGINEERS.

2 45 p.m. Students' Visit to the Cable Depot of the London Tramways Company, Streatham Hill.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper will be read: "Notes of a Trip to the United States, and to Chicago, 1893," by W. H. Preece, C.B. F.R.S., Past President.

FRIDAY, January 26th.

PHYSICAL SOCIETY.

8 p.m. The following Papers are down to be read: (1) "A New Mode of Making Magic Mirrors," by J. W. Kearten. (2) "Some Observations in Diffraction," by W. B. Croft, M.A. (3) "A New Photometric Method and Photometer," by J. W. Spurge.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Smoking Concert at the St. James's Hall Restaurant (Banquet Room), Regent-street, W.

ROYAL INSTITUTION.

9 p.m. Friday Evening Discourse: "Old Irish Song" (with vocal illustrations by Mrs. Hutchinson and Madame Marie Brema), by Alfred Perceval Graves, M.A.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

Royal Society.—The following Papers were down for reading yesterday :—E. H. Griffiths, "Appendix to a communication termed 'The Mechanical Equivalent of Heat.'" O. Heaviside, "On the Transformation of Optical Wave-surfaces by Homogeneous Strain." G. A. Schott, "On the Reflection and Refraction of Light."

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The Electrician.

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SPECIAL NOTICES.

We publish this week (Gratis to Subscribers) a COLOURED MAP, showing the Streets in the Metropolis in which Mains for Private Lighting are actually laid, up to January, 1894, with the areas allotted to the different Supply Companies.

With the issue of "The Electrician" for January 26th will be published (Gratis to Subscribers) a fine STEEL-PLATE PORTRAIT of Mr. ALEXANDER SIEMENS, President of the Institution of Electrical Engineers for 1894.

STEEL-PLATE PORTRAITS

Of Willoughby Smith; W. H. Preece, C.B., F.R.S. (President of the Institution of Electrical Engineers); Michael Faraday; Sir John Pender, G.C.M.G., M.P.; Sir William Thomson, F.R.S. (Lord Kelvin); C. H. B. Patey, C.B.; Dr. John Hopkinson, F.R.S.; Dr. Oliver J. Lodge, F.R.S.; Prof. William Crookes, F.R.S.; Prof. von Helmholtz; Prof. W. E. Ayrton; Lord Rayleigh, F.R.S.; Cyrus W. Field; Werner von Siemens; Sir James Anderson; and Joseph Wilson Swan, have been issued as Supplements to "THE ELECTRICIAN."

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MR. ALEXANDER SIEMENS' PRESIDENTIAL ADDRESS.

Presidential addresses before scientific societies often consist of elaborate Papers by specialists on their own subjects, Papers which might have been contributed to the societies in the usual way, but upon which unusual care has been expended; or they present a historical record of the past ten, fifty, or hundred years. Too seldom do presidents offer in their addresses original thoughts on general subjects, and examine the causes and conditions which have determined the growth of a science or the development of an industry, the circumstances which are influencing its present position, and the factors which may affect its future. Important though it was as a special contribution to our knowledge, the address, for example, by Dr. J. HOPKINSON on Magnetism may be classed with the other valuable writings of the same author. Historical and statistical addresses ought to be useful historically and statistically—they seem to be

so, while they are being delivered; but who ever consults them afterwards when searching for historical or statistical information? Any specialist can write a Paper on his own subject, and he may mark the occasion by publishing some new research for the first time. Not even personal work is needed for the review-of-a-century address, and it is difficult to infuse the personality of the author into it. The Presidential address of Mr. SIEMENS, half of which we print elsewhere, is of the rarer kind to which we have alluded. It deals with many subjects which are seldom brought before the meetings of the Institution of Electrical Engineers, and is well worthy of thoughtful study.

Mr. SIEMENS begins with a clear account of the electric lighting legislation which has starved that which it was intended to foster, and has impeded that which it was meant to encourage. The curious changes in this legislation, and its influence on the progress of electrical engineering, are briefly discussed, and in concluding this part of his address the President clearly points out the principal cause of the delay in the development of electric supply. It is true that the 21 years' purchase was a mistake; it was intended to encourage municipalisation, but it only checked, perhaps wholesomely checked, an industry which was destined without any State encouragement to fall into the hands of municipal authorities. It is true that the system of licences, which might have allowed this country to enjoy the facilities under which supply systems have developed in other lands, has been dropped, and that the consent of the local authority is absolutely necessary; all these hindrances have had their effect. But the principal cause of the delay has been "the exaggerated expectations that were raised either by ignorance or by design, when the general public first seriously thought of regarding electricity as a commodity for every day use. . . . There was a short time of excitement to the public and of profit to the promoters; then the confidence of the public in electricity was almost destroyed, and could only be repaired by years of patient work." Nothing but the payment of dividends could restore this confidence. The display of actual electric lighting by pioneer stations was of no more value than the promises of the pioneers, of whom Mr. SIEMENS speaks moderately. But no sooner were a few sound systems established—at the cost of immense exertion and enterprise, both of capitalists and of engineers, and dividends paid—than the municipal authorities at once seized upon the industry; dividends will no longer be the measure of success, but those obscure "profits" which, as the President says, have already "relieved the rates at the expense of the wealthier classes, in a perfectly legitimate manner."

Passing on to emphasise the importance, nay, the absolute necessity, of sound mechanical engineering, he alludes to the electrical appliances, which were formerly constructed like scientific instruments, with a neglect of mechanical considerations, and to the healthy re-action which took place, but which, indeed, is not yet complete, when the mechanical engineer took over the applications of electrical energy from the hands of the instrument maker. He brings back enthusiastic schemes for traction at 200 miles an hour, and the nine days' wonder of the Frankfort-Lauffen transmission, to the sound standpoint of concerns which will pay.

With Mr. SIEMENS' opinions on the education of engineers we cordially agree, coinciding so completely as they do with the views often put forward in these columns, and offering so salutary a protest against the system advocated by many teachers. The distinction between education and instruction, for which we have combated, is thus clearly expressed:—"It has always appeared to me that at school the mental powers should be principally exercised in a way to make them fit for learning. . . . Although it has been the fashion of late to deprecate the study of Latin and Greek, I am quite certain that the attack is made from quarters where the mental training which the study of these languages entails is not appreciated at its right value, nor is the enormous advantage considered which their knowledge gives in the study of modern languages. After the mental powers have been prepared in this way, it is of no great consequence whether most of the details of the school teaching are speedily forgotten or not; the essential point is that the student should have acquired a good method of learning, so as to assimilate to the best advantage the course of training he attends at college." We commend these views to those who ridicule the acquisition of "useless knowledge." The President advocates, as we have done, that "the teaching at engineering colleges should be confined to general principles," and he deprecates the tendency which is present even at the older Universities towards early specialisation, by pointing out that "while the student is trained afterwards in practical work, he has time to select to what special branch of the profession he wishes to devote his life." We welcome this part of Mr. SIEMENS' Presidential Address the more since it comes from one who must be familiar with the elaborate system of so-called technical education on the Continent, which we are continually informed is so much better as an educational instrument than anything we have in this country.

THE TESLA ELECTRICAL OSCILLATOR.*

In the lecture delivered before the Chicago Electrical Congress, Mr. Nikola Tesla first drew attention to the method which he had devised for the continuous production of alternating currents of constant period by the employment of his oscillating engine, in which all rotating parts are avoided directly to the movement of the generating coil in the magnetic field. In applying the Tesla oscillator for the generation of currents of constant period certain conditions are encountered which must be taken into consideration in order to satisfactorily secure the desired result. These conditions may be secured by properly proportioning the self-induction and capacity of the circuit, including the generator.

Mr. Tesla has, however, observed the further fact in connection with the use of such engines as a means for running a generator, that it is advantageous that the period of the engine and the natural period of electrical vibration of the generator should be the same, as in such case the best conditions for electrical resonance are established, and the possibility of disturbing the period of mechanical vibrations is reduced to a minimum. Mr. Tesla has found that even if the theoretical conditions necessary for maintaining a constant period in the engine itself are not exactly maintained, still the engine and generator combined will vibrate at a constant period. For example, if instead of using in the engine an independent cylinder and plunger, as an airspring of practical constant rigidity, the piston may impinge upon air cushions at the ends of its own cylinder. Although the rigidity of such cushions or springs might be considerably affected and varied by the variations of pressure within the cylinder, still, by combining with such an engine a generator which has a period of its own, approximately that of the engine, constant vibration may be maintained even through a considerable range of varying pressure, owing to the controlling action of the electromagnetic system. Under certain conditions the influence of the electromagnetic system may be made so great as to entirely control the period of the mechanical vibration within wide limits of varying pressure. This is likely to occur in those instances where the power of the engine, while fully capable of maintaining a vibration once started, is not sufficient to change its rate.

Referring to Fig. 1, A is the main cylinder in which works a piston, B. Inlet ports, C C, pass through the sides of the cylinder opening at the middle and on opposite sides. Exhaust ports, D D, extend through the walls of the cylinder and are formed with branches that open into the interior of the cylinder on each side of the inlet ports and on opposite sides of the cylinder. The piston, B, has two circumferential grooves, E F, which communicate through

* Abstract from an advance proof, kindly sent by the *Electrical Engineer* of New York.

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openings, G, in the piston with the cylinder on opposite sides of the piston respectively.

The particular construction of the cylinder, the piston and the ports controlling it, may be very much varied, and is not in itself material, except that in the special case under consideration it is desirable that all the ports, and more especially the exhaust ports, should be made very much larger than is usually the case so that no force due to the action of the steam or compressed air will tend to retard or affect the return of the piston in either direction.

The piston, B, is secured to a piston rod, H, which works in suitable stuffing boxes in the heads of the cylinder, A. This rod is prolonged on one side and extends through bearings V in a cylinder, I, mounted in line with the first, and within which is a disc or plunger, J, carried by the rod H. The cylinder I is without parts of any kind and is air-tight, except as a small leakage may occur through the bearings V, which experience has shown need not be fitted with any very considerable accuracy.

The cylinder I is surrounded by a jacket, K, which leaves an open space or chamber around it. The bearings V in the cylinder extend through the jacket to the outside air, and the chamber between the cylinder and the jacket is made steam or air-tight by a suitable packing. The main supply pipe L, for steam or compressed air, leads into this chamber, and the two pipes that lead to cylinder A run from this chamber, oil cups M being conveniently arranged to deliver oil into the pipes for lubricating the piston.

In the particular form of engine shown, the jacket K, which contains the cylinder I is provided with a flange N, by which it is screwed to the end of the cylinder A. A small chamber O is thus formed, which has air vents, P, in its sides, and drip pipes Q leading out from it through which the oil which collects in it is carried off.

In the position of the parts shown, or when the piston is at the middle point of its stroke, the plunger J is at the centre of the cylinder I, and the air on both sides of the same is at the normal pressure of the outside atmosphere. If a source of steam or compressed air be then connected to the inlet ports C C of the cylinder A, and a movement be imparted to the piston as by a sudden blow, the latter begins to reciprocate in the well-known way.

The movements of the piston compress and rarefy the air in the cylinder I at opposite ends alternately. A forward stroke compresses the air ahead of the plunger J, which acts as a spring to return it; similarly, on the back stroke the air is compressed on the opposite side of the plunger J, and tends to drive it forward.

The compressions of the air in the cylinder I, and the consequent loss of energy due mainly to the imperfect elasticity of the air, give rise to a very considerable amount of heat. This heat is utilised by conducting the steam or compressed air to the engine cylinder through the chamber formed by the jacket surrounding the air-spring cylinder, the heat thus taken up and used to raise the temperature of the steam or air acting upon the piston is availed of to increase the efficiency of the engine.

In any given engine of this kind the normal pressure will produce a stroke of determined length, and this will be increased or diminished according to the increase of pressure above, or the reduction of pressure below, the normal. In constructing the apparatus proper allowance is made for a variation in the length of stroke by giving to the confining cylinder I of the air spring properly determined dimensions. The greater the pressure upon the piston the higher will be the degree of compression of the air spring, and the consequent counteracting force upon the plunger.

The rate or period of reciprocation of the piston, however, is mainly determined by the rigidity of the air spring and the inertia of the moving system, and any period of oscillation within very wide limits may be secured by properly portioning these factors, as by varying the dimensions of the air chamber, which is equivalent to varying the rigidity of the spring, or by adjusting the weight of the moving parts. These conditions are all readily determinable, and an engine, constructed as above described, maintains a perfectly uniform period through very wide limits of pressure.

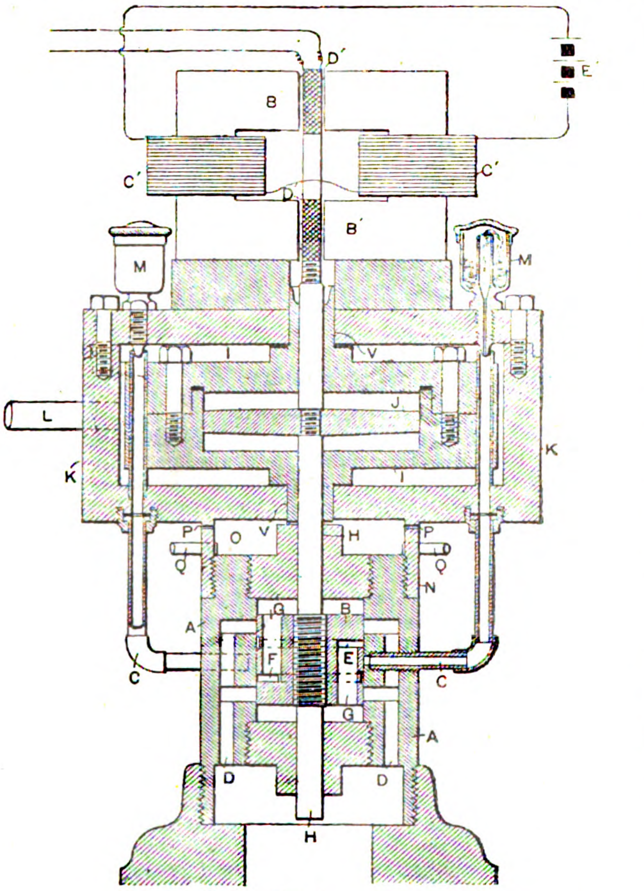

Fig. 1.

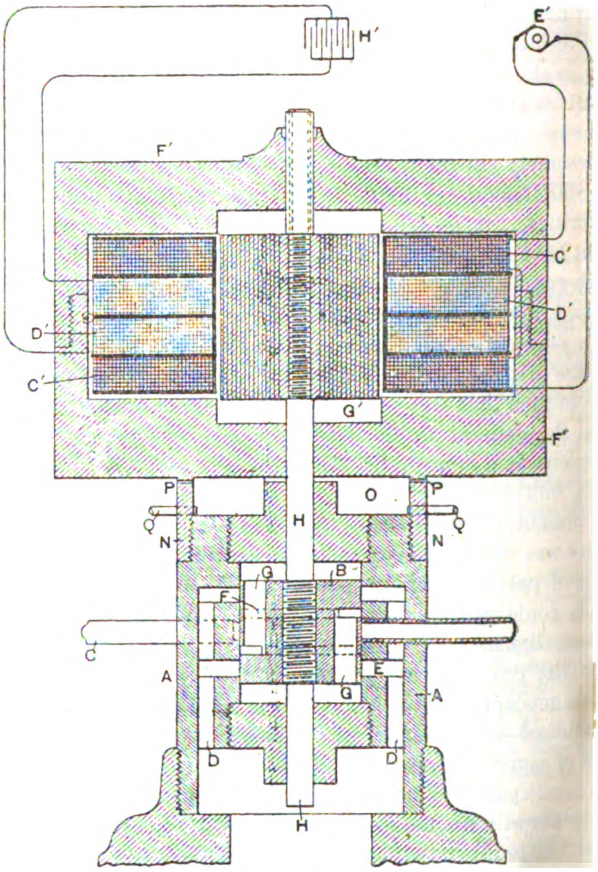

Fig. 2.

To the piston rod H is secured a coil, D′, which, by the movements of the piston, is oscillated in the magnetic field produced by two magnets, B′ B′, which may be permanent magnets or energised by coils, C′ C′, connected with a source of continuous current, E′. The movement of the coil D′ across the lines of force established by the magnets gives rise to alternating currents in the coil. These currents, if the period of mechanical oscillation be constant, will be of constant period.

In the case under consideration it is assumed as a necessary condition that the inertia of the movable element of the generator and the electromagnetic reaction which it exerts will not be of such a character as to materially disturb the action of the engine.

Fig. 2 is an example of a combination in which the engine is not of itself capable of determining entirely the period of oscillation, but in which the generator contributes to this end. In this figure the engine is the same as that shown in Fig. 1. The exterior air spring is, however, omitted, and the air spaces at the ends of the cylinder A relied on for accomplishing the same purpose. As the pressure in these spaces is liable to variations from variations in the steam or gas used in impelling the piston they might affect the period of oscillation, and the conditions are not as stable and cer-

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tain as in the case of an engine constructed as in Fig. 1. But if the natural period of vibration of the elastic system be made to approximately accord with the average period of the engine such tendencies to variation are very largely overcome, and the engine will preserve its period even through a considerable range of variation of pressure.

The generator in this case is composed of a magnetic casing F′, in which a laminated core G′ secured to the piston rod H is caused to vibrate. Surrounding the plunger are two exciting coils, C′ C′, and one or more induced coils, D′ D′. The coils C′ C′ are connected with a generator of continuous currents, E′, and are wound to produce consequent poles in the core G′. Any movement of the latter will therefore shift the lines of force through coils D′ D′, and produce currents therein.

In the circuit of coils D′ is shown a condenser, H′. By the use of a proper condenser the self-induction of this circuit may be neutralised. Such a circuit will have a certain natural period of vibration, and as this depends upon the capacity and self-induction, the period may be varied to approximately accord with the period of the engine.

In case the power of the engine be comparatively small, as when the pressure is applied through a very small fraction of the total stroke, the electrical vibration will tend to control the period, and it is clear that if the character of such vibration be not very widely different from the average period of vibration of the engine under ordinary working conditions, that such control may be entirely adequate to produce the desired results.

ON THE MEANS OF INCREASING THE SAFETY OF HIGH-PRESSURE ALTERNATE-CURRENT DISTRIBUTIONS.*

BY G. CLAUDE.

One of the most serious defects of the high-pressure alternate current is undoubtedly the danger to human life. An investigation, therefore, into the means by which we can as far as possible increase the safety of alternate currents is of capital importance, and the following ideas on the subject may be of interest to you.

To increase the safety of a given system it would seem at first sight as if the means available were few; that the only thing to be done is to make the insulation of the system as high as possible, taking every imaginable precaution to prevent contact between the human body and any parts at a high potential. If, in practice, too much importance is attached to the first condition, it is impossible to observe the second very thoroughly. It is, in fact, certain that if, by suitable arrangements, we could absolutely prevent contacts between the body and high potentials, the question of the safety of high-pressure distributions would by that very fact be completely solved. Unfortunately in practice this cannot be done, and whatever precautions may be taken, an imprudent act, an accident, may at any moment result in the dreaded contact, involving as a consequence the death of the individual in question.

By quite other methods, however, it is possible to obtain important results. Since we cannot entirely prevent contact, we can at least arrange matters so that in the majority of instances these contacts shall be harmless. This result may appear at first sight rather difficult to obtain, but, as a matter of fact, it is easily reached if we take into consideration an element which up to the present has been somewhat neglected, notwithstanding that it plays the principal part in the majority of accidents, due to the alternate current; this element is the capacity of the system of distribution.

In a general manner the capacity may be divided into (1) the direct capacity, C_1, between the two cables; (2) the capacity, $C\ C'$, of each cable with respect to earth, so that the total capacity, C_2, of the two cables becomes $C_2 = C_1 + C\,C'/(C + C')$. When the current is on, each of the condensers, C_1, C, and C' (Fig. 1) is submitted to an alternating potential, and we know that under these conditions it presents an insulation resistance of the form $1/\omega C_2$; that is to say, the apparent resistance between the two cables is $1/\omega C_1$, and that between each cable and earth is $1/\omega C$ and $1/\omega C'$ respectively. In practice, moreover, the values of C_1, C, C' and ω are such that the corresponding *apparent* resistances $1/\omega C_1$, $1/\omega C$, and $1/\omega C'$ are, at the most, a few thousand ohms, so that we may totally disregard the *ohmic* resistances ρ_1, ρ, and ρ', measured when the line is at rest, which are always of the order of tens of megohms. In other words, the insulation of a given system of distribution, measured during rest, may be excellent, and reach hundreds and even thousands of megohms, but the moment the dynamos are switched on this insulation becomes only *a few thousand ohms*. Thus, on the Halles network I found for each lead an insulation resistance of only 2,000 ohms with the dynamos at work.

* Abstract of a Paper read before the Société Internationale des Électriciens.

It is necessary to distinguish the two capacities, viz., the direct capacity and that between the cables and earth, for, from the point of view I propose to take up, their influence is of very different importance. In fact, however large the direct capacity C_1, and however small in consequence the resistance $1/\omega C_1$, there is no danger; it is in fact as if we united the conductors of the two cables by a metallic resistance, such as the primary of a transformer, of impedance $\sqrt{R^2 + \omega^2 L^2}$ equal to $1/\omega C_1$. But this is not the case with the apparent resistances to earth $1/\omega C$ and $1/\omega C'$, and the low values that these have in practice may have the gravest results as regards human life. There is between each cable and earth a difference of potential which, if we suppose the apparent resistances of the two cables to be equal, is equal to one-half the total difference of potential that is impressed upon the system. If an earthed individual touches *one* pole of the system his body is submitted to this difference of potential, which in the majority of cases is greater than 1,000 volts, and which falls but slightly in consequence of the contact, the apparent resistance of the corresponding cable being small compared with that of the body. The result is a permanent current through the body of sufficient amount, if its application is prolonged, to cause death. This is the way in which the majority of accidents connected with alternate currents arise.

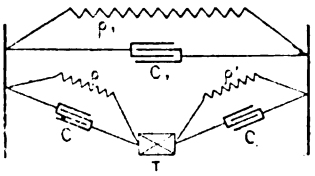

Fig. 1.

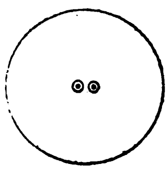

Fig. 2.

If, on the other hand, we are able by any device whatsoever to greatly increase the *apparent* resistance of either cable, the danger of touching *one* pole when to earth would be completely overcome, since the current could not complete the circuit to the other pole through a low apparent resistance. In other words, there would always exist between each cable and earth a difference of potential equal one-half the total, but this difference of potential instead of being *stable* would be *unstable*, and would fall to zero, or at any rate to a very small figure the moment contact was made with the cable. On this hypothesis one must in order to be in danger touch two poles *simultaneously*, an occurrence which is evidently much more infrequent than the coming into contact with a single pole. Hence in this manner the most common cause of accident would be eliminated. Now, since the capacity is the sole cause of the lowness of the apparent resistance the inevitable conclusion is that it would be enough to annul the capacity or to combat its effects.

Here a word of explanation is necessary. Capacity, as M. Boucherot has pointed out, plays a beneficial part in alternate-current distribution, besides having the effects analysed above. Capacity diminishes the lag of transformers during light and no load, and consequent beneficially affects the efficiency, diminishes in a degree that may be considerable the current output of the alternators at these loads, whilst its influence, which is unfavourable at full load,

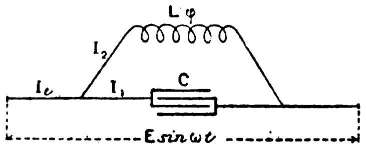

Fig. 3.

is then negligible. In short, the influence of capacity is so advantageous that according to my experience at the Halles the average annual power factor is 0.9, when without the capacity of the cables it would be only 0·82 to 0·83. We can see by these figures what the influence of capacity must be at no load, and especially what it would be if the network were more extensive and the capacity greater.

It would, therefore, be a pity to completely suppress the capacity with a view to securing safety. Fortunately this result need not be feared, since we see, by what has been previously said, that the direct capacity between the cables does not enter into the question of safety, so that we can leave it alone or even try and increase it as much as possible by the employment, for instance, of concentric cables. All we have to eliminate is the capacity with regard to earth, and for that purpose we have three different methods at our disposal.

Firstly, the expression for the apparent resistance being of the form $1/\omega C$, we see for a given network that as regards capacity the smaller ω is the better will be the apparent insulation; a fact which leads us to the use of the lowest possible frequencies. In practice the frequency varies between $\omega = 100$ and $\omega = 500$. From

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this it follows that according to the frequency adopted the apparent insulation of a network may vary in the ratio of 1 to 5.

Again, we may go to work on the earth capacity itself, and by suitable dispositions bring this capacity down to as low a figure as possible. In this way we could obtain appreciable results if we placed our cables in the middle of large diameter tubes (Fig. 2), and all the more so because the dielectric constant of air is only one third or one quarter of that of the ordinary cable insulation. In this connection it may be worth while to mention overhead cables which, having a very small capacity with regard to earth, have, even when insulated with corresponding care, an apparent insulation far greater than that of underground cables.

But it is clear that we are not in a position to make use of the two devices I have just pointed out in the case of an existing installation.

My last suggestion is to neutralise the effects of earth capacity by making use of the well-known properties of self-induction. In order to ascertain how far it is satisfactory we must solve the following

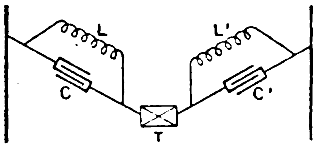

Fig. 4.

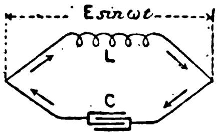

Fig. 5

problem. The apparent resistance of a capacity C being $1/\omega C$, what does it become when we shunt that capacity by a self-induction as in Fig. 3 the final result is

$$I_t \min = E \, \omega \, C \cos \phi \, (\omega \, t - \phi_1)$$

where I_t is the total current, and $E \sin \omega t$ is the difference of potential.

We thus see that by the addition of the self-induction placed in shunt with C we are able to substitute for the original apparent resistance $1/\omega C$ a new apparent resistance $1/\omega C \cos \phi$, which is always larger, and in this way obtain the arrangement shown in Fig. 4. The ideal would be to obtain an infinite insulation, but to do so $\cos \phi$ must equal zero, hence $\phi = 90°$, which is not practically realisable, since self-inductions are not perfect and never have zero ohmic resistance. If the inductance we make use of is the primary of a closed magnetic circuit transformer we know that at no load $\cos \phi$ is never less than 0·5 or 0·6, so that all we can do is to double the apparent resistance. This is, in fact, the experimental result that I have obtained on the Halles network with Ferranti transformers. If the efficacy of the device were limited to this it is certain that its application would not be very useful. But if we employ suitable impedance coils we can make $\cos \phi = 0{\cdot}04$, or even less, so that it is possible to make the apparent insulation resistance *twenty-five times greater*. This result is of supreme importance. The apparent resistance so obtained being much greater than that of the human body, a contact between it and one of the cables will make the difference of potential between the cable and earth fall to a very small value. We therefore arrive at this conclusion, which at first sight appears very singular, namely, that the most efficacious method of improving the working insulation of a network is to metallically connect each cable to earth by resistances of fairly high apparent resistance, but of very small ohmic resistance.

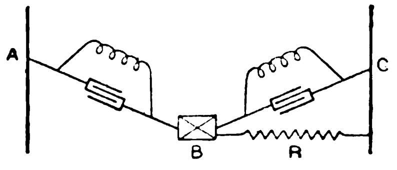

Fig. 6.

The physical explanation of this result is very simple. Owing to the lead caused in the capacity, and the lag caused in the inductance, and to the relationship between capacity and inductance, which in the case of a perfect arrangement would be $\omega^2 L C = 1$, the two branches, L and C (Fig. 5), are traversed at any instant by equal and opposite currents whatever may be the difference of potential, E, at their terminals. The system acts, therefore, as a closed circuit, into which no outside current can enter. If an individual, R, makes an earth through his body, as shown in Fig. 6, he alters the distribution of potential between A and B and between B and C, and consequently the flow of electricity in each of the two devices, A B and B C. But in order that this person should receive a permanent shock his body must be traversed by a current, and this, to get to the other pole, must flow through A B, which is impossible.

In all the preceding remarks I have assumed that the resistance in the condenser circuit is zero, which is not the case, since the circuit comprises the earth. To make the device work properly it would, therefore, be as well to branch off partial inductances at intervals, especially if the circuit is very long and consists of unarmoured cables. We then obtain the arrangement shown in Fig. 7, whose resemblance to Prof. Silvanus Thompson's transatlantic telephonic device is worthy of notice. The point connected to earth in each choking coil is that which divides them into two parts inversely proportional to the capacities of the two cables. In the case of concentric cables, which is in practice one of the most important, the danger of contact is evidently localised upon the middle conductor, and it is sufficient in order to improve the conditions of safety to connect the outer conductor to earth through a suitable inductance (Fig 8).

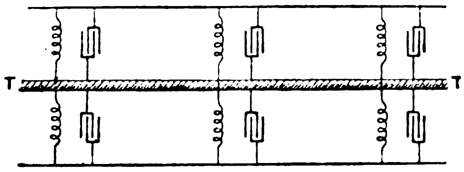

Fig. 7.

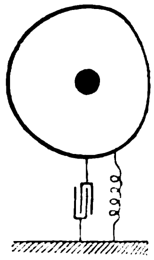

Fig. 8.

There is one point which I have up to now left unnoticed. I observed that the object of the addition of the inductance was not to modify the value of the difference of potential between each cable and earth, but to render this difference of potential unstable and reducible to a small figure the moment any body touched a conductor. But it is none the less true that the potential to which the body would be submitted, varying from 1,200 to 0, whilst that between A and B increased from 1,200 to 2,400, we have to do with the variable state. Hence we must take this fact into account. The steady state will be reached the sooner for the inductance the greater the resistance, whilst for the capacity it is the reverse. Hence there will no longer be at every instant exact compensation between the influences of the capacity and of the inductance, hence the human body concerned will be traversed by a current until the steady state is reached. But if we put things at their worst, that is to say, if we suppose contact to be made at the precise instant of maximum electromotive force, and if we neglect the inverse action of the inductance, we have the body subjected to the discharge of a capacity equal to that of the line charged to a potential equal to half the maximum potential difference. Is this discharge likely to be dangerous? On investigating what will happen, one is led to conclude that it will not be dangerous. In fact, accidents due to

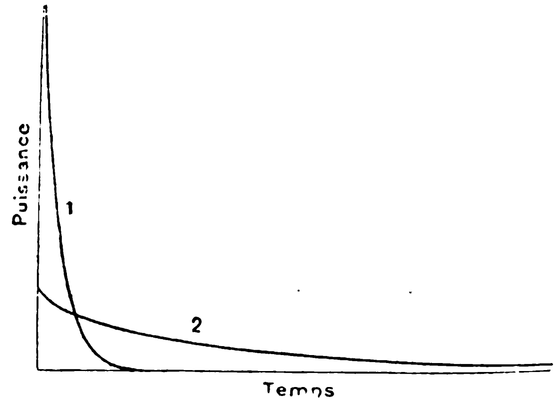

Fig. 9.

electricity are of two kinds—those due to shock and arising from the discharge of powerful condensers charged to static potentials, and those due to the passage through the body of permanent currents, causing death by the prolonged stoppage of the heart and lungs. It is evident, first of all, that we need not consider the latter case, since the variable period is only a very small fraction of a second. On the other hand, from the point of view of shock, one frequently receives, without inconvenience, the discharge of Leyden jars, having, it is true, very little capacity, but charged to a very high potential, and in which the energy, increasing as it does with the square of E ($\frac{1}{2} C E^2$), may be very considerable. Even assuming the quantity of energy in a network to be equal to that in a Leyden jar, the discharge of a Leyden jar is, from the point of view of shock, far more serious, since, owing to the higher pressure, the initial current, and especially the initial power, are much greater than in the case of the dis-

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charge of a network. We may, indeed, represent the two discharges as in Fig. 9, where the curves 1 and 2 enclose equal areas. In other words, in the case of a Leyden jar the same quantity of energy traverses the body in an infinitely shorter time, and must therefore cause a much more violent shock. And since Leyden jar discharges do not result in grave consequences, we are led to the conclusion that *a fortiori* the discharge from a network will be harmless.

There can, therefore, be no doubt about the efficacy of this system and about the need of employing it. Moreover, when it is possible to combine it with one of the two methods previously discussed, that is, when it is possible to balance a capacity, made as small as possible by the methods I pointed out, by an inductance, we can obtain working resistances of the order of hundreds of thousands of ohms.

I cannot conclude without calling attention to a curious consequence arising out of the preceding considerations. Since, do what one will, the working insulation of an alternate-current system of distribution cannot reach even a few hundred thousand ohms, it is absolutely useless to sink large amounts of capital in obtaining an extraordinary insulation when the current is not on. All that need be required is that the ohmic insulation should be appreciably superior to the apparent insulation, so that one and even half megohm for each lead will be amply sufficient, provided we are sure of its maintaining that value. We may, therefore, enunciate this apparently paradoxical doctrine that, contrary to what has hitherto been thought, the insulation of high-pressure alternate-current distributing systems may be comparatively neglected, and that it would be much better to devote all our attention to the low-pressure continuous-current distributing networks, the deterioration of which by electrolysis can only be avoided by the use of very high insulation.

DISCUSSION.

R. ARNOUX: I should like to ask M. Claude what experiments he has carried out to corroborate his theories from the physiological point of view, which is the practically interesting one. I should also like to know if M. Claude has been able by his device to reduce the capacity current *sufficiently*, that is to say, to such a point that there would be no danger in any one touching a "live" network at any point. It is not necessary to reduce the current to zero, but to about 0·01 ampere. Above this amount one cannot get away from the circuit; below it one can. It is the current we have to limit, and not as is generally supposed the difference of potential. It is very difficult to even approximately adjust a capacity and a self-induction, and I should like to know how this is to be done in practice. Certainly nothing that may safeguard human life can be without interest to us, but I must confess that *experimental proof* seems to me in this case more than in any other to be absolutely necessary, if only to avoid the evil of over-confidence. With care the experiment could be carried out without danger. I am aware that my language is that of a practical man, but I think it is the language of prudence.

G. CLAUDE: I am in absolute agreement with M. Arnoux; I recognise the necessity of experimental corroboration. Since the danger to life depends on the current traversing the human body, it is at a maximum when the resistance is zero. Now take the case of an insulation of 2,000 ohms and a pressure of 2,400 volts, and suppose that by the addition of self-induction the resistance is brought up to 50,000 ohms. In the first case the body is traversed by 2,400/2000 = 1·2 ampere, in the second by 2,400/50,000 = 0·05 ampere, a harmless current on M. Arnoux's own showing. Even if experiment does not show that my device eliminates all danger, I should be inclined to apply it. Of two evils let us choose the least, and 50,000 ohms in series with the body would always be a safeguard worth having.

INSTITUTION OF ELECTRICAL ENGINEERS.*

MR. ALEXANDER SIEMENS' PRESIDENTIAL ADDRESS.

In taking this chair, and in thanking you sincerely for having elected me to be your President during this year, it is only natural that I should remind you of the fact that the late Sir Wm. Siemens was your first President. For this reason I may claim to be the first representative of the second generation of electrical engineers who have been called into separate existence by the founding of this Institution 22 years ago. During this period the Institution has grown from small beginnings to its present flourishing condition, thanks to the ability and energy of its founders and of my predecessors in this chair, who have spared neither time nor trouble to secure for electrical engineers the position to which the growing importance of the applications of electricity entitles them. In these endeavours they have been most ably assisted by the permanent staff of our Institution; but the greatest aid has been the benevolent friendship of the parent Institution and its officers. The permission to use this hall for their meetings started the Society of Telegraph Engineers with a standing in the engineering world that it would have cost years of work to achieve elsewhere; and the kindly counsel of the veteran Secretary of the Institution of Civil Engineers has often guided the Society in times of difficulty during the period of infancy, and we sincerely hope that he will long continue his useful work in this building.

* Delivered January 11, 1894.

The contrast which exists in the applications of electricity at the time of the founding of this Institution and at the present time has been so clearly and ably put forward by Mr. Preece in his address last year, that it would be wasting your time if I entered into any details to illustrate the progress. On the other hand, it may not be out of place to analyse the various factors which have influenced the development of our profession from the time at which telegraphy was the only important practical application of electricity until now, when it is called upon to supply energy for an immense variety of purposes. During the past 22 years our profession, and with it the Society of Telegraph Engineers, have changed their character, until these and the scope of their activities have become much more comprehensive, and much more intimately connected with the everyday life of the general public. With reference to this, telegraphy may be compared to the railways, as they both are for the indiscriminate use of the general public, and it is only an exception if a railway or a telegraph line is constructed for private purposes only. For working both these lines a special staff is required, and general rules for their use have to be adhered to by everybody; while in the modern applications of electricity the chief aim is to distribute the electrical energy so that each individual user can apply it in the manner and during the time that it best suits his convenience.

I need not recapitulate the reasons which for a long time made this distribution of electrical energy commercially impossible; but when these difficulties had been overcome, and the electrical engineers were ready to supply the public, it was found that, excepting the Corporation of the City of London, there existed no authority in the United Kingdom that could permit the laying of underground mains, and that a special Act of Parliament was requisite. To the unsophisticated mind this appeared to be extremely simple, as all that was needed was to extend the powers of the various authorities to whose care the laying of water and gas pipes and of telegraph lines was entrusted, so that they could deal in a similar manner with electricity mains. Some of the electric-light companies were of opinion, however, that the same object would be attained if they received powers from Parliament to make agreements with the local authorities, subject in every case to the approval of the Board of Trade, for establishing a system for distributing electrical energy in the various districts; and in pursuance of this policy several private Bills were filed for the session of 1882. The Government of the day did not consider it to be of public advantage that a limited number of electric-light companies should have such roving powers, but brought in a general Bill with the intention of facilitating and expediting the general application of electricity. With this object in view powers were to be given under the Bill to the Board of Trade to grant licences or provisional orders to electric-light companies. The licence to establish a system of electrical distribution in any district was to be granted to an electrical company who had succeeded in gaining the consent of the Local Authority; and its conditions were to be settled between the Local Authority and the Company, subject to some general provisions to be drawn up by the Board of Trade, and subject to the sanction of the Board of Trade. In districts where the Local Authority objected, the electric light company should, nevertheless, be able to establish itself by means of a Provisional Order of the Board of Trade; but to obtain this the company had to prove that the majority of the inhabitants of the district desired to have facilities for obtaining electrical energy. It will be observed that in this draft the license was intended to be the usual way of obtaining power to lay underground mains, and the formalities for settling it were extremely simple; the Provisional Order, on the other hand, was to be resorted to in exceptional cases as a means of overcoming the objection of Local Authorities. This is confirmed by the fact that in the draft the duration of the licence and of the Provisional Order were equal. These benevolent intentions were, however, thoroughly upset during the passage of the Bill through Parliament, and the Electric Lighting Act (1882), which was the outcome of the discussions before a select committee, has given rise to angry denunciations on account of the obstacles which, in the opinion of many, it was raising to an early introduction of lighting by electricity on a large scale.

Curiously enough nobody, during the passing of the Act or afterwards, seemed to care much about the fate of the licensing system, which was completely stripped of its importance, and alluded to by the learned counsel on both sides as suitable only for experimental purposes. Following up this train of ideas, the duration of a licence was curtailed to seven years. Had the intention of the Government, however, been carried out as at first designed, we should now enjoy in the United Kingdom the same facilities of establishing electric supply systems that have aided the development of the electrical industries so much in other countries, instead of being obliged to apply to Parliament in each separate instance at great trouble and expense.

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Disregarding entirely this vital alteration of the Bill, another provision was seized upon to explain the failure of so many electric enterprises to which the aid of the public had been invited about that time ; you all know that this was the clause giving the local authority the right to buy out the electrical company after the lapse of 21 years, paying only the market value of the plant. This agitation was continued until, seven years later, the objectionable clause was modified, and in consequence of this alteration it was said that the confidence of the public in electrical enterprises had been restored. At the same time the system of granting powers by way of a licence was practically dropped altogether, and since then the Board of Trade has declared its intention not to grant provisional orders to electric light companies unless they have obtained the consent of the local authority, thereby abandoning entirely the original object of the provisional orders.

The ultimate result of all this legislation has, therefore, been to create a number of difficulties in the establishment of distributing systems in the United Kingdom ; in fact, the formalities of applying for a provisional order are very similar to those required for a private Bill, so that practically we are not in a very much better position than before the passing of the Electric Lighting Act (1882).

In order rightly to understand the influence which this legislation exercised on the development of the electrical industry, it is necessary to examine into the character and the number of the applications made to the Board of Trade under these Acts, and to trace how many of them have led to the establishment of distributing systems. Taking first the case of the electric light companies, or, as the Act calls them encouragingly, "the undertakers," we find that in 1883, 55 provisional orders were granted, all of which have been revoked; in 1884, 3 provisional orders and 1 licence were granted, all of which have been revoked ; in 1885, 1 licence was granted for the lighting of St. Austell, and this has been put into operation ; in 1886, 1 provisional order was granted to the Chelsea Electricity Supply Company: this also has been carried out; 4 licences granted during the two following years, 1887 and 1888, have since been revoked ; so that, up to the time of the passing of the amending Act (1888), 1 licence and 1 provisional order are the sole survivors. These facts clearly indicate that under the Electric Lighting Act (1882) the undertakers have not succeeded in their object to make electrical energy obtainable as a household commodity. It is, of course, quite another question whether there were not very strong causes of another kind which prevented the powers obtained under the Act from being exercised.

Since the Electric Lighting Act (1888) was passed, a new impetus was given to these enterprises, and, without examining the result of each year's applications separately, the grand total of the undertakers' efforts is that since 1882, 138 provisional orders have been applied for, and 15 licences ; of these, 81 provisional orders and 9 licences have been revoked, so that 57 provisional orders and 6 licences are still in force. To this number 2 provisional orders have to be added, which have been transferred from local authorities to undertakers. An electric supply has been established, or the work is actually taken in hand, in 54 cases, and about 53,000 H.P. will be available. On the other hand, of local authorities, a few had obtained powers under special Acts. The City of London, as mentioned above, had been able to make some experiments of street-lighting without any special permission ; but a number of them availed themselves of the opportunity given by the Electric Lighting Acts, and obtained 121 provisional orders and 6 licences up to the end of 1892. Of this number, 8 provisional orders and 4 licences have been revoked, or merged in provisional orders, so that 113 provisional orders and 2 licences granted to local authorities are still in force ; but two of the provisional orders have been transferred to undertakers, as mentioned above. Under these powers 51 electrical systems of distribution, with 35,000 H.P., have been established, or are in course of construction, while in almost all the other instances the intention soon to carry out the work is apparent. With your permission, a table, giving the details of all these applications and of their fate, will be added to the Address, if you consider it worthy to be printed in the transactions of our Institution.

From the figures which I have given, it is, however, plainly apparent that the local authorities will very shortly have a good many more stations at work than the electric lighting companies ; and, in my opinion, this is as it should be. The financial success which has invariably attended the municipal electric enterprises has relieved the rates at the expense of the wealthier classes in a perfectly legitimate manner ; and the more electricity becomes one of the common necessaries of life, the better it is that its supply should be in the hands of the community, and not in those of monopolists.

A strange fact in connection with this subject is that the great majority of the local authorities should have waited until the passing of the Electric Lighting Act (1888) before applying for powers to supply electricity, for it must not be forgotten that their position was in no way affected by the alteration of the Electric Lighting Act (1882). The explanation must perhaps be looked for in the exaggerated expectations that were raised by the statements of company promoters in the year 1882, when the most reckless assertions were made as to the results to be obtained by establishing electric systems of distribution. The natural consequence was that the inquiries set on foot by various local authorities in no way confirmed the sanguine estimates that had been dangled before the public to obtain its support ; and the total failure of the electric light companies to carry out a single one of the orders and licences obtained by them in the years 1883 and 1884, made the local authorities hesitate before they embarked the ratepayers' money in such precarious undertakings. Fortunately for the progress of our industry, there were some Corporations who could be convinced by the result of their inquiries that the use of electric light would be very advantageous for a variety of purposes, and that the knowledge and ability of the electrical engineers had progressed sufficiently to make a profitable distribution of electricity from a generating centre possible. We have seen that their example has been largely followed, and there is every prospect of a continuous and ever-increasing development of this branch of electrical engineering.

To be sure, in foreign countries, especially in the United States, the use of electricity is much more common than here ; but this is the natural outcome of the greater facilities for establishing centres of supply under the laws of the various countries, where the local authorities in the majority of cases have the power to make agreements with electrical companies for supplying the district with electrical energy for various purposes. Another important factor in retarding the spread of the applications of electricity in this country is the otherwise very laudable desire of the electrical engineers to show in every new undertaking a distinct advance on its predecessors. In this way the details of constructions are undergoing a constant change—in strong contrast to the United States, where the leading manufacturers have their standard sizes of plant and accessories ; these are manufactured wholesale by specially designed machinery, and can, therefore, be supplied much more cheaply than apparatus specially constructed for each case. At the same time the whole transaction is greatly simplified by the absence of long negotiations about the construction of the apparatus, the town which is to be lighted simply specifying how many glow lights and arc lights are to be supplied. This system of working has certainly been instrumental in accelerating the introduction of electricity for a variety of uses throughout the States ; but it can hardly be pretended that such a cast-iron application of the same apparatus under a variety of circumstances can lead to the most economic results, nor has it been possible to keep up the quality of the work to the English standard. Those of you who have visited the World's Fair at Chicago last year, and have examined a little into the details of workmanship and design, will doubtless agree that Sir Richard Webster was fully justified, in his address to the Society of Arts, in contrasting the American and the English exhibits in this respect, very much in favour of the latter.

However much other causes may have contributed to delay the development of electrical engineering, it is clear that the principal one must be looked for in the exaggerated expectations that were raised, either by ignorance or by design, when the general public first seriously thought of regarding electricity as a commodity for everyday use. At that time the promoters of electric companies preached to the public that electricity was in its infancy, that the laws of this new science were totally unknown, and that wonders could be confidently expected from it. There was a short time of excitement to the public and of profit to the promoters ; then the confidence of the public in electricity was almost destroyed, and could only be regained by years of patient work. That the electrical industry was not altogether killed by all these adverse factors is undoubtedly due to the firm scientific basis on which it rests, and to the advantages which the applications of electricity possess as compared with other means for accomplishing the same ends.

In a discourse before the Royal Institution I had an opportunity of reminding the audience that during the last 60 years the most eminent scientific men have studied the phenomena produced by electricity, and that, in consequence, the laws which govern electric currents were perfectly well known when the supply of electricity on a large scale became commercially possible. Since that time the study of electrical phenomena has been carried on with even greater zeal than before, and electrical engineering is now in no danger of lagging behind for want of theories, but is largely aided in its progress by the painstaking investigations carried on in many laboratories, both in England and abroad. While electrical engineering is thus closely allied to physical science, it has quite as intimate a relation to mechanical engineering ; in fact, its real progress dates from the time when the close connection of electrical and mechanical engineering was thoroughly recognised ; and since then these two branches of engineering have reacted on one another to their mutual advantage.

The contrast between present practice and that of the pioneers of our profession is at once recognised in reading the first papers

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and reports on dynamo-electric machines, where particular stress is laid on the small size and on the low weight of a dynamo to produce a given result; but the necessity of having the moving parts durable, and of not always working the machine up to its maximum power, was completely ignored in the desire to produce a large effect with the minimum expenditure of materials. A glance at a modern dynamo, especially when it is built on the same lines as a machine of 20 years ago, will at once reveal the progress of mechanical design that has taken place in the interval. The circumstance that at first only weak currents of electricity were utilised for practical purposes, and that during this period the electrical appliances were constructed like scientific instruments, had undoubtedly brought about this neglect of mechanical considerations, and a healthy re-action could only take place after the mechanical engineer had taken the management of the applications of electrical energy from the hands of the instrument makers. On the other hand, the requirements for driving dynamos to the best possible advantage have served as no mean incentive for mechanical engineers to introduce a number of important improvements into the design of steam engines; in fact, the class of high-speed economical engines may be said to have been called into existence by them, and this has led to the use of direct-driven dynamos, in which this country undoubtedly has taken the lead.

In another direction the governing of the speed of the steam engines has been vastly improved, although at first the mechanical engineers regarded the complaints of the electrical engineers simply as an excuse to shift the blame for the bad performance of their dynamos on to the steam engine. They very soon learned, however, the importance of running at an unvarying speed, and the result is that even comparatively cheap steam engines can be obtained nowadays that govern infinitely better than a high-class engine of 20 years ago. Originally the steam dynamos were designed for use on board ship, where economy of space is of importance, and great credit is due to the Admiralty for introducing very early a system of testing, which has been no small incentive to all concerned to improve the dynamos as well as the steam engines. In these tests the dynamo is run for a number of hours at its maximum output, and no part of it must get hotter than the surrounding air by more than a prescribed number of degrees of heat. Nothing could be simpler than this test, and at the same time it is the most reliable way of finding out whether a dynamo has been constructed suitably for its work. During the same run the water is measured which, in the form of steam, is supplied to the engine, and the relation between the water consumed and the electrical energy supplied to the electrical circuit determines the merit of the steam dynamo tested.

(To be concluded.)

LEGAL INTELLIGENCE.

The Medical Battery Company (Limited).

C. B. Harness, Managing Director of the Medical Battery Company, J.M. M'Cully, and C.B. Hollier, surrendered to their bail on Wednesday last, before Mr. Hannay, at Marlborough-street, to answer the charge of having conspired together to obtain money by false pretences from divers persons.

The Rev. HENRY MONTAGUE VILLIERS, Vicar of St. Paul's, Knightsbridge, said that in September, 1893, he was suffering from an attack of neuritis in the right arm, and went to the Medical Battery Company. His medical man advised him to use electricity. At Oxford-street he saw Mr. Harness, who arranged that he was to pay three guineas for six applications of electricity. He was not examined by a doctor there. He was treated at the establishment with great benefit.

Cross-examined by Mr. TERRELL: He did not get an introduction when he went to Oxford-street, nor did he go there owing to advertisements he had seen. He went because he heard he could get good electrical appliances. Mr Harness was the first person he saw; he was taken direct to his room. Not a single word was said to him about buying a belt. He did not know that the treatment he received was called electrical massage. A current of electricity was applied to one of his nerves. When the sum of 24 guineas was mentioned he indicated that it was more than he was prepared to pay.

Re-examined by Mr. AVORY: He believed that it was Dr. Laird who treated him at Oxford-street.

CECIL D. GREENWOOD, M.R.C.S., L.R.C.P., said that in 1889 he was not in good health, and was suffering from a sluggish liver, indigestion, and insomnia, owing to overwork. He tried the experiment of using a Harness electropathic belt, which he obtained at the premises at Oxford-street, where he called from curiosity. He saw Mr. Harness there, and told him that he was a medical man. Mr. Harness gave him a belt to experiment with. He wore it, with the result that in a fortnight he was practically well. At intervals he had worn a belt ever since. When the first belt was worn out he got another. On August 23, 1889, he sent a testimonial to the Company, speaking highly of the beneficial results which he had experienced from using the belt. He had recommended about 12 of his patients to use the belts, with, in most instances, good results.

Cross-examined by Mr. TERRELL: The old belt that he had discarded he had broken up to make therapeutic experiments with. At the present moment he was wearing one of the belts. It was a connected belt. In the first belt there was no connection between the discs, and nothing was said to him about connecting them. He had nearly always worn the belt next his bare skin. The reason why he had not always worn the belt next his skin was, that it produced sores at first. That was at the time when it was unconnected. He had not made experiments to test its electrical properties. His experiments were limited to finding whether it would cure or not. Successful results had followed the wearing of an ordinary warm belt. He had seen Mr. Harness altogether about a dozen times. He had never reported to Mr. Harness the experiments he made with the belt. They led him to a result which was not consistent with the wearing of an ordinary belt. Before he wore a Harness belt he wore an ordinary flannel belt, which did not produce the same result as the Harness belt. The difference between the Harness belt and an ordinary flannel belt was that one produced electricity and the other did not. He only knew that from what he had been told. He had no special knowledge of electricity, other than that which any medical man had. He could not say whether unconnected zinc and copper plates would produce electricity when placed on the body.

Re-examined: A great deal of his knowledge of medicine was from his reading, combined with his practice. He was quite certain that it was an unconnected belt that cured him. He never received any fee from the Medical Battery Company, and got nothing for writing the testimonial, which was quite spontaneous. He looked upon sores caused by wearing the belts as a proof that electricity was generated.

Mrs. SOPHIA MIDDLETON stated that four years ago she was suffering from neuralgia, and went to four medical men who did her no good. She then went to 52, Oxford-street, and purchased a belt and spine-band, paying five guineas. She wore the belt for about a month, and the spine-band for several months, with the result that she was cured. About two years ago the neuralgia returned, and she went again to Oxford-street to have a course of electrical treatment. She was under treatment by statical electricity for about six weeks, going there nearly every other day. She paid 50 guineas, and gradually got much better.

The Rev. EDWARD FRANCIS SHAW deposed that five years ago he purchased a battery and belt at 52, Oxford-street. He paid six guineas for the battery and three guineas for the belt. He got the belt on the understanding that it only generated a slight quantity of electricity. He wore the belt for nearly four years. He applied the battery to the belt. Sometimes he wore the belt without applying the battery to it. He had a tender throat from overwork, and that induced him to try the treatment, which did him very much good. He had tried other remedies with no avail. He was satisfied that the appliances he got at Oxford-street had cured him entirely. He had studied science and had lectured upon astronomy. He did not believe in imagination, which was the author of all error. He believed he was cured by electricity.

Cross-examined by Mr. TERRELL: He was a strong believer in the efficacy of electricity. He had not studied electricity.

In re-examination the WITNESS said that he had a slight knowledge of electricity. From his knowledge he felt convinced that the belts were electrical.

Mr. HANNAY at this point adjoined the further hearing of the case till next Monday afternoon.

Re the Printing and Telegraph Company of the Agence Havas —ex parte Cammell.

In the Chancery Divison, before Mr. Justice Stirling, this week an action was brought which raised a question of some importance in company law relating to the liability of directors in respect of their qualification shares, and also gave the public an insight into the manner in which public company issues "go to allotment." It was a motion by Mr. Charles Cammell, of Marshfield, Chippenham, asking that the register of members of the above-named Company might be rectified by removing his name therefrom as holder of forty shares, on the ground that he never applied for or agreed to take or accepted the allotment to him of the said shares, and that such allotment, if made, was improper and invalid. The Company was formed in March last, and Article 62 of the Articles of Association provided that the first Directors should be appointed by a majority of subscribers to the Memorandum of Association. Article 64 provided that the qualification of a director should be the holding of £200 of share capital, in respect of which all calls for the time being due should have been paid; and this qualification was to apply as well to the first directors as to all future directors, but such first Directors should be allowed one month from the first general allotment of shares of the Company in which to acquire their qualification. By Article 70 the office of Director was to be vacated (*c*) if he ceased to hold the requisite number of shares, or in the case of a first Director, if he failed to get them within the prescribed time; (*d*) if he should send in a written resignation to the Board, and the same should not be withdrawn for seven days, or be previously accepted. The applicant signed the Memorandum of Association for one share, and was appointed a Director. On March 19th the first Board meeting was held, which the applicant attended. On March 29th the second Board meeting took place, but the applicant was not present. At this meeting resolutions were passed for the allotment of shares in accordance with certain allotment sheets, which included the name of the applicant in respect of forty shares, for which, however, he had made no application, and he was put on the register of shareholders. On May 7th the plaintiff wrote formally resigning his position as Director. In July the plaintiff first heard that his name had been put on the register, and wrote to the secretary asking that it should be removed. To this the secretary answered that the applicant's letter should be placed before the Board. In September the applicant received notice calling on him to pay £85 in respect of the shares. On November 1st the notice of motion was given by which the applicant sought to have his name removed from the register of shareholders in respect of all the shares in his name, except the one for which he signed the Memorandum of Association.

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Mr. Justice STIRLING, in giving judgment, said: I think that upon the evidence it must be taken that until May 15th the applicant was unaware that any shares had been allotted to him. The first question to be considered is whether the applicant has agreed with the Company to take the 39 shares in question from it. Express agreement there is none. Can any be implied? The applicant no doubt acted as director, but this was not sufficient. The applicant had bound himself to conform to the regulations contained in the articles, including, of course, those as to the qualification of directors. There is no provision in the articles that the directors shall take the shares required for qualification or be liable as if they had taken them. There is only a provision that if a director does not acquire the requisite number of shares within a limited time he shall cease to be a director. That regulation makes it his duty not to act after the prescribed time, but that is quite different from a regulation that if he continues to act he shall be deemed to have contracted to take them. In this case the name of the applicant had been entered on the register as the holder of the shares allotted to him on March 29. If the applicant had been aware of this, I should readily infer an assent on his part to take the shares; but I think he did not actually know it until the middle of May, and I also think that he cannot be fixed with constructive notice of the fact. But although the applicant may not actually have agreed to take the shares, either express or by implication, he may have so acted as to preclude himself from denying that he has entered into such an agreement, and the main contention on the part of the company has been that he did in fact so act. I think he cannot be taken to have acted in respect of a qualification, or be held to have estopped himself from denying that he agreed to take the shares in question. In my opinion, therefore, the name of the applicant was entered on the register without sufficient cause, and he does not appear to be precluded by anything which has happened from having his name removed. There must, therefore, be an order in accordance with the notice of motion.

Judgment for the applicant accordingly.

Royce and Co. v. Cuthbert.

At the Hull County Court an action was brought by Messrs. Royce and Co. to recover £38. 10s. 6d. from the defendant, Mr. Alfred Cuthbert, lessee of the Theatre Royal, Hull. Messrs. Royce and Co., in December, 1892, installed the electric light in the theatre, which was sufficiently completed for use on the Boxing Day of that year, and it was so used. In March last the first instalment of £100 was paid, and a further sum of £50 in August following. The balance was due in October, and this action was brought to recover this balance, with some extras.

For the defence it was stated that the terms of the contract had not been carried out.

Judgment was deferred.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *January* 6, 1894.

The General Electric Company.—The General Electric Company has at last "taken the bull by the horns," and instead of continuing to maintain an attitude of defiance toward its critics and denying all reports reflecting upon its affairs, has finally come down to a basis more in accordance with its changed condition. The great works at Lynn are to be almost entirely abandoned, and the expensive and multitudinous offices in New York and Boston abolished. All manufacturing and business interests will be concentrated at the Schenectady works. The lamp works will remain at Harrison, N.J. This move implies that the New York or Edison interests in the Company have got the upper hand, and the next thing to expect is a rival New England organisation composed of the former Thomson-Houston interest.

The Telephone Situation.—The expiration of the Bell diaphragm receiver telephone patent on January 30th will direct strong attention toward the Government-Berliner suit, which may develop into a scandal of no mean proportions. It will be remembered that the Berliner patent on variable resistance contact was kept in the Patent Office for 14 years by means of interferences, all said to have been collusive, thus extending the monopoly to that extent, and presenting the anomaly of a main patent being issued after a number of its subsidiary patents had expired.

New Electrical Manufacturing Enterprises.—Two large Western manufacturing companies have commenced to extend their activity to the electrical field; one of them, the Walker Company, of Cleveland, O., to manufacturing electric street railway apparatus. As both are conservative firms, and there is no suspicion of stock-jobbing or dependence on patents, the new departure is significant, and an indication that in a few years the electrical industry will have settled down to the same basis as any other business.

CORRESPONDENCE.

INSULATION RESISTANCE.

TO THE EDITOR OF THE ELECTRICIAN.

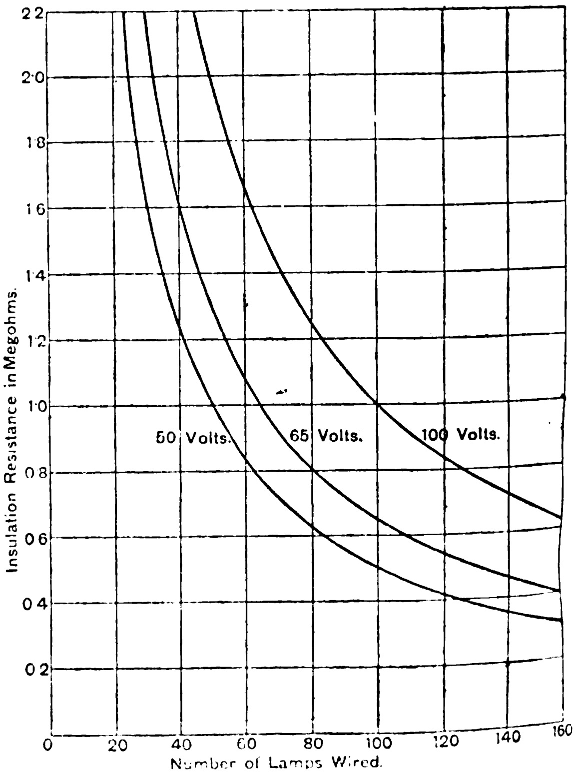
SIR: The article in your columns of last week on the rules in vogue dealing with the insulation resistance in house wiring is highly interesting and instructive, the diagram making painfully apparent the extraordinary differences in the numerous rules on this important subject.

It certainly is desirable that some change in the direction, if possible, of a standard formula should be adopted, applicable to the various conditions of supply.

There are, first, the two and three-wire systems of our public companies, and next, the private installations of a low voltage, to be considered. It will be noticed that of the numerous rules you quote, not one takes into consideration the E.M.F., and yet surely, when dealing with insulation, the voltage is an important factor.

Next, we have to consider the number of lamps (irrespective of their candle-power), as they practically govern the surface leakage due to switches and cut-outs. Hence the Bradford rule (10 megohms ÷ amperes) is scarcely satisfactory, and an arbitrary insulation per lamp is not sufficiently flexible to meet the varied conditions of supply.

If, however, we take the volts as our constant, and divide them by the number of lamps, and let the product represent the resistance in *megohms*, we have the simple formula $\frac{\text{E.M.F.}}{\text{lamps}}$ = megohms, and one that squares very fairly with modern practice.



Taking the range of lamps, as per your diagram, and the voltages mostly in vogue, we obtain the following results:—

Lamps.	I. 50 volts.	II. 65 volts.	III. 100 volts.
20	2·5	3·25	5·0
40	1·25	1·62	2·5
60	0·833	1·08	1·66
80	0·625	0·81	1·25
100	0·5	0·65	1·0
120	0·416	0·54	0·833
140	0·357	0·46	0·714
160	0·312	0·40	0·624

Columns I. and II. would mostly apply to private installations, and Column III. to the majority of our public supplies. All that is now needed is to fix a maximum and minimum to meet the extreme ranges—say, 5·0 Ω and 0·1 Ω respectively. Upon plotting the above it will be found that columns I. and II. give curves closely corresponding with T on your diagram, while column III. is above that of A, but exacts nothing beyond what is attainable with good work.—Yours, &c.,

11, Lombard-street, January 16, 1894. H. HUMAN.

ELECTRIC TRACTION IN LIÉGE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Page 262 of your valuable paper (issue of the 12th inst.), you refer to "Electric Traction in Liége," and describing briefly the plant, you say that much of the experience of American engineers has been disregarded in the construction of the line. As I have been connected as consulting engineer with the Company who has built the line, I hope you will allow me to reply to your information by the following statements:—

(*a*) The overhead construction has been made according to American experience; insulating materials are of American patterns.

(*b*) The motors, controllers, trucks and cars have been designed in Belgium, according to American engineers' experience, and they might be compared favourably with any American made at the time the line was started.

(*c*) The power station is not furnished with high-speed American steam engines, and the reason is that the contractors purchased in Belgium moderate-speed engines (150 revolutions per minute), which run the plant economically, the amount of coal burned in the boilers being only three pounds per car kilometre.

I am myself sincerely convinced that the American engineers have had the largest experience in electric traction, and I have tried to carry out their ideas in Belgian practice. The Compagnie Internationale d'Electricité, from Liége, who were the contractors for the plant, are now associated with the Thomson-Houston Company in Belgium, and that fact leads me to think that I have succeeded in convincing the Belgian engineers of the value of American practice in electric traction.—Yours, &c.

27, Rue de la Sablonnière, Bruxelles, W. DIERMAN.
January 13, 1894.

THE ELECTRICIAN AND THE BRIGHTON COMPANY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Brevity is undoubtedly the very soul of wit, but at the same time the wit is liable to lose a great portion of its charm when it displays a palpable lack of verisimilitude. I do not think I am wrong in adding that this is one of the accepted canons of journalism, and I am therefore extremely surprised to find in the last issue of *The Electrician* a statement which shows a very reckless disregard to this rule.

In your article upon the Newport tenders you comment upon the Brighton and Hove Electric Light Company's business and in a statement, as conspicuous for its illogical reasoning as for its brevity, you declare its value should be marked "Goodwill, £5,000; plant, *nil*."

Now, I have no concern whatever in regard to your title to call into question the procedure on the Newport tenders, but when you declare that our plant is valueless I claim the right to refute such an absurd and libellous statement, and I protest against your attempt to depreciate the asset which is in our possession.

Will the Electric Construction Company feel grateful for your declaration that four of their 70-unit alternators are worth nothing? Are you paying a compliment to the Westinghouse Company by naïvely telling them that the value of some hundreds of their Shallenberger meters is *nil*? Do you think the Brush Company will thank *The Electrician* for the information that Mr. Mordey's famous alternator and converters besides three of their 40-light machines are not worth anything? And the Cardew voltmeters, the Sir William Thomson ampere balances, Fowler's engines, the Electric Construction and the Leeds and London transformers; is it, after all, your opinion that the value of these can be marked up *nil*?

We are convinced that all the machines and instruments mentioned above, which are in our possession, are of first-class value, and your unwonted statement that our plant is *valueless* is as unfair to us as it is injurious to the reputation of the manufacturers. Moreover, it can only be very prejudicial to our interests in the realisation of the concern, and I have to ask you to retract your statement no less prominently than you gave it publicity.—Yours, &c.,

G. W. SPENCER HAWES, Secretary.

THE NEWPORT TENDERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is, of course, quite excusable for the editor of a technical journal to be unaware of business methods, but when he presumes upon his ignorance to the extent of ridiculing a business document as some class of "interesting game" he lays himself open to a charge of unfairness. My remarks, of course, have special reference to the manner in which you dealt in your last issue with my report on the tenders for electric lighting plant submitted to the Newport Corporation. Treating the document, as you do, as a huge joke from beginning to end, your readers may be glad to hear my view of the matter.

Some 60 tenders were referred to me for examination and report, and I coped with the task in a document, eventually ordered to be printed, of 50 pages. It would involve too great a claim upon your space to explain the report in detail, but in order to show the principle underlying the method which you hold up to ridicule I will confine my remarks to three 150-I.H.P. engines, for which 19 tenders were submitted. I give sample details of some of them:—

Three Engines, each to give off 150 I.H.P.

	Size of Cylinders.		Stroke.	Speed.	Bearing surface (per main bearing).	Steam consumption in lbs.	Efficiency.	Price.
	High Pressure.	Low Pressure.						
	in.	in.	in.		sq. in.		%	£
A.	11	20	30	110	72	16	93	2,520
B.	14·5	24	24	110	80	16 to 17	85	2,450
C.	13	24	24	110	112	18 to 20	86	2,337
D.	14	23	32	85	84	18	90	2,190
E.	12	18	33	100	77	18	80	2,139
F.	11	21·5	30	100	49·5	18 to 20	80	1,950
G.	12	20	24	110	55	19	91	2,262
H.	11	20	30	100	60	14 to 15	85 to 90	2,685

It will be noticed that though all the engines are guaranteed to do the work required of them they differ considerably in price. The offers are all from first-class makers, and I am puzzled to gather from your remarks how you would deal with the task of selection. Your reproach is that I did not "simply recommend one tender in each class with or without reasons." I preferred to clearly show my principals the nature of the choice that lay before them.

To have simply recommended the tender which named the lowest price would have been unfair to the other tenderers, who were prepared to offer engines of a better class. To bring all the *pros* and *cons* to a level I chose a standard, and in order not to make an invidious choice I selected the standard arbitrarily. I then proceeded, simply for the purpose of comparison, to appraise in each case of variation from the standard the approximate money value of that variation. I fully explained the method by which I arrived at these approximate values, which, applied to all the engines alike, were fair to all. To make the method clear I may state that, in the case of the engine I took as a standard:—

Size of cylinders { High pressure.............. 14in. diameter.
Size of cylinders { Low pressure .... 23in. „
Stroke.. 32in. „
Speed 85
Volume swept by the pistons per minute = 3,060,000 cubic inches.
Bearing surface (per main bearing) 84 square inches.
Steam consumption, 18lb.
Mechanical efficiency, 90 per cent.

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with the result that the engine "A" had to be penalised as follows:—

Bearing surface (assuming that the other parts of the engines bear a like proportion), standard 84 sq. in. for 85 revolutions, for 110 revolutions, should be 108 sq. in. Deficiency, 36 sq. in., at £1 per square inch per engine		£108
Volume swept by the pistons per minute standard = 3,060,000		
Against	2,640,000	
Deficiency	420,000	
At 5s. per 1,000 cubic in.		105

and credited with:—

Mechanical efficiency	93	
Standard	90	
Allowance	3	
At £30		90
Steam consumption (*i.e.*, 2lb. × £163, basis of consumption being 18lb.)		326

Dealing with each engine in this way I was able to arrive at a fair comparison, by which it appeared that engine D gave the best value for money. If any one of your readers can suggest a sounder method of dealing with such tenders I shall be glad to know of it through your columns.

With regard to the remainder of your article, I cannot conceive why you should do such an injustice to the "pioneer" Brighton Station as to characterise its plant as *nil*. It is, I think, generally regretted in the electrical profession that the Brighton Corporation did not see fit, when they embarked in electricity supply, to take over the "pioneer" station then supplying Brighton, and personally I regret, to the tune of a good many thousands, that I did not then succumb to the inevitable, and recommend the abandonment of the enterprise instead of extending the works; but it is hardly generous on your part, at a time when negotiations are pending for the sale of the plant, to write down its value as *nil*, especially when the plant is about the counterpart to that which is working so satisfactorily in Dublin, Leeds, Eastbourne, Blackpool, West Brompton, and Madrid.

I pass over your innuendos to the effect that, as a consulting engineer, I find it is impossible to act independently when the tenders of Messrs. Fowlers are under consideration. Strange as it may seem to your leader writer, I feel quite able to exercise a perfectly impartial and fearless judgment when the interests of the Newport Corporation or any of my other principals are at stake.—Yours, &c.,

ROBERT HAMMOND.

117, Bishopsgate, London, E.C., January 15, 1894.

[As the report on the tenders is public property, we give the names of the engine makers referred to in this letter:—

A.—Yates & Thom.	E.—Brush Company.
B.—Jas. Watt & Co.	F.—Copeland.
C.—John Fowler & Co.	G.—Cole, Marchent & Morley.
D.—Davey Paxman.	H.—Hick, Hargreaves.

—ED. *E.*]

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1894 Edition of "'THE ELECTRICIAN' ELECTRICAL TRADES' DIRECTORY AND HANDBOOK" is in preparation, and will shortly be published. *New names, alterations of addresses, &c., should be sent in at once.* Full printed particulars can be obtained, post free, from "The Publisher," *Electrician* Office.

"ELECTROMAGNETIC THEORY," by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application to the Publisher.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.) Prospectus on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—This book, written by Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

TENDERS INVITED.—The Mayor of the Commune de Jassy, Roumania, invites tenders for contracting for the erection of the Théatre National. Amongst the contracts are included ironwork and skilled smiths' work, ironmongery, telegraphs and lightning conductors, waterpipes, creosoting, engineering work, an electrical installation, heating and ventilating appliances, appliances and fittings for lighting, &c. Either the whole or a portion of the work can be tendered for, and offers must be sent in to the Hall of the Mairie, by Thursday, the 3rd/15th February next, between 2 and 4 p.m., in writing. Particulars of the plans, &c., can be inspected at the Office of Works of the Commune, or on application to the architects, Messrs. Fellner et Helmver, Ix. Bez, Servitengasse 7, Vienna.

——— The Electric Lighting Committee of the Borough of Halifax invite tenders for the supply of an overhead travelling crane. Tenders must be sent in to Mr. Keighley Walton, Town Clerk, by 10 a m. on the 25th inst. Further particulars are given in our advertisement columns, and all information can be obtained of Mr. T. P. Wilmshurst, electrical engineer, Cripplegate, Halifax.

——— The Corporation of the borough of Great Yarmouth invite tenders for the construction, supply, and laying down of the necessary plant and mains for the supply of electricity in the borough, in accordance with the specification, plans, &c., which can be obtained of Mr. J. W. Cockrill, A.R.I.B.A., borough surveyor, Municipal Buildings, Great Yarmouth, after Tuesday next. Tenders, which may be for the whole or any part of the plant, &c., must be sent in to Mr. T. M. Baker, town clerk, not later than noon of Monday, February 19th. Further information concerning the specifications, &c., may be obtained from Mr. A. H. Preece, 39, Victoria-street, London, S.W.

——— Readers are reminded that the tenders for electric lighting plant required by the Edinburgh Corporation have to be sent in not later than the 30th inst. All information regarding these tenders can be obtained of Prof. A. B. W. Kennedy, 14, Old Queen-street, Westminster, S.W.

TENDERS ACCEPTED.—The offer of Mr. J. F. W. Bray has been accepted by the Corporation of Great Yarmouth for the erection of their electric lighting station for the sum of £2,626.

——— The tender of Messrs. Spagnoletti and Crookes has been accepted by the Baths, Cemetery, and Recreation Grounds Committee, of Burnley, for providing and fixing electrical fittings at the plunge baths for the sum of £50.

REMOVAL NOTICE.—Mr. Arthur H. Vesey, A.M.I.C.E., has removed his offices from the central station of the Chelsea Electricity Supply Company to Bradon House, George-street, Croydon.

LIQUIDATION.—A petition has been presented by Mr. James Stevens, of Rosherville, for the winding up of Elmore's Foreign and Colonial Patent Copper Depositing Company (Limited), and is down for hearing at the Royal Courts of Justice on the 24th inst.

RE J. AND W. WEEMS.—The trustee in the sequestration of this estate calls a general meeting of creditors at the offices of Messrs. Thomson, Jackson, Gourlay and Taylor, 24, George-square, Glasgow, on Wednesday next, at eleven o'clock, for the purpose of electing a Commissioner in place of one resigning.

MESSRS. E. P. ALLAM AND CO.—This firm have just completed the electric lighting of the extensive range of offices and sample rooms of the Mazawattee Tea Company, Eastcheap, E.C. The firm have also several other lighting contracts in hand, or nearing completion.

BERLINER TELEPHONES.—Messrs. O. Berend and Co. have just issued list "T," which members of the trade can obtain on application. The list deals with the Berliner carbon pencil sets, Blake transmitter combinations, the "Universal" transmitter sets, battery sets, magneto generators, and, in addition, complete telephone exchange outfits. Telephone accessories are fully illustrated, and prices accompany the descriptions in each case.

THE "HARD" INCANDESCENT LAMP.—Messrs. Wilhelm and Co., of the Wool Exchange, E.C., inform us that they have already received orders for large quantities of the "Hard" incandescent lamp, for which they are the agents.

BROCKIE-PELL ARC LAMP.—In reference to our Trade Note last week that, amongst the contracts carried out by the Brush Company, was the supply of the whole of the electrical plant at Earl's Court Exhibition of 1893, we are asked to state that the arc lamps used were the standard Brockie-Pell throughout.

MANCHESTER EDISON-SWAN COMPANY.—This Company have recently built and opened extensive new show rooms at the Exchange Station approach, Victoria-street, Manchester, where stocks of the Company's specialties are also kept. Besides the ordinary show rooms, the Company have fitted up a complete suite of model rooms, furnished and arranged with a variety of electric light fittings to enable intending users to gather the general effect to be obtained from the various styles and designs. Amongst the fittings for which these model rooms are especially notable, are crystal

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glass and gilt metal-work, an attractive design for a large electrolier being particularly noteworthy, the crystal lending itself very readily to artistic effect. A billiard room is included in the suite. Both gas and steam power is employed in generating the large amount of current necessary to keep the show rooms fully lighted, and this is an additional inducement to those contemplating putting in the light, as they are shown both steam and gas at work, and can judge for themselves which would be more suitable where isolated installations are under consideration. Visitors to Manchester should not miss the opportunity of inspecting the show rooms.

South Wales Institute of Engineers.—The new and handsome block of buildings in Park-place, Cardiff, the head-quarters of the South Wales Institute of Engineers, and of the Monmouthshire and South Wales Coalowners' Association, were opened this week. The building was commenced in July, 1891, and was completed this month, a long stoppage having occurred owing to the strike in the building trade. The block of buildings is partly lit by gas, but a complete electric light installation has been provided by Messrs. B. Verity and Son, of London and Birmingham. The electric light fittings are very tasteful, and everything is in readiness to connect the building on to the Cardiff Corporation's system when this is complete. At present the electric light supply is obtained from Cardiff Castle, by permission of the Marquis of Bute.

Messrs. C. A. Parsons and Co.—Included in a large number of contracts completed by this firm during the past year is the supply of turbine engines to the Newcastle and District Electric Lighting Company, the Cambridge Electric Supply Company, and the Scarborough Electric Supply Company, showing an aggregate of 1,400 H.P. A number of smaller plants of the steam turbine class and ordinary lighting plants for ship, mill, and private house lighting have been completed, giving a total of nearly 2,000 H.P. Orders for steam turbine motors of an aggregate of more than 3,000 H.P. are now under construction, including a 250-H.P. steam turbine alternator for the Portsmouth Corporation. Other contracts in hand include transformers for the Halifax Corporation and for the three electric supply companies mentioned above, as well as a number of search-light reflectors and other electrical specialities for the manufacture of which the firm are well known.

Electric Pianofortes.—Messrs. Grob and Co. notify that they have arranged with the Sherborne Electric Installation Company to exhibit their new type of pianos played by electricity. Instruments can be seen at the Sherborne Electric Installation, and inspection is invited.

Messrs. Faraday and Son.—In order to meet the growing demand for their No. 21 standard, with tilting silk shade, this firm have recently made reductions in price. The tilting shade, which is protected under Register No. 134,442, retains its position wherever placed.

Diaries for 1894.—The Eastern Telegraph Company present to their customers a very handy diary and pocket calendar for 1894, which, in addition to a list of chronological events of special interest to telegraph men, contains several useful tables, a neatly-ruled diary, and a set of admirable maps (of course, on a small scale), showing in red the cable systems of the world. The Company also issue a neat pocket memorandum book, in leather case, with medallion data and pencil. For the fourth year in succession the Company present a *papier-maché* paper-knife and calendar, with a neat map of the Eastern and Eastern Extension Companies' cable system printed thereon.

Calendars.—We have received from Messrs. Causton and Sons, of Eastcheap, E.C., a parcel of calendars in various forms, which will be found very useful for office and domestic use.

Aberdare.—The Local Board has recently held a special meeting to consider the application of Messrs. J. C. Howell and Co., for the Board's consent to a Provisional Order for the lighting of a portion of the town by electricity. Subsequently a vote was taken, and the Board's consent to the application was finally approved.

Bradford.—Following the example set by many of the local authorities throughout the country, the Town Council are collecting information in connection with the introduction of a refuse utiliser in conjunction with their electric lighting works. It is probable that a sub-committee will be appointed to present a report to the Council.

Blackburn.—The Gas Committee of the Town Council have now resolved to proceed with their electric lighting works. It has been decided to let the contracts immediately the minutes have been confirmed by the Council. The motive power is to be steam, and not gas, as was originally suggested.

Charge of Embezzlement.—At the Ipswich Borough Police Court, on Monday, Robert Mann, formerly manager at Ipswich for the National Telephone Company, was charged with embezzlement. It was stated that the prisoner had been in the employ of the National Telephone Company for some years, and was transferred from King's Lynn to Ipswich in February, 1892. His duties were to obtain orders and superintend the construction of telephone lines. It was no part of his duty to collect accounts, but any money tendered to him by the Company's customers should be sent on to the district manager, at Norwich. It was alleged that the prisoner received orders for the erection of telephones, but failed to account to the Company for the amounts received for the work. On being taxed with this he is alleged to have remarked that he "could not live on the income he was receiving from the Company, and the Company had better not do anything, for their own sake." Prisoner, who reserved his defence, was committed for trial at the Ipswich Sessions, which commenced yesterday.

Coleraine.—The Board of Guardians will shortly advertise for tenders for the supply and fitting of electric bells throughout the workhouse and infirmary.

Edinburgh.—A special meeting of the Edinburgh Town Council was held on Tuesday to consider an application on behalf of Messrs. Dick, Kerr and Co., the lessees of the Edinburgh street tramway undertaking, applying for the Corporation's consent to a sub-lease of that undertaking to the Edinburgh Tramways Company (Limited). After a long discussion, it was proposed and carried that the Corporation approve generally of the application from Messrs. Dick, Kerr and Co., and remit to the Lord Provost Committee for consideration as to the conditions on which the sub-lease should be granted, the Committee to report to the Council.

Fleetwood.—A public meeting of the residents has been held to receive and consider the report adopted by the Commissioners in reference to the installation of the electric light in the district. A resolution to the effect that the action taken by the Commissioners be approved was put, and carried unanimously. The recommendations of the Commissioners will be found in a recent issue of *The Electrician.*

Folkestone.—A special meeting of the Corporation was held last week to receive and consider the report of the Electric Lighting Committee. A squabble arose as to the right of trustees of the local gas company to vote on the electric lighting question, and a formal protest was entered against the ruling of the Mayor that such persons could not vote on the subject. The Electric Lighting Committee's report states that in April last they were appointed to consider and prepare a provisional scheme for the public and private lighting of Folkestone by electricity, with power to consult an expert on the subject. Acting upon this authority, Mr. Mark Parker, of Rochester, was retained to advise the Committee upon technical details. This gentleman has presented his report to the Committee, in which he describes the various systems of lighting now in operation, and their respective advantages and disadvantages. The report is accompanied by diagrams, which have materially assisted the Committee. This body are of opinion that there already exists a sufficient demand for the light to warrant the Corporation in proceeding with the erection of works, &c. They recommend that the lighting should be carried out by the Corporation, and that it would be prejudicial to the interests of the ratepayers to allow statutory powers to be granted to a private undertaking, which will probably result if the Corporation does not decide promptly in the matter. The Committee advise the adoption of the high-tension alternating-current transformer sub-station system. The report sets out the area of supply, which includes the principal thoroughfares of the town. The sum of £35,000 is estimated as the capital required, and details are given showing the estimate of cost, annual working expenses, and estimated revenue. The Committee recommend that the works be at once proceeded with under a Board of Trade licence, to be applied for forthwith, and that the services of Mr. Parker be retained, on terms to be arranged, to advise and assist the Committee and the Town Clerk in obtaining the proposed licence, in designing the necessary generating and distributing works, supervising their construction, and advising the Committee in reference to the acceptance of tenders, &c. On the motion that the report be adopted, a lengthy discussion ensued, and it was ultimately decided to adjourn the consideration of the report for three weeks, with an instruction to the Committee to ascertain what amount of current was likely to be taken by private consumers.

Galashiels.—The Town Council have considered the proposed application to the Board of Trade by the Caledonian Electric Supply Company (Limited) for authority to supply electric light within the borough of Galashiels, and, after a long discussion, have resolved to delay further consideration for another fortnight.

Heckmondwike.—The extensive electric lighting installation at the Co-operative Wholesale Society's Shoe-works has this week been brought fully into use, and is giving every satisfaction. The work has been carried out by Messrs. Ernest Scott and Mountain. There are more than 500 16-c.p. incandescents.

Inquest.—An inquest was held this week on the body of William George Taylor, who was burnt to death at the works of the British Xylonite Company, at Homerton. Mr. Curtis Hayward, B.A., the Company's solicitor, watched the case on their behalf. It was

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alleged that xylonite (or celluloid) was composed of a specially manufactured tissue paper treated with nitric and sulphuric acids, and after being mixed with camphor and spirits of wine was worked into a dough, pressed into sheets, and dried. It was explained that Government experts have certified that the material is not an explosive, and as the actual manufacture was carried on in Suffolk and not in London, the works where the fire occurred (employing 300 hands) were not licensed. Mr. A. Spenser, chief officer of the Public Control Department of the London County Council, in giving evidence, stated that the room should have been lighted by electricity, as other parts of the works were, and with this precaution and Government supervision being permitted, no such accident could have happened. A verdict of "Accidental death" was returned, with a rider to the effect that no exposed lights should be allowed where the manufacture or storage in large quantities of such substances as xylonite was going on.

LANCASTER.—We are informed that the whole of the preliminary arrangements for the fitting up of the buildings and laying the mains for the public electric light installation are now almost completed, and it is anticipated that by the middle of February the Corporation will be in a position to supply current to the whole of the prescribed area.

LIVERPOOL.—*The Liverpool Mercury* thinks that now the electric light is in use in a large number of the principal business establishments in Liverpool, it is time for the Corporation to consider the question of introducing the light into the principal thoroughfares, and so to create a bulwark against the encroachments of the monopolist gas company.

MARGAM.—At a recent meeting of the Parliamentary Committee the question of the lighting of the district was discussed, and it was resolved to obtain a report from Messrs. Drake and Gorham as to the cost of lighting the district by electricity.

OSWESTRY.—At its last meeting the Town Council decided to submit objections to the Provisional Order of the local electric lighting company.

RAMSBOTTOM.—The Electric Lighting Committee of the Local Board recently held a meeting to consider a scheme for the supply of electric light to the district, and decided that, having regard to the necessity of obtaining a Provisional Order, the matter should be adjourned for further consideration, and the Committee be instructed to obtain further information on the subject.

SHOREDITCH (LONDON, E.)—The Dusting and Scavenging Committee of the Vestry have recently considered the advisability of providing a refuse destructor to deal economically with dry refuse. It appears that the barging of this refuse at present costs the Vestry nearly £7,000 per annum, and from a report received by the Electric Light Committee of the Vestry, from a leading firm of engineers, it is estimated that a saving of nearly £4,500 per annum would be effected if a refuse utiliser were provided. The Vestry have decided to take the matter into consideration. The Electric Lighting Committee have further considered the question of the proposed sight for the central lighting station, and have decided that the Pitfield-street position is the best, and recommend that the sum of £33,500 be offered therefor. The Committee's report has been adopted.

SOUTHAMPTON.—At the meeting of the Harbour Board, on Tuesday, it was reported that the two electric cranes now being fitted on the Town Quay were completed, and had stood all tests satisfactorily. The cranes are to be at once put into work. The Town Quay and offices are to be lighted by electricity.

SWANSEA.—The Sub-Committee recently appointed to report to the Local Board upon the question of electric lighting for the borough have reported that the time has now arrived when the provisions of the Swansea Electric Lighting Order, 1889, should be carried into effect. The Sub-Committee recommend that Mr. Manville be instructed to report fully upon the subject.

WESTON-SUPER-MARE.—Some time back the question of lighting the district by electricity came up for discussion, but nothing has since been done in the matter. In reply to a question at the last meeting of the Town Commissioners, the Deputy-Clerk replied that the consideration of the question had been deferred until the consultation scheme had been carried out.

WINDSOR.—At the last meeting of the Town Council correspondence was read from Messrs. C. A. Parsons and Co., and the Fowler-Waring Cables Company, in regard to negotiations which are in progress between the liquidator of the Windsor and Eton Electric Light Company (Limited), and the above-mentioned firms, with the object of making arrangements to enable the Windsor Company to resume its business in a manner satisfactory to the Council. It is proposed to put down a central station with entirely new plant, for the supply of 10,000 8-c.p. lamps, the plant to be manufactured by Messrs. Parsons and Co., and to be similar to that supplied to Scarborough, Cambridge and Newcastle-on-Tyne, the mains to be supplied by the Fowler-Waring Company, and to be similar to those supplied to the London and City of London Companies, and to the Corporations of Exeter, Brighton, &c. The system proposed is the high-tension transformer system. It is calculated that the above would involve an expenditure of £15,000, and would take six months in execution. This correspondence has been considered by the waterworks Committee of the Town Council, who have been in communication with the Board of Trade, who replied that the Provisional Order obtained by the Windsor Company had not been revoked, and did not appear to contain any provision for the transfer of its powers, duties and obligations to any company or person. The matter having been discussed, it was agreed to appoint an electric lighting committee, who will report to the Council.

WORTHING.—Preparations for the forthcoming experiments in the electrical treatment of sewage, referred to in a previous issue, are being proceeded with, and it is expected that operations will be commenced next we k. Applications for permission to be present have been received from representatives of a large number of local authorities throughout the country, as well as by many persons interested in sanitary science questions.

ANNUAL DINNER.—The annual dinner to the employés of Messrs. Laurence, Scott and Co., Gothic Works, and of the Norwich Electricity Company, was held last week, under the presidency of Mr. R. Laurence. More than ninety guests were present.

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Company (Limited).

The following report has been issued by the Directors of this Company for the half-year ended September 30th last, and will be presented to the forty-third half-yearly ordinary general meeting, to be held at Winchester House, E.C., on Thursday, the 25th inst., at one o'clock.

The revenue for the period amounted to £369,967. 5s. 1d., from which are deducted £98,106. 8s. 10d. for the ordinary expenses, and £31,906 4s. 3d. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £6,753. 16s. for income tax, there remains a balance of £233,200. 16s., to which is added £1,133. 8s. 10d. brought from the preceding half-year, making a total available balance of £234,334. 4s. 10d. From this balance there have been paid—

	£	s.	d.
Interest on Debentures and Debenture Stock......	27,696	18	0
Dividend on Preference shares	20,384	12	11
Two interim dividends of 2s. 6d. per share each on the Ordinary shares	100,000	0	0
	148,081	10	11

Leaving a balance of £85,252. 13s. 11d., which is carried forward to the next account.

The revenue includes £22,373. 7s. 4d. dividends for the half-year upon the Company's shares in the Eastern and South African, the Black Sea, the Direct Spanish, and the African Direct Telegraph Companies.

Under the terms of a contract dated June 17, 1893, with the Portuguese Government, the Brazilian Submarine Telegraph Company and this Company have secured an additional ten years of their respective privileges under existing Portuguese concessions. To obtain this extension this Company and the Brazilian Submarine Telegraph Company undertook to connect Lisbon and this Company's general system with the islands of the Azores, and the two Companies hold a large proportion of the shares in the Europe and Azores Telegraph Company, which has been formed to work the line. The new cable was laid in August last.

Since the last general meeting a cable has been laid from Zanzibar to Seychelles and Mauritius, under agreement with Her Majesty's Government and the Eastern and South African Telegraph Company, thus connecting these colonies with the Company's system of submarine telegraphs.

In accordance with the provisions of the Articles of Association, two of the Directors, Sir John Pender, G.C.M.G., M.P., and Charles W. Stronge, Esq., C.B., retire by rotation at this meeting, and, being eligible, offer themselves for re-election. The retiring auditor, Mr. Henry Dever, desires to offer his firm, Messrs. Deloitte, Dever, Griffiths and Co., for election as auditors to the Company. Messrs. Welton, Jones and Co. also retire, and offer themselves for re-election.

Anglo-American Telegraph Company (Limited).

The following is the report of the Directors of this Company to be presented at the ordinary general half-yearly meeting to be held at Winchester House, E.C., on Friday, the 26th inst. at two o'clock:—

The total receipts from July 1st to December 31, 1893, including the balance of £503. 1s. 9d. brought forward from the last account, amounted £151,095. 1s. 7d. This sum, however, is subject to revision, as the law-suit between this Company and the Paris and New York Telegraph Company is still pending before the Court of Appeal in Paris. The traffic receipts show a decrease of £8,493 as compared with the corresponding period of last year.

The total expenses of the half-year, including repair of cables, &c., as shown by the revenue account, amounted to £59,250. 19s. 3d., an increase of £622. 11s. 9d.

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Interim quarterly dividends of 12s. 6d. per cent. on the Ordinary stock, and £1. 5s. per cent. on the Preferred stock, were paid on November 1st last, absorbing £43,750, leaving a balance of £48,094. 2s. 4d., out of which the Directors recommend the Proprietors to declare final dividends of 13s. 6d. per cent. on the Ordinary stock, and £1. 7s. per cent. on the Preferred Stock, amounting to £47,250, making a total distribution for the year ended December 31, 1893, of £2. 11s. per cent. on the Ordinary Stock, and £5. 2s. per cent. on the Preferred Stock, leaving £844. 2s. 4d. to be carried forward to the next account.

With the exception of the Brest-St. Pierre (1869) cable, broken in April last year, and the Valentia-Heart's Content (1874) cable, broken in July, the Company's cables and land lines are in good working order and condition. The Company's s.s. "Minia" and the Telegraph Construction and Maintenance Company's s.s. "Calabria" were engaged during the summer and autumn in endeavouring to repair the two broken cables, but were unsuccessful in both cases owing to unfavourable weather.

In view of the age of the Company's cables, and the necessity for assuring the efficiency of the service, the Directors after much and anxious deliberation, have decided to lay a new cable from Ireland to Newfoundland in the coming summer. A contract has been entered into with the Telegraph Construction and Maintenance Company for the manufacture and laying of 1,955 miles of cable, between Valentia (Ireland) and Heart's Content (Newfoundland), for the sum of £450,000, which will be paid out of the renewal fund. This cable will be superior in strength and carrying capacity to any yet laid across the Atlantic.

The Directors greatly regret the loss by death, in September last, of their colleague Mr. Henry Weaver, who was connected with the Company as General Manager and Managing Director since 1870. In accordance with the Articles of Association, two Directors of the Company, Samuel Barber, Esq., and Sir Albert J. Leppoc Cappel, retire at this meeting, and, being eligible, offer themselves for re-election. Mr. Joshua Dean and Mr. John Gane, F.C.A., the auditors, retire, and offer themselves for re-election.

Direct United States Cable Company (Limited).

The following is the report of the Directors of this Company for the six months ended December 31st last, which is to be presented at the thirty-third ordinary general meeting of the Company, to be held at Winchester House, E.C., on Tuesday next, the 23rd inst., at 2 o'clock :—

The half-year's revenue, after deducting out-payments, amounted to £41,051. 19s. 11d. as compared with £43,629. 6s. 1d. for the corresponding period of 1892, being a difference of £2,577. 6s. 2d. against the half-year under review. The working and other expenses for the same period, including income-tax, amounted to £19,059. 16s. 5d., leaving a balance of £21,992. 3s. 6d. as the net profit, making with £819. 2s. 4d. brought forward from the previous half-year a total of £22,811. 5s. 10d. For the corresponding period of 1892 the working expenses and other payments amounted to £18,982. 3s. 7d.

Interim dividends of 3s. 6d. per share for the quarter ended September 30, 1893 (paid October 24, 1893), and of 3s. per share for the quarter ended December 31, 1893 (payable January 24, 1894), together amounting to £19,730. 15s., have been declared, and the balance of £3,080. 10s. 10d. on the revenue account has been carried forward.

The reconstruction of the station buildings at Ballinskelligs is being proceeded with.

The Directors announce with regret that, in consequence of failing health, Mr. Charles John Günther has resigned his seat at the Board. The casual vacancy thus created in the Board of Directors has been filled up by the election of Mr. Charles Eugene Gunther.

National Telephone Company (Limited).

An extraordinary general meeting of this Company was held yesterday (Thursday) at the Cannon-street Hotel, under the presidency of Mr. J. S. Forbes, "for the purpose of submitting a report on the progress of the Company and its business for the half-year ending October 31st last, and for considering the expediency in the future of holding half-yearly in lieu of yearly ordinary general meetings."

The SECRETARY (Mr. Albert Anns) having read the notice calling the meeting,

The CHAIRMAN in the course of his remarks said :—I want you to understand at the opening of the proceedings that this is an extraordinary general meeting, called by the Directors in order to bring before you and, so to speak, gather your opinion upon the subject referred to in the short notice convening it. The fact is that this Company, as you know, is now assuming considerable dimensions, and we believe is of some importance to the community as well as to you ; and the Directors, in existing circumstances, are rather oppressed with the responsibility when they have to carry the business on from year to year subject to the obligation, at present, of coming before you only once a year. We unanimously feel that it would be more in the interests of the Company—the shareholders, the directors, and the officers—if we had more frequent opportunities of getting into touch with each other. Every one knows that the present position of this Company is not too absolutely defined, and under any circumstances, from the very nature of it, it is not altogether an entirely smooth path. We are sufferers somewhat from a circumstance over which we have very little control—the worst circumstance possible that can affect a commercial company—the circumstance of uncertainty as to where we are. As you know, owing to the action of the Government, the position of the Company is somewhat altered. The Government came to the conclusion that the intercommunication between the great centres for telephonic purposes must be taken over by them. There was a certain Treasury Minute laying down the principles upon which that transfer of trunk wires and the future development of trunk wires by the State should be held, and we ourselves and the other telephone companies—other licensees, whoever they might be, were to be charged with the limited service in certain areas to be agreed. That was all determined in August, 1892. It was the subject of considerable negociations with the authorities of the Post Office at that time, and it was a subject of enquiry before a committee of Parliament, who reported upon it ; and upon consideration the Directors came to the conclusion that if the State insisted, there was no alternative, and that they must make the best of it by agreeing to terms that would leave them in that position. Within the area of the licence as amended they were to carry on the telephone business—the local business, so to say. The State was to provide the communication in the nature of trunk wires in all the great centres, and we were to co-operate with the Post Office in carrying on with efficiency, and as economically as circumstances justified, the telephonic communication, both local and through. That has been pending a long time. As a condition of that agreement, of course, the moment it appeared the State assumed the duty of furnishing what we called trunk connections between the great centres, and it was useless for us to spend any more money on those connections outside the areas which, under the revised licence, we should be charged with the work of, and we were called upon by the Post Office to abstain from further work in the direction of trunk wires, the condition of the bargain being that those wires which we have already, at a considerable expenditure of capital, constructed between these centres, are to be transferred to the Postmaster-General on payment of their book cost, with a small addition to cover the cost of administration and so forth. We therefore suspended any further capital expenditure in that direction, naturally. However, the thing goes on. The Post Office, no doubt, are engaged at the present time in the construction of certain great arterial lines, but in many portions of the country where intercommunication between towns requires some expansion to carry on the trunk messages between those towns—for instance, Manchester and Liverpool, and Liverpool and Leeds—we are now beginning to suffer rather seriously from the want of more communications of that sort. In the meantime there has been a change of Government, and the agreement subsisting between the Government and the Company is in a state of suspense—at all events, it has not progressed very rapidly. It was rather complicated and not very simple or easy to enlarge, although the heads of agreement are contained upon a sheet of foolscap. When you come, with the assistance of your technical friends and of your legal friends—Sir Robert Hunter on the one side, and Mr. Crisp on the other side—there are certain words which have a pregnant meaning as to where the parties differ—some questions of principle which, when you tackle the details, involve necessarily a good deal of discussion and some differences of opinion, and it all has at last, by compromise or agreement, to be got into what is called a legal form. That has been going on. Meantime one of the conditions upon which we entered into this agreement has been somewhat altered. We assumed when the Postmaster-General, duly authorised by the Government, put his initials to the heads of agreement that that was the agreement, and those heads of agreement we are prepared to carry out loyally and efficiently. Meantime, however, Parliament has had some discussion on the subject, and the Government, I daresay actuated by the best motives, have pledged themselves that our agreement shall not be completed until it has been submitted to Parliament. Every one knows that during the last two months Parliament has been occupied upon matters even more vital to the community than the efficiency of telephonic communication, and our agreement is not through ; but I will tell you what is going on all this while if the agreement flags. Our business is obstructed, and the general convenience is being neglected, and that is one illustration of the kind of reason which has induced the Board to say, We are like an ordinary individual charged with a great responsibility. He sometimes finds that he cannot carry it all, and then he takes counsel of his friends, and that is the underlying thought and principle which has brought us together to-day. In these great and complicated businesses, with hundreds of centres, the necessities of the thing require an enormous mass of detail—the accounting, the letter-writing, the necessary exchange of correspondence and documents, and all that sort of thing—involving enormous machinery and great labour. As our company was constituted we came into existence on a particular day of the year—unhappily not on the 1st of January, but the 1st of May ; so when you talk of a telephonic year, the times are out of joint. One gets fairly puzzled as to whether it was 1892 or 1893 that one was talking about. I am now going to talk about a year which is partly 1893 and partly 1894. It is a great inconvenience, and we think it quite worth our while to get rid of it. There is another reason why we should do so. Most of the great commercial companies have a yearly account based on the calendar year, and what we propose to recommend, if you see no great objection to it, is the adoption of a similar course. We have had the accounts prepared for the half-year ended October 31st, and although, I believe, we have not received the official approval of the auditors, you may take it that the figures I shall present to you are duly authenticated, and they are useful as showing where the Company has got to in the interval of six months since we dealt with the year's accounts. Generally, you remember what took place at the last meeting. You remember our absorption of the other companies, and one of our conditions with the Post Office in the agreement I referred to is that we should procure the surrender by those companies of all the country licences, because our licence now is one restricting us to certain limited areas. Last year we had made considerable progress after long and difficult negotiation, in getting all those companies into the fold, and our capital up to the end of that year represented not only the cost of the original three companies amalgamated under the term "National," but of a number of companies brought in. The Irish Company, however, was then outside, but that, too, is now in ; and I believe that as far as we are concerned that is an end of the affair. The purchase of this company will account for one of the principal items of

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the expenditure of capital in the half-year. Then, it has always been necessary for us, and I am afraid it always will be, to add to our capital expenditure for the expansion of our business. Those are the only two additions to our capital; and without referring to the figures, I may say that the capital expenditure has been in round figures about £121,000 on the purchase of the Irish Company, and about £90,000 upon the expansion of our business. Then, what is the result of the working of the undertaking? Upon the last year, without the Irish Company, we found ourselves in this position—that after paying the working expenses, and the enormous royalty to the Post Office, we were enabled to clear the interest on our debentures, to pay the interest on our first and second preferences, which amount to £150,000 each, and bear 6 per cent.; we were also able to pay 5 per cent. on nearly £600,000 of third preference shares, and with the almost universal assent of our proprietors, we paid 5 per cent. on the Ordinary capital, carrying a considerable balance to reserve. It was thought wise in our circumstances, the Company having a constant pressure on it for making extensions, and with our short "life," to adhere to the sound principle of paying a moderate dividend and carrying a large sum to reserve, so that we might be armed in the furure against contingencies. Applying this to the business of the past half year, notwithstanding that our capital account has increased by the purchase of the Irish Company and our additional outlay in extending our business, we shall be able to maintain the same position and carry forward a considerable margin into the current half-year. When we come to the end of our year—April 30th—we have no reason to doubt that our position will be the maintenance of these payments upon our debentures and our several stocks, and to carry forward a considerable margin to our reserve. We had intended to present the half-year's accounts to you as you came into the room, but upon reflection we thought that that might be open to the suggestion that a certain number of shareholders would have the figures in their possession before the general body of the shareholders. We therefore decided that it would be fairer to send the accounts out with the report of these proceedings as early as possible after the meeting. Our business is progressing, notwithstanding the considerable drawbacks attending the state of uncertainty in which we are placed, and I trust that it has also increased in efficiency. There is no doubt that there were (and, I dare say are) grounds of complaint, but we are not only devoting enormous time and skill, but are also spending a very large sum of money on the concern. If people will take the trouble to compare like with like, I will venture to affirm—backed with all the knowledge and experience of my colleagues, who are practical working men, and some of them skilled electricians—that we are now doing this service in our chief centres as efficiently and as cheaply as it is being done in any place in the world. In order that that statement may be contradicted I invite a challenge from anyone interested. There is an illusion that our subscription in London is £20, but it is really £15. We have in London an enormous number of subscribers—over 10,000—and the average payment is £15, of which an equivalent number of shillings goes into the pockets of the Post Office. The wayleaves in London are not only extremely costly, but in consequence of the nature of our occupation are extremely complicated and multiplied. We have no power to do, in a legal and in the most efficient mechanical way, what the service requires, and we are obliged to go by roundabout and costly methods. That is not the case in Stockholm; all this is done there by the Government, who do exactly what they please. In Paris, too, it is done by the Government, who do not pay anything excessive for wayleaves. All these things ought to be remembered in connection with the cost of our work and the way in which it is done. If our Company were placed in the position that it ought to be in, and which two separate Committees of Parliament have said we ought to be in—that is, armed with power to erect their wires so that the most efficient service could be given to the public—your working expenses would be enormously less, and the subscription would probably fall in a relative degree. The resolution I shall propose is:—

"*That in future two ordinary general meetings be held in each year, and that the Directors be requested to take the necessary steps to have the Articles of Association of the Company altered accordingly.*"

The rider to that will be that those two meetings shall be so arranged as to fit in with the natural year. We have just paid six months' interest to October 31st. Our ordinary year ends on April 30th. In the ordinary course, about the early part of July we shall meet you and distribute the balance for the year. What we should propose to do, with your approval, would be to defer the payment of next half-year's interest until we closed the accounts up to June 30th, and probably we should declare a dividend at the meeting in July up to June 30th, which would, in fact, be eight months' dividend instead of six months. Subsequently we should fall into a regular state of things.

Lord BALFOUR OF BURLEIGH, in seconding the motion, reiterated the Chairman's statement regarding the unanimity of the Board in their desire to hold half-yearly instead of yearly meetings.

The CHAIRMAN, in reply to some remarks from a shareholder, stated that there was no doubt they must have a very large reserve fund, but whether it was essential that it should be invested in the business or in securities apart from the business was a matter which they could determine when they approached the question nearer than they had done up to the present time. He might state that the reserve fund had increased, and it now amounted to £161,401, which might have been distributed among the shareholders, but for prudential motives. There was no necessity for anyone to be alarmed about the Company only having a short "life," but it was necessary on that account to increase their savings. Their tenure was 18 years from January 1st, but the State might resume possession before the end of that period. If the Government under their powers gave them notice in 1897, they would take possession on arbitration terms, but he did not know they would pay the market price. The Directors had considered the question of putting the reserve into investments, but they had not yet arrived at any decision on the point, although they might do so at their next meeting. In answer to a further question, the Chairman stated that the agreement with the Post Office had to be submitted to the House of Commons, but if it was dealt with by that assembly in a manner detrimental to them they would reserve their right of re-entry. The fact that there was no agreement, however, placed the Company and the users of the telephone "between the devil and the deep sea"; and every month the Company were deprived of the benefits of their enterprise, and were prevented from adding to the efficiency of the service.

The motion was then adopted unanimously, and a vote of thanks to the Chairman and Directors closed the meeting.

Fowler-Waring Cables Company (Limited).

The fifth ordinary general meeting of the Fowler-Waring Cables Company (Limited) was held at the offices, Victoria Mansions, 32, Victoria-street, Westmister, London, on the 12th inst., Mr. William Fowler presiding.

The SECRETARY (Mr. D. Stephen) having read the notice calling the meeting as above,

The CHAIRMAN said: The motion that I have to propose is, "That the report and accounts, as distributed, be received and adopted," and in moving that, I have to make a few remarks. Like everyone else, I greatly regret that we are not able to pay a dividend this year, more especially as we have not paid a dividend since the formation of the Company. This has been a cause of great regret to us all, but I should observe that we, as Directors, have on this occasion, as you see by the accounts, waived all our fees, both for the past and the present year, and, therefore, we have shown our disposition to assist the Company, financially and otherwise, in every possible way. The real cause of the want of dividend, I think, may be stated to be the general depression of business in 1893—in all business, including electrical business—and the great competition which there has been in the electrical business itself especially. That I think everyone who knows anything about the matter will know to be a correct statement. The general condition is so fully set forth in the report that I do not think I need enter into details. The balance-sheet is very carefully drawn up, and everything, I may say, has been taken with the intention of showing the shareholders exactly how the matter stands, and we have not shown a profit that was not actually made. In fact, we might have shown a much larger profit had we chosen to value things beyond what is correct in a business point of view. We have taken great care not to do that, but to show only the real, genuine profit made. I only regret, as I said before, that it has not been larger. All that we want, with our admirable factory and admirable machinery of every kind, is a larger amount of orders, and I think we may hope that the year now begun will be a better year than the last. There is one other point I must refer to, and it is not a pleasant one, but we have mentioned it in the report—that is, that we do still require additional working capital. We are endeavouring to raise that in a way that I hope will be satisfactory, but if we do not succeed in that, we may have to appeal to the shareholders for their help in the matter. So far we have obtained no such help from the shareholders, but I hope, if it is absolutely necessary to appeal to them, that they will come to our assistance. I trust, however, that that will not be necessary. I do not think if I made a very long speech I could say more than I have done, but I should like to add one word. I do think that the management of our Company, speaking generally, has been extremely able, and all that we could desire. My impression is that if we were to appoint a hundred men we could not get a better man than we have already, and I feel every year additional confidence in his management of the Company, in his energy, his industry, and his ability, and I think you will all agree that no Company of this sort can succeed unless the management be of the right kind. One might say that with such management we ought surely to have obtained a better result; but I have already mentioned the reasons why I believe we have not done so. However, I have great hope that with this management we shall yet make this a successful Company. That is all I have to say, but if any shareholder present likes to ask me any question I shall be happy to reply.

Mr. FLETCHER said he had attended the meeting on purpose to express, on behalf of the shareholders as well as on his own behalf, their deep thanks to the Board for the way they had met the position of the Company, and the example they had shown to Directors generally, in giving up their fees and in also meeting the difficulties of the Company by advancing it money. He wished that other Directors had done their duty half as well in other companies in which he had been concerned. Reference had been made to the depression in trade. He did not know anything about the electrical trade; but wherever one went nowadays in England and abroad, one saw everything connected with the laying of cables. He had rather expected to hear some sort of explanation as to their own want of success in the face of this enormous increase in the use of electrical cables. It seemed to an ordinary outsider (and he only spoke from an outsider's point of view) that there never was so busy a time for electrical working and the laying of new mains. He had been wondering whether the Fowler-Waring cable was the best for the purpose, or whether it was being superseded by other mains for transmitting current. If that were so would it not be better at once to wipe off from the credit side of the balance-sheet the item "by patents and goodwill," £41,000? It was only a paper asset at any time, and I think it would be an encouragement to the Directors if this item were written off. It was a matter that could be done in a few days and at no expense, and he thought it would be more satisfactory to the Directors themselves to do so, as they would then have less capital to pay on, and they would thus show better results. The shareholders had no idea as to

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what the turnover of the Company was, and it was impossible for them therefore to judge in any way what capital they required and why it was required. Certainly things looked improving now. There were two ways of meeting the depression. One was to concentrate their works, and the other was to increase them, and the general idea in the last ten years had always been to increase them, and to say that if there was more work there would be more profit. The result of this view, however, had been that trading in this country had been eminently unsatisfactory in the past ten years.

The CHAIRMAN: I will ask Mr. Mavor to say a few words with regard to the question of depression in electrical and other business. I have no doubt that what you say is perfectly correct, that there is great activity in the electrical industry; but Mr. Mavor can inform us whether in 1893 there has been depression in electrical works even, as in all other kinds of business. As to our turnover, we do not generally publish particulars, but we should be very glad to tell you privately after the meeting the actual amount of our turnover in each year. There is no doubt that the turnover last year was considerably greater than it was in the year before, and that is satisfactory as far as it goes. The profit was not so large proportionately, the reason being that owing to competition the estimates had to be made on a somewhat less profitable scale than in former years. With respect to reducing the capital, that is, apparently, an easy matter, but we should have to go to the Court, and I believe that you would have to put the words "and reduced" after the name of your Company. For a certain period that would have to be done, and I think that would be very objectionable, although it has often been done. Still, I do not like it, and I should not care to have my name associated with such a proceeding. That may be partly a question of feeling, but I think that such a proceeding would tend to reflect on the credit of the Company. You spoke about concentrating, and making the business more profitable with the existing capital. You must remember that the real difficulty is this—that the fixed charges of a business remain very much the same whatever the amount of the business is. If you do a large business the profit is far greater in proportion than if you do a small business, but doing a large business requires more actual money in hand. I think that that is the explanation of the point you refer to about our requiring more capital. In order to make the business pay we must have a larger turnover in proportion to the fixed charges of the business. That is the case with all manufacturers, unless we can obtain a small number of orders at a very large profit. In that case we can do with a small capital. The trouble is that the tendency in modern times in everything is to have work done at a less rate of profit, and in a finer way, as regards profit and loss, than in former times. I am therefore afraid that there would be some difficulty in our doing what you desire in that respect, although no one would be more desirous of doing it than the Directors. We should greatly like to do a small business at a very large profit, but I do not think that in these days that is easy of accomplishment. I will now ask Mr. Mavor to tell us in a few words what he feels regarding the subject of depression in electrical matters in 1893.

Mr. FLETCHER said he had rather referred to the reduction of capital as a suggestion for the Directors' consideration than advocating it himself.

Mr. MAVOR stated that with respect to the state of electrical enterprise in England in 1893, it would be utterly impossible in a few words to give a detailed explanation, and fully amplify the statement that it was depressed, but it was very easy for him to give evidence to that effect, because on the previous night the President of the Institution of Electrical Engineers delivered his Inaugural Address, and sketched the progress of electrical enterprise since 1882, when the Electric Lighting Act was passed, and clearly showed how electrical enterprise in England had been kept back, having been severely hampered by a great many causes, but mainly by legislative difficulties. The business was active in the later months of 1893, and the shareholder was quite correct in saying that at present every one saw streets being opened up and mains laid; and it might be consoling to him to know that this Company have a large share of this work in London and other places. As to whether their cables maintained their position, they were at least as good as any and better than many. He would not say that theirs were the only good cables, but trials had demonstrated clearly that the Company were in the front rank as cable manufacturers. As to the asset of £41,000 for "patents and goodwill," which has been pointed to, he did not think that that amount would appear so large when the Company's position was reviewed at a later stage of its history. They were thoroughly in a position to compete with the greatest of their rivals, and so far as they had gone, they have really equalled the best of the work that had been done.

Mr. FLETCHER said he was much obliged to Mr. Mavor for his statement.

The CHAIRMAN: I may add, in answer to what was said about our cables holding their own, that the fact that we have had a large increase in our turnover this year shows that we hold our own.

Mr. FLETCHER assented, and added, that with an increased turnover now and with practically everything wiped off, the prospect of having a dividend next year looked satisfactory.

The CHAIRMAN: I can make no promise, but I have great hopes.

Lord MEDWAY then seconded the adoption of the report, which was unanimously agreed to.

The CHAIRMAN then proposed "That Lord Medway and Mr. Smart, the retiring Directors, be re-elected."

Mr. GEORGE FLEMING seconded the motion, which was adopted, and Messrs. Cooper Bros. were afterwards re-elected as Auditors.

On the motion of Mr. FLETCHER a vote of thanks was passed to the Chairman.

The CHAIRMAN: I thank you very much. I wish I could have placed some more agreeable statement before you.

The meeting then separated.

NEW COMPANIES, STATUTORY RETURNS, &c.

KERBEY BOWEN (LIMITED).—This Company was registered on January 16th with a capital of £20,000, in £10 shares, to carry into effect an agreement between Mr. Kerbey D. Bowen, electrical engineer, and Nathaniel Hemming, to carry on business as builders and manufacturers of and dealers in launches, yachts, ships, and boats of all kinds, to be propelled by electricity, steam, or other power, and also as electricians, iron and brass founders, engineers, and manufacturers of machinery, tools, and implements of every description, and to erect, construct, lay down, enlarge, alter and maintain any buildings, charging stations, works, and machinery necessary or convenient for the Company's business. The subscribers with one share each are: K. D. Bowen, J. Strick, L. H. Grundy, H. V. Reader, W. Sidley, Mrs. E. Bowen, T. M. Colson.

ANDER'S TELEPHONE COMPANY (LIMITED).—By an agreement, dated November 25, 1893 (filed December 5th following), the Company acquires from George L. Anders and Walther Kottgen the patents Nos. 1,637, 5,712, 12,528, and 20,610, of 1892, relating to improvements in telephonic apparatus, and in consideration therefor agrees to allot as fully paid 750 shares, of £1 each, to George L. Anders, and 2,250 shares to Walther Kottgen.

BOURNE AND GRANT ELECTRICITY SUPPLY COMPANY (LIMITED).—The statutory return of this Company, made up to September 25, 1893, has just been filed. The nominal capital is £25,000, divided into 24,900 Ordinary and 100 Founders' shares, of £1 each. 18,207 Ordinary and 100 Founders' shares have been taken up, and a call of 10s. upon each share made. The calls paid have realised £9,078. 10s., while £75 remains unpaid. By special resolution, passed December 18, 1893, and confirmed January 3, 1894, the nominal capital was increased to £45,000 by the creation of 20,000 new Ordinary shares of £1 each.

BRITISH VOLTA ELECTRIC GLOW LAMP COMPANY (LIMITED).—This Company, on December 19, 1893, entered into an agreement with William Habgood and Edwin C. Lacey for the acquisition of provisional patent No. 16,514, of 1893, for "Improvements in electric incandescent lamps," and agreed to allot 300 fully-paid shares to William Habgood and 100 similar shares to Edwin C. Lacey as a purchase consideration.

CITY NOTES, &c.

CENTRAL AND SOUTH AMERICAN TELEGRAPH COMPANY.—This Company has declared a quarterly dividend of $1\frac{1}{4}$ per cent., which was payable on January 10th. The quarter's working showed a surplus above dividend requirements of $28,248, making with receipts from other sources, including the Guatemala subsidy, a total surplus of $194,157. Deducting expenses for improvements, including the cost of the Guatemala cable connection, there was a surplus of $159,223, which, added to the surplus on September 30th, made a total at the end of the year of $537,554.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The accounts of this Company for the past half-year show a balance, after providing for the debenture interest and the full dividend on the 5 per cent. Preference shares, sufficient to allow the payment of a dividend on the Consolidated Ordinary Stock at the rate of $\frac{5}{8}$ per cent. per annum, against a dividend at the same rate for the corresponding period last year, leaving £1,064 to be carried forward, as against £822 for the same period last year.—The traffic returns of this Company for the week ended January 14th, were £951, as against £1,008 for the corresponding period of last year, being a decrease of £57. The total receipts for the half-year amount to £1,941, as against £2,006 for the corresponding period of 1893, a decrease of £65.

CHATHAM, ROCHESTER, & DISTRICT ELECTRIC LIGHTING COMPANY (LIMITED),—A prospectus is issued inviting applications for £4,000 5 per cent. 1st mortgage debentures in this Company (forming part of £12,000 authorised). The subscriptions are £10 on application, £15 on allotment, and £75 within 14 days after allotment.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company notify that the Coupons on the Five per cent. Debentures due February 1st will be paid on and after that date by Messrs. Glyn, Mills, Currie and Co., 67, Lombard-street, E.C. Coupons should be left at the bank three clear days for examination.

MEXICAN TELEGRAPH (CABLE) COMPANY.—This Company has declared a quarterly dividend of $2\frac{1}{2}$ per cent., which was payable on January 17th. The quarter's operations showed a surplus of $19,000, but repairs and renewals required $21,400, leaving a deficit of $2,400. As, however, a surplus of $366,261 was brought in, the year closed with an accumulated surplus of $363,837.

PORT BEIRA PIER, TRAMWAY, AND TELEGRAPH COMPANY (LIMITED).
It is announced that letters of allotment in this Company's recent application for subscriptions have been posted.

MESSRS. ROBEY AND CO. (LIMITED).—A prospectus has appeared this week inviting subscriptions for £125,000 $4\frac{1}{2}$ per cent. registered first mortgage debentures in the above Company, secured by a first mortgage on the freehold engineering works of the Company at Lincoln, and also forming a floating charge on all other property of the Company. The prospectus states that this issue is made in consequence of the deaths of partners, and with a view of facilitating family arrangements. The present management is to remain unchanged. The debentures may be redeemed by the Company any time after January 1, 1914, at £105. The subscription list closes to-day (Friday), at 4 o'clock. £5 per debenture is payable on application, £25 on allotment, and £70 on March 31st next.

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ST. JAMES' AND PALL MALL ELECTRIC LIGHT COMPANY.—The Directors of this Company recommend the payment of a dividend of 4½ per cent. for the year ended December 31st last. The transfer books of the Company will be closed from the 20th inst. to Feubrary 5th.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ending January 12th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,297.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price, Jan. 10.		Price Wednesday, Jan. 17.		Rate per Cent. Yielded. £ s. d.	Dividend Due	Business Done During Week Ending Jan. 17. Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	12/6	Anglo-American	42	44	43	45	6 2 3	Jan., Apr., July, Oct.	43	42
£2,932,680	Stock	25/0	Do. Preferred	79½	80½	81	82	6 14 2	" "	80¾	79½
£2,932,680	Stock	5/0	Do. Deferred	7	7½	7½	8	..	.. ..	7¾	7
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	99	102	99	102	3 18 5	January and July	—	..
130,000	£10	3/0	Brazilian Submarine	11½	12	11½	11¾	5 10 8	Mar., June, Oct., Dec.	11⅞	11½
£18,700	£100	5%	Do. 5 per Cent. Bonds	101	104	101	104	4 16 2	January and July	..	—
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	—	—
10,000,000	$100	7%	Commercial Cable Capital Stock	130	140	130	140	5 0 0	Jan., Apr., July, Oct.	—	..
16,000	10	8/0	Cuba Submarine	11½	12½	11½	12½	6 8 0	February and August	12½	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	..	..
60,710	20	3 0	Direct United States Cable, 1877 xd	11⅛	11⅝	11	11½	6 4 5	Jan., Apr., July, Oct.	11⅝	11½
400,000	10	2/6	Eastern xd	15	15¼	15	15½	4 5 3	" "	15 3/16	14¾
70,000	10	6%	Do. 6 per Cent. Preference xd	15¾	16¼	15¾	16¼	3 13 10	" "	16⅛	..
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	..	..
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	108	111	108	111	4 10 1	February & August	..	..
250,000	10	2/6	Eastern Extension xd	15⅝	15⅞	15½	15¾	4 8 11	Jan., Apr., July, Oct.	15⅞	15 5/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	115	118	115	118	3 7 10	February & August	116½	..
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	101	104	101	104	4 16 2	January and July	—	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor Deb., 1900	101	104	101	104	4 16 2	" "	—	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103	106	103	106	3 15 6	February & August	..	—
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	106%	109%	106%	109%	3 13 5	May and November	106½	..
180,227	10	1/3	Globe Telegraph and Trust xd	8½	8¾	8½	8¾	5 2 10	Jan., Apr., July, Oct.	8¾	8½
180,042	10	6%	Do. 6 per Cent. Preference xd	15⅝	15⅞	15½	15½	3 17 5	" "	15½	15½
150,000	10	5/0	Great Northern	19¾	20¼	19¾	20¼	4 4 2	Jan., April, and July	20¼	20⅛
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 14 4	March & September	..	..
17,000	25	12/6	Indo-European	41	44	41	44	5 13 7	May and November	42½	—
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	3 6 8	" "	—	—
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	105	108	5 11 1	March & September	107	—
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red" 1942	100	103	101	104	3 16 11	..	102	..
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	..	..
3,381	£100 Cert.	35/0	Submarine Cables Trust 6 per Cent.	114	119	114	115	5 4 4	" "	114½	..
15,609	10	5/0	West African Telegraph	5½	6½	5½	6½	7 13 10	January and July	..	..
£249,900	100	5%	Do. 5 per Cent. Debentures	99	102	100	103	4 17 1	March & September	101½	..
30,000	10	2/0	West Coast of America	1½	2½	1½	2½	..	January and July	1⅝	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	97	101	97	101	7 18 5	June and December	..	..
88,321	10	1/0	West India and Panama	1	1½	1	1½	..	..	—	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10¼	9¾	10¼	5 17 1	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 7	June and December	108	107½
64,242	15	4/6	Western and Brazilian	6	6½	6	6½	3 9 4	May and November	6½	..
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5¼	5¾	5¼	5¾	..	..	5⅝	—
33,129	7½	4/6	Do. 5 per Cent. Deferred	1½	1¾	1½	1¾	..	..	..	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	104	107	104	107	5 12 2	February & August	106½	—
£222,700	100	6%	Do. 6 per Cent. Mort. Debs. Series "B" 1910	104	107	104	107	5 12 2	" "	—	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	106	102	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	—	—	—
224,850	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	—
220,000	£1	4·76d.	Oriental Telephone and Electric (11s. paid)	¼	⅜	¼	⅜	5 6 5	Yearly	..	.
484,597	5	2/6	National	4⅝	4⅞	4⅝	4⅞	5 2 7	June and December	4⅞	4⅝
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14	15	14	15	4 0 0	" "	15	—
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	13½	14½	14	15	4 0 0	" "	14½	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¼	5½	5¼	5½	4 10 11	..	5½	5 5/16
925,017	£100	4½%	Do. Deb. Stk. 4½%	112	114	112	114	3 18 11	January and July	113	112½
58,000	5	1/0	United River Plate	1½	2	1½	2	—	" "	—	—
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	—	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11¼	11¾	11¼	11¾	—	..	11⅝	11½
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	13	13½	13	13½	..	—	13⅝	13 7/16
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	—	..	—
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	..	—
8,322	£5	..	House to House Electric	..		..		..	—	—	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		—	..	—	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	—	—
30,000	£5	1/9	Liverpool Electric Supply (£3 10s. paid)	4½	4¾	4½	4¾	..	—	—	—
15,000	£5	2/6	Do. (fully paid)	6⅛	6⅝	6⅛	6⅝	..	—	..	—
111,000	5	..	London Electric Supply	¼	¾	¼	¾	..	..	..	..
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	8	8½	8¼	8¾	2 5 7	..	8⅝	8½
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	104	108	104	108	4 12 7	June and December	..	..
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	—	—	5¼	5
19,980	£5	9½%	St. James' and Pall Mall	5¾	6¼	6	6¼	..	—	6¼	..
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	—	8¾	8
59,900	5	1/6	Westminster Electric Supply (fully paid)	5	5½	5¼	5¾	3 0 10	—	5½	5¼
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	2/1	Brush Electrical Engineering	2⅜	2⅝	2⅝	2⅞	6 5 4	—	2¾	2½
90,000	2	6%	Do. 6 per Cent. Preference Non-Cumulative.	2	2¼	2	2¼	5 6 8	—	2¼	2 3/16
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	104	106	104	106	4 4 11	March & September	104½	104½
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	4	4½	4	4½	..	January and July	..	—
12,139	5	..	Edison and Swan United	—		—		—	—	..	—
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	—	..	..
120,000	2	..	Electric Construction	½	1	½	1	..		..	..
12,845	2	..	Do. 7% Cumulative Pref.	1	1½	1	1½	..	..	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜	—		—	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..		..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	22	23	23	24	5 4 2	February & August	23½	23
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	..	—	—
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	—	—
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/16	5/16	3/16	5/16	..	..	—	—
78,949	5	3/6	Swan United (£3. 10s. paid)	2¼	2¾	2¼	2¾	.	May and November	..	36⅝
37,350	12	12/0	Telegraph Construction and Maintenance	36	38	36	38	4 9 1	March and July	37½	105
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	103	106	103	106	4 14 4	January and July	105½	..
37,514	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		—	—	—	—
41,098	£5	..	Do. Preference (fully paid)	..		..		—	—	—	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	¾%	City and South London Railway	28	33	28	33	2 5 5	May and November	..	—
87,500	£10	—	Liverpool Overhead Railway	4⅞	5⅛	4⅞	5⅛	—	—	—	

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THE ELECTRICIAN:

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NOTES.

The most sensational experiment at the Royal Institution on Friday last was the freezing of air into solid transparent ice. Prof. Dewar has not yet succeeded in solidifying oxygen, and until further improvements are made in the process, neither feat seems worth the expense; for the scientific value of the experiment seems small compared with the many other researches which have been carried out at very low temperatures. Prof. Dewar is so very reluctant to publish any authoritative account of his work, that it is not surprising if it is sometimes misrepresented. The opaque vacuum fallacy was started in *The Times* just a year ago, in an account of a lecture by Prof. Dewar, was countenanced by technical journals (important and otherwise), and deceived many readers, among whom was Mr. Tesla; but, as far as we know, was never disclaimed by Prof. Dewar in print. *The Times* on Monday last dwelt at some length on vacuum and liquid oxygen jackets to show that it is now quite orthodox, but the *Daily Chronicle* could hardly be expected to give three-quarters of a column to a scientific subject without an ambiguity, if not an amusing mistake. The latent fallacy appears, moreover, in an apparently verbatim report. Electric discharges were sent through exhausted globes, "but all the well-known phenomena of phosphorescence ceased as soon as intense cold was applied, the electricity tried to pass by any route rather than through the globe. 'What did this mean?' said the professor. 'Obviously that something was now frozen out which had before enabled the electricity to pass across the vacuous space.'" Everyone who has even casually perused Prof. Crookes' writings is familiar with the fact that the luminosity of vacuum tubes begins to fall when lower pressures than about one millionth are reached, and that non-conducting vacua are obtained without difficulty; but a timely word from Prof. Dewar would stop the propagation of the idea that the ether was frozen out. Now the general public, and those who write for them in the daily papers, are sufficiently familiar with the ether to discourse pleasantly about it, Dr. Oliver Lodge writes in a contemporary that at the temperature of absolute zero the molecules of a perfect gas "would be lying all about the floor in an inert and stationary condition, and could be swept up." It is rather dangerous to let the public hear such things. We shall hear one fine day that Prof. Dewar handed round lumps of frozen ether on a plate.

The six sections of Mr. Preece's "Notes of a Trip to the United States and to Chicago, 1893," which were read before the Institution of Electrical Engineers last night, are of more technical interest and importance than one might at first be led to expect from a glance at the title. Meanwhile, we may remark that the bulk of the communication by Mr. Preece consists of a careful and expert analysis of the telegraph system of the United States, appended to which we have sections on American telephones, electric lighting, and electric railways, and Mr. Preece's views on the so called "World's Fair" and the Electrical Congress at Chicago. One of the most instructive features of the Paper is the series of comparisons which is drawn between the details of American and British practice, to the advantage on the whole of the practice on this side of the Atlantic. "Our apparatus is better," says Mr. Preece, in his criticisms of American telegraphy, "our speed is higher. Messages are handled with greater reliability." This may be taken as the keynote of the Paper, which will be published in our next issue.

In a recent communication to the Royal Society, Mr. E. H. Griffiths has submitted a corrected value of Joule's mechanical equivalent of heat. In his original Paper, about a year ago, the author stated that a careful comparison of thermometers would be made. This comparison has been completed, and he announces that the corrected value of J in terms of a thermal unit at 15°C. is given as $4{\cdot}1982 \times 10^7$ ergs, with an estimated limit of error equal to $\pm$ 0·0020. Hence, assuming that $g = 981{\cdot}17$ cms. per second per second, the mechanical equivalent of one British thermal unit is equal to 779·77 ft. lbs. If there is one thing more remarkable than another about the successive determinations of J which have been made from time to time, it is the alarming rate at which the value is rising above the original 772·55.

Although some of the rules for the insulation of house-wiring are expressed in terms of the leakage current, it is a mistake to suppose that the leakage current is in itself a matter of importance. The leakage current allowed by the rules of the Institution of Electrical Engineers—$\frac{1}{5000}$ of the whole current—would, as we have already observed, be too small to do any harm; but the quality of the insulation which would allow such a current to pass is not good enough to satisfy most engineers. Our correspondent, who suggests that the standard for alternating work should be about 1·4

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times higher than for continuous-current supply, seems to consider the leakage current rather than the quality of the materials and work. Higher insulation has been demanded for alternate-current work probably on account of a vague idea that this system is associated with high voltage, that it is rather mysterious, and that double precautions had better be taken. We are inclined, to think on the contrary, that lower insulation might be used. The only harm of a leakage current, namely, electrolysis, would probably be less with an alternating than with a direct current, and where house transformers are used, the insulation of a single house is alone concerned, and not the insulation of the supply company's mains. One of the greatest advantages of alternate-current supply seems to be, or rather to have been, this isolation of each separate secondary circuit, and the impossibility of interference with one circuit by the presence of a leak on another. We say that this was an advantage, for now that sub-stations and low pressure networks are becoming fashionable, this feature disappears, and there remain the advantages that secondary batteries and motors cannot be used; but about these there is some doubt.

In spite of the steadily-increasing economy with which the City and South London Railway is worked, both in the gross and in the matter of locomotive and generating expenses, it continues to pay a dividend of microscopic proportions, and it is pretty evident that it is to the extensions, north and south, that the ordinary shareholders must look for a more substantial return. Since the opening of the line some three years ago nearly 17½ million passengers have been carried, and about £128,000 have been earned, the returns for the last half-year showing, under both these headings, that the stationary stage has been reached, although the train mileage continues to grow, and now stands at 224,101 for the six months ended December 31st last. The figures below, exhibiting, as they do, a steady improvement, serve to show the monetary value of experience; but, unfortunately, engineering economies alone will not make a fat dividend any more than one swallow will make a summer:—

—	Train mileage.	"Loco." and generating expenses.	Ditto per mile run.
Half-year ending June 30, 1891...	174.435	£6.587	9·0d.
" " Dec. 31, 1891...	188.666	6,199	7·9d.
" " June 30, 1892...	188,944	6,035	7·6d.
" " Dec. 31, 1892...	234.417	6.348	7·1d.
" " June 30, 1893...	217,664	5,876	6·5d.
" " Dec. 31, 1893...	224,101	5,814	6·2d.

Similar causes do not always give rise to identical effects. During the recent coal crisis, the fuel at one of the London electric supply stations began to run short, and a few tons of coal to which the stokers were unaccustomed was brought in, hurriedly thrown on the stoking floor, and used on all the boilers under steam in the station. As dusk came on nearly all the fires clinkered, steam began to fall, and nothing could be done but to draw the fires, clean the bars, and rely on the batteries. As the load rose, thousands of amperes were discharged, the cells stood the strain bravely, but the fires were not made again until the volts had begun to follow the steam pressure. Next morning the secretary was inundated with letters; each consumer complained that something had been wrong with "his" electric light, it had "gone dim last night," and begged that some one might be sent round "to see to it." It speaks well for the service that hitches of this kind were absolutely unknown in this district, and caused so much agitation. The converse case occurred a few days ago. The owner of a new and admirably decorated house was showing some friends over it, turning on the electric lights as he passed from room to room, and forgetting to turn them off again. The main fuse, by extreme carelessness of the contractors, was a makeshift affair, "went," and left the house in utter darkness. Never thinking that there could be anything wrong, since an insulation of millions of ohms had been declared only a few days earlier, he at once concluded that some disaster had befallen the supply station. His son was despatched at once, with instructions to beg that if all the machinery were not wrecked, some electric light might be sent to —— Gardens. One of the staff obligingly came to the rescue, and put matters right within an hour or so.

Tunbridge Wells.—The Local Government Board has sanctioned the application made by the Corporation to spend £13,000 on electric lighting.

Electric Traction in Japan.—A concession has been secured by an American for the construction of an electric railway between Tokyo and Yokohama, a distance of about 17 miles.

The Heilmann Locomotive.—This locomotive has been tried on the railway between Havre and Paris. It was attached to a train of 13 carriages, and attained, it is said, a speed of 75 miles an hour.

Meter Inspectors.—The Paisley Town Council are proposing that the gas meter inspectors should wear a distinctive badge. It was suggested that they should wander about with an oil lamp in their hand seeking for an accurately-registering meter.

The Cost of Lighting the City.—An account of the estimated assets and liabilities of the Commissioners of Sewers of the City of London has just been published. The liabilities amount to £383,362, including electric lighting, £18,332; gas lighting and testing, £7,500.

Electrical Trade Section.—A meeting of the Electrical Trade Section will be held at Botolph House, Eastcheap, on Monday next, at 3 p.m., to consider, amongst other things, the report of the Traction Committee, and the appointment of a Parliamentary Committee.

Gutta-Percha.—The Société d'Encouragement pour l'Industrie Nationale is offering a prize of £120 to anyone who will devise a substance capable of completely replacing gutta-percha in one at least of its principal uses, or for a work contributing to the increased production and better exploitation of this gum.

The Telegraph on the Congo.—The Congo Company contemplate the building of a telegraph line from Boma, over Matadi, Leopoldville, and Stanley Falls to the Tanganyika Lake. The total distance is about 4,800 miles, and the completion of the whole line will occupy several years. The Boma-Kenge section is expected to be finished during 1894-95.

A New French Cable.—A new French submarine cable is about to be laid in the Red Sea, crossing the bay of Jibuteel, and placing Obock in communication with Jibuteel, which is to be the new seat of government of the French colony. The cable is 31½ nautical miles in length, and is to be laid by the telegraph ship "La Charente."

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Central London Railway.—The Examiner on Standing Orders of the House of Commons has found that the standing orders had not been complied with in the case of the Bill for the extension of time of the Central London Electric Railway, on the ground that no proof had been adduced of service of notice upon certain owners, lessees, and occupiers of property in the parish of Holbo:n above Bars.

Newport.—At a meeting of the Parliamentary and Improvement Committee of the Corporation, on Tuesday last, the question of lighting the town by electricity was again taken into consideration. After a protracted discussion nothing definite was arrived at, but the members of the committee agreed to accept an offer made by Messrs Crompton to inspect their works at Chelmsford before deciding upon a tender.

Candles v. Electricity on Coastguard Ships.—The *Broad Arrow* is responsible for the statement that orders have been issued to the coastguard ships which are fitted with the electric light that candles are to be used upon all occasions when not under weigh. From a calculation which has been made in one ship, it appears that the cost of lighting by the electric light per day is 5s., and by candles 4s. 8d.

A Journal of Elementary Mathematics.—At the twentieth meeting of the Association for the Improvement of Geometrical Teaching, held at University College on the 13th inst., the following resolution was passed unanimously :—"That a terminal Journal of Elementary Mathematics be published by the Association; that it be entitled *The Mathematical Gazette*, a terminal journal for students and teachers; that it be edited by Mr. E. M. Langley."

Football by Electric Light.—A peculiar question will, it is said, probably come before the Scottish Football Association at its next meeting. With the object of playing night matches the Celtic Club introduced the electric light on to their field, and during a match the other week the ball came in contact with the wires several times. Protests were lodged, but eventually withdrawn, though the question is to be brought before the notice of the authorities.

Cable Interruptions and Repairs:

	Date of Interruption.	Date of Repair.
Bonny-Cameroons	Jan. 15th, 1894	Jan. 18, 1894
Foochow-Shanghai	Jan. 15th, 1894	Jan. 19, 1894
Penang-Medan	Jan. 14th, 1894	Jan. 24, 1894
Cayenne-Paramaribo	Oct. 15th, 1893	—
Cayenne-Vizeu	Nov. 25th, 1893	—
Haiphong-Hongkong	Dec. 11th, 1893	—
Garachico-Santa Cruz de Palma	Dec. 27th, 1893	—

The Ludgate Hill Explosions.—At the last meeting of the City Commissioners of Sewers, Mr. Ross, in the absence of the engineer, read a report from Mr. W. H. Preece on the subject of the recent explosions on Ludgate-hill. Mr. Preece stated that the explosions were due to a collection of coal-gas and air in the boxes, but the cause of ignition was not apparent. Since the occurrence the City Company had introduced a system of inspection of such boxes so as to prevent a collection of gas from leaky mains in them.

A 10,000-Light Westinghouse Alternator.—The Westinghouse Company have recently built four new alternating-current dynamos for the Louisville Gas Company. The armatures are 12ft. in diameter, and the number of poles is 80. This allows the dynamos to be run at 90 revolutions. Each machine has a capacity of 10,000 lamps and weighs 50 tons. A notable feature is the economy of floor space in connection with the large output; but considerable head-room will be required, as the dynamos are 20ft. high. These alternators are designed to be directly coupled to engines.

The Cost of Lighting Paris.—According to the estimates just published, the cost of lighting Paris during the current year will be as follows:—Price of gas, 4,075,511fr.; maintenance of gas apparatus, lamps, &c., 1,166,400fr.; lighting the markets, abattoirs, &c., 101,500fr.; for oil and the maintenance of oil lighting apparatus, 70,400fr.; electric lighting of streets, 507,453fr.; electric lighting in markets, abattoirs, and others places appertaining to the Municipality, 587,000fr.; maintenance of the municipal electric lighting station at the Halles Centrales, 456,400fr., or in all about 7,000,000fr.

Northern Society of Electrical Engineers.—The Inaugural dinner of the Society was held at the Palatine Hotel, Manchester, on Monday last. In the unavoidable absence of the President (Dr. John Hopkinson), Mr. Henry Edmunds, one of the Vice-Presidents, occupied the chair. He was supported by Messrs. G. E. Preece, and W. P. J. Fawcus, Vice-Presidents and the following members of Council: Dr. Edward Hopkinson, Messrs. J. Vincent Swindells, A. Eckstein, G. W. Lowcock, E. A. Claremint, Alex. Marr, J. H. Rider, J. Taylor, C. S. Northcote, Mr. Geo. J. Somerville, Hon. Treasurer, Mr. John Darney, Hon. Secretary, and upwards of 50 members.

Prof. Minchin's Sensitive Cells and the Light of the Stars.—In a letter to *Nature* of January 18th, Prof. Minchin describes some results obtained by him at Daramona House, Westmeath, by aid of Mr. W. E. Wilson's two-feet reflector in measuring the photo-electric effect of the light of the planets and fixed stars. The sensitive cells employed were seleno-aluminium-aenanthol cells, three square millimetres in area, and were connected with the telescope in place of the eye-piece. Clifton's form of the quadrant electrometer was employed. An electromotive force of 1 volt was represented by 460 scale divisions. Venus (quarter of disc) gave 40 divisions; Sirius, 9 divisions. Aldebaran gave no result.

Long-Distance Telephony.—At the conclusion of a mathematical article, by Mr. F. W. Dunbar, in the *Electrical Engineer* of New York, the following result is arrived at:—The fundamental and first prominent overtone of the male voice reach the receiving instrument at Chicago with a difference in phase of 90deg. When the octave is zero the fundamental is a maximum, and *vice versâ*. The remaining component parts of the complete tone arrive with their phases varying throughout the entire 360deg. The resultant tone should be perfectly inarticulate if any such action limited in any degree the transmission of speech or music telephonically. But the displacement of phase in the case cited is similar to that which exists whether a person listens to a vocal duet from a distance of 20 or 21ft. from the performers. Pitch 160 and its octave will vary from coincidence to a difference of 90deg. in phase by the change in position. The ear is an analytic organ, and appreciates the component parts of the complete wave whatever their phase difference may be. We may fear no limit to telephony from this cause.

The Heat Produced by Dielectric Polarisation.—Herr A. Kleiner, in a recent number of *Wiedemann's Annalen*, has made some interesting and curious observations on the heating of dielectrics, by means of a thermo-couple of copper and nickel placed inside a condenser insulated with plates of various materials. Calling the heat produced in an ebonite condenser with circular tinfoil plates after a certain number of periods 1, then similar plates of other materials, treated in a similar manner, produce quantities of heat represented by the following numbers:—Paraffin wax = 0, mica = 0·28, glass = 0·74, india-rubber = 1·41, kolophonium = 0, wax = 0·6, gutta-percha = 0·76. In spite of all attempts by variation of the conditions of experiment, no heating could ever be detected for paraffin or kolophonium. Condensers made of the latter materials add to the property of high and robust insulation that of short period of charge. The author concludes, therefore, that dielectric polarisation does not necessarily involve conversion of energy, and points out the analogy between these observations and hysteresis in magnetic polarisation.

The Electric Lighting Delay in the City.—The following letter, signed L.B. and G.B., appeared in the *City Press* of Saturday last:

"SIR,—Twelve months ago we had our house wired for the electric light, and made a contract for fittings to be put in when the time came for the City of London Electric Lighting Company to supply current, which we were given to understand would be by the middle of the year, or before September last. Upon making inquiry we were informed by this Company, in writing, that the current would be available within the next two or three weeks. This promise has been repeated several times since, but now complete ignorance is affected. Upon the strength of the promises made by the Company we had the fittings put up, and unfortunately they are close to the gas fittings, so that they have been greatly damaged by our having been compelled to use the gas again all over the place. We have hardly any doubt that we can hold the Company responsible, but we write to your valuable paper for the purpose of ascertaining whether there are

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other people in the same position as ourselves, who also comprehend that those who have rights also have duties, and that if the Company has the rights and the monopoly it must also carry out its duties. We enclose our card, and shall be obliged if you will give our names to anyone who wants to join us in seeing what can be done in the matter."

Newcastle.—The Members of the Newcastle Watch Committee were, says the *Newcastle Daily Leader*, thrown into a flutter of excitement at their last meeting, by the contents of a communication which had been received from the Newcastle and Gateshead Gas Company, which seems to show that the latter are determined to fight the electric light. The letter stated that owing to the partial adoption of the electric light by the Corporation the special discount of five per cent. which it has been customary to allow the Corporation will in future not be allowed, and further that the Gas Company intend to charge for the lamps up to March which had been extinguished owing to the lighting of Grey-street and other places by the electric light. The Company charge the Corporation a fixed rate per street lamp, but a number have not been in use for a considerable time owing to the new light being adopted, and it is the intention of the Company to charge for the lamps as though they had been used up to March. This will, of course, amount to a large sum, while the loss of the discount alone will come to £700 per year. It was decided to take the matter into consideration at a special meeting of the Watch Committee to-day (Friday.)

Electrical Convection.—At a recent meeting of the Société Française de Physique, says *Nature*, M. Hurmuzescu showed some experiments on electrical convection in air. He finds that if you cause dissymmetry between the two discharging knobs of a Wimshurst electrical machine, by fixing a point to one of them, then, on placing a sensitive gold-leaf electroscope at a distance of about two metres, when the machine is worked, the discharging knobs being separated, the electroscope becomes charged. The electroscope becomes more highly charged when it is fitted with a point than when it has only a varnished ball at the end of its electrode. That the charge is not due to induction, but to convection through the air, is shown by the fact that the interposition of a metallic screen does not interfere with the effect, while if the electroscope is covered over by an insulating shade no electrification is observable. In addition, it is found that the charge on the electroscope is of the same sign as that of the terminal of the machine on which the point is fixed. The most marked and rapid results are obtained when the point on the machine is negatively electrified, while no effects are observed if the point is turned towards the plates of the machine.

Thermo-electric Effect due to Molecular Stress in a Single Metal.—It is well known, says *Nature*, that electric currents may be produced by heating a single metal, if there be any variation in temper, or if the distribution of heat be very irregular, and the changes of temperature abrupt. Mr. W. H. Steele has made some experiments on these effects in the Physical Laboratory of Melbourne University. A sensitive galvanometer put in circuit with a piece of iron wire showed a current when the wire was simply warmed with the fingers. This was the only metal which gave a current when at a temperature below 100°C. Altogether twelve different metals and four alloys were examined, and the effect noticed in each of them. In order to raise the wires to a high temperature without fusing them they were passed through clay tubes (stems of tobacco-pipes), and, in the case of metals having low melting points, the tube was completely filled with the metal. The highest E.M.F. obtained from iron was 0·002 volt; 0·3 volt was observed with six different metals—lead, copper, gold, tin, zinc, and antimony; while with others, *e.g.*, silver and aluminium, the effect was exceedingly small. In the case of lead the effect showed no sign of ceasing after the metal had been heated for half a day. Gold gave the highest effect, as much as half a volt being observed. Mr. Steele remarks that these phenomena are generally quite sufficient to mask the ordinary thermo-electric effect at a red heat, and that thermo-electric tables are consequently not trustworthy for high temperatures.

Newman Lawrence Testimonial.—We have been requested to call the attention of members of the electrical profession to the case of Mr. H. Newman Lawrence, an earnest worker in the field of electro-therapeutics, who finds himself in embarrassed circumstances. Mr. Lawrence was the founder, in conjunction with the late Mr. William Lant Carpenter, of the Institute of Medical Electricity, which, under the sanction and control of many eminent men and electricians, for several years did good work in electro-therapeutics. Since that institute was closed Mr. Lawrence has continued to work on similar lines. During the whole of his professional career Mr. Lawrence has steadfastly sought to raise electro-therapeutics to its proper position as a science. It has been ascertained that Mr. Lawrence has an opportunity of making his way in the United States, and it is proposed that the funds that may be raised as a result of this appeal should be devoted to furthering this object. Any members of the Old Students' Association who may read this are reminded that Mr. Lawrence was the founder and first president of that society. This fact, it is hoped, may influence at least some to support the movement herein referred to, which has the support of a committee consisting of Viscount Templetown, Mr. W. H. Preece, Profs. Ayrton, Silvanus Thompson, Victor Horsley, R. Mullineux Walmsley, Dr. W. E. Sumpner, Messrs. Gisbert Kapp, T. E. Gatehouse, H. C. Marillier and others. Subscriptions will be received by Mr. E. C. De Segundo, 28, Victoria-street, Westminster, S.W., or Mr. Thomas Adams, 24, Hillfield-road, West Hampstead, N.W.; or they may be paid into the "Lawrence Testimonial" account at Messrs. Lloyd's Bank (Limited), 54, St. James's-street, S.W.

Smoke-Prevention Legislation in Massachusetts.—The last Legislature of Massachusetts passed a law regulating the smoke nuisance in the large cities. This law provided that in the cities of over 300,000 inhabitants, after July 1, 1893, no person should "use bituminous coal for the purpose of making steam in boilers in any building unless the furnace in which said coal is burned is so built or equipped that at least 75 per cent. of the smoke is consumed or otherwise prevented from entering the atmosphere, the degree of suppression being determined by the quantity of such smoke emitted, as shown by the density and colour of the issuing smoke and the length of time which it is visible, the maximum standard of comparison being a continuous discharge of dense, dark smoke during the time the furnace is in active operation." The penalty was fixed at not less than $10 nor more than $100 for each week during which the violation of the law should continue. Acting under this law the Mayor of Boston named the Superintendent of Streets as the official to be charged with the enforcement of the Act, and the latter, in order to secure some ground on which to deal with the smoke nuisance, instituted a thorough system of inquiry throughout the city. Inspectors were instructed to see every factory and other business place where bituminous coal was used. The investigation extended to a large number of items, including the time of erection of boilers, their number and size, as well as horse-power, the area of heating surface and of chimney and smoke flues, the daily amount of coal burned and the number of hours in use of boiler, summer and winter, and any devices for smoke consumption in use or contemplated. Naturally, such an investigation, if properly conducted, could not be finished in one week or two weeks, and it has occupied nearly two months or more; but as a result a large amount of reliable information is said to have been collected.

New Year's Calls by Telephone.—Only an American paper with a limited circulation could indulge in the following insane amusement:—That enterprising newspaper, the St. Louis *Globe Democrat*, says a New York contemporary, this year indulged in New Year's calling up to date—that is, they called up every telephone subscriber in St. Louis, and wished all who answered a "Happy and prosperous New Year." There are 3,755 telephone subscribers in St. Louis, and the *Globe Democrat* has three telephones in its business office. For this occasion this number was reinforced by seven instruments, which were placed on the fourth floor of the building. Superintendent Durant, of the Telephone Company, personally superintended the novelty in New Year's calling, which was at the same time a practical test of the efficiency of the telephone

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service. That it might be the more satisfactory in the latter sense, no special provision was made for the reception and transmission of messages at the central office. The regular list of telephone subscribers was divided into 10 portions, in alphabetical order just as printed, and a portion given to each of 10 operators. The calls were made in accordance with the prescribed rules of the Company, which are printed, framed, and hung up at the side of every instrument in the city. Half a minute was allowed each station called for to respond before the number was checked off as not answering, and the next number on the list was then taken up. The calls were commenced at 8:30 a.m., and the last of the greetings had been delivered at 11:55. The best results were achieved by operator McDonough, of the telephone corps. He is an expert at the telephone. He called up 514 stations in 3 hours 27 minutes, secured 260 answers, found 14 busy, 5 out of order, and 235 not in use for the day. The whole time occupied in the transmission of the messages was 53 hours and 8 minutes; the average time of each operator was 3 hours and 19 minutes, and the average rate was 113 calls per operator per hour, a little the fastest thing in New Year's calling on record.

Hysteresis in Iron and Nickel.—The *Philosophical Magazine* for the present month contains a Paper, by H. Nagaoka, on the hysteresis attending the change in length produced by magnetisation in nickel and iron. The author at first used the interference fringes produced between a plano-convex lens and a plate of plane glass attached to the end of the rod under examination to measure change in length. He found, however, that it was impossible to keep the temperature of the apparatus constant during the time necessary to make an observation, and also that there was considerable difficulty in counting the number of fringes displaced. To overcome the temperature difficulty the author has made use of the principle of the grid-iron pendulum, and has by this means succeeded in almost entirely overcoming this difficulty. In place of the interference bands he uses an optical lever, that is, a mirror fixed to a small base, to which are attached three needle points, two of these rest in a groove on the base-plate of the instrument, while the third rests on a small glass plate fixed to the end of the iron or nickel rod. The rod was placed along the axis of a solenoid which lay in a horizontal position pointing magnetic east and west. The deflection of the mirror was measured by means of a microscope with a micrometer eyepiece, such that one division of the scale corresponded to a deflection of the mirror of $0''{\cdot}295$ of arc, or to an elongation of $0{\cdot}805 \times 10^{-7}$ c.m. Experiments were made on wires of iron and nickel of different lengths, and he finds in every case that the elongation in iron and the contraction in nickel by magnetisation is accompanied by marked hysteresis. The curve of hysteresis is symmetrical with respect to the line of zero magnetising force, so that the elongation or contraction during cyclic changes is an even function of the magnetising force. When a wire has been magnetised it cannot be brought to its original length by simply reversing the magnetic field. In a note communicated to the same number of the *Philosophical Magazine*, Prof. Knott calls attention to the similarity between the effects observed by Mr. Nagaoka and those which he has himself observed in the case of magnetic-twist cycles for iron and nickel. A steady current was passed along the wire under observation, and the longitudinal field acting on the wire was gradually altered between the limits $\pm$H, and at suitable intervals observations of the twist made. It was found that with a small range of field the hysteresis curve obtained by plotting twist against field was very similar to the well-known hysteresis curve of magnetisation. With limiting fields, however, stronger than the field which produces the maximum twist, the hysteresis curve crossed itself twice and formed three loops. In the magneto-elongation cycle the change of sign of the magnetising force does not produce a change of sign in the elongation. On the other hand, in the magnetic-twist cycle, as the magnetic force passes through zero from positive to negative, the twist tends to do the same, though with a lag. The author considers that the twist, under a given combination of circular and longitudinal magnetising forces, depends not only upon the elongations but also upon some function of these forces which changes sign with each, and to which the existence of the maximum twist is largely, if not entirely, due.

Correlation of Solar and Magnetic Phenomena.—The difficulties which arise in attributing "magnet storms" to direct solar agency have been the subject of a lengthy correspondence in *Nature*, the two latest contributors to the discussion being Dr. Veeder, of Lyons (N.Y.), and Mr. William Ellis, of Greenwich Observatory. Dr. Veeder writes:—"The opinion of Mr. Whipple, quoted at p. 2 of *Nature* for November 2nd, to the effect that the solar outburst observed by Messrs. Carrington and Hodgson on September 1, 1859, was not the cause of the coincident magnetic perturbations, corresponds to my own conclusion in regard to the matter based upon evidence of an altogether different character. There was a recurrence of strong magnetic perturbations and auroras twenty-seven days later than the great magnetic storms of August 28 and September 1, 1859, thus following the general rule which is found to apply in such cases, there being a well-marked periodicity of such outbreaks at this precise interval corresponding to the time of a synodic rotation of the sun. Such recurrence manifestly could not exist if outbreaks upon the sun were able to produce terrestrial magnetic effects indifferently in all locations. In order that there may be recurrence at the synodic period the magnetic effects must proceed from the sun at some particular angle exclusively, and fortuitous outburst elsewhere, no matter how violent, must fail to have any perceptible effect. In the estimation of the writer there is no point more important in connection with solar physics than the determination of this period and this angle with the greatest accuracy possible." Mr. William Ellis is of opinion that it is "better to advance surely, if slowly, towards truth, rather than accept too hastily evidence that is incomplete. We must remember that on the occasion of the solar disturbance seen by Trouvelot, the magnets were especially quiet, not only at the time, but also before and after. But any explanation of these phenomena must include all cases. The position of things, as stated in my first letter, referred to above, still, I consider, holds, qualified only by the circumstance that, instead of one presumed case of direct relation, three are now adduced, with a fourth case (the Trouvelot observation), which unquestionably was not accompanied by magnetic disturbance. If we further consider that, since the year 1859, when attention became distinctly drawn to this question, there has occurred magnet movement, equal to and in very many cases far exceeding that accompanying the Carrington-Hodgson observation, on some 400 different days, we see on how slight a foundation the presumption for direct relation, that is of a nature more or less instantaneous in action, exists, although the general relation between the two classes of phenomena remains undoubted. Dr. Veeder, from his own point of view, supports the contention that the 1859 solar outburst cannot be taken as causing the accompanying moderate magnetic movement; indeed, there was far greater movement some three days previously, and again early on the morning of the following day; but in regard to his affirmation that there exists a well-marked periodicity in magnetic outbursts corresponding to the period of the sun's rotation, whilst this in a limited sense may be in some degree true, I cannot say that my personal acquaintance with magnetic records during very many years enables me at present to accept such conclusion as a general one, or, indeed, what as a consequence follows, that anything really depends on the position in rotation which the sun occupies relatively to the earth. The whole subject is, however, exceedingly interesting, and various considerations arise. One bearing on the present question may be mentioned. Great terrestrial magnetic disturbances are evidently in character cosmical, produced, it would seem, or stimulated, by some external cause. For it has been shown (*Proc. Roy. Soc.*, Vol. III., p. 191) that, on occasions of unusually sudden magnetic disturbance, the commencement of disturbance, at places so widely separated on the earth's surface as Greenwich, Pawlowsk and Bombay, is simultaneous within a much smaller limit of time than had before been supposed. Such sudden simultaneous action would thus appear to indicate an impulse, solar or otherwise, from without, but whether one distinctly solar, or in what other way produced, is a question yet to be determined."

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MORE MAGNETIC MYSTERIES.*

BY S. EVERSHED.

The specific gravity of a substance may be determined by hanging a mass of it on the end of an elastic wire and noting its period of oscillation about a vertical axis. The radius of gyration, elasticity, and length of the wire being calculated, and air friction allowed for all the data for finding the mass, and therefore specific gravity of the substance, are to hand. But although an interesting problem for a third year student it is not quite the best way of going to work if our end is to measure specific gravity. It would be better to weigh the substance in the usual manner. We are led to make these apparently inconsequential remarks after carefully reading Mr. Thomas Gray's Paper, in which he works back from the curve of current time in an electric circuit embracing iron to the magnetic cycle, and hence the hysteresis loss in the iron. Very interesting and instructive the curves undoubtedly are, but the method cannot be seriously advanced as accurately determining the magnetic constants of iron.

After referring to the more or less well known methods of measuring magnetic qualities of iron involving the use of a ballistic galvanometer, and remarking that with large masses of iron the growth of induction becomes too slow for the galvanometer, Mr. Gray says:—

"It occurred to me, somewhat more than a year ago, that the cause of the difficulty in the ordinary method of measuring magnetic quality in large masses of iron might be made an advantage if the method of experiment were changed; that, in fact, the desired information might be more easily obtained by recording, not the total value of the induction for each of several particular values of the magnetising force, but the curve showing the rise of current with time, immediately after the circuit is closed. Preliminary experiments showed that, for many of the cases most difficult by the ordinary method, this could be done both accurately and easily. In these preliminary experiments the coils of a large electromagnet, having laminated cores and pole-pieces, were joined in circuit with a storage battery and a non-inductive resistance. An automatic arrangement was devised, by means of which the circuit could be closed and the instant of closing recorded by a chronograph. The ends of the non-inductive resistance were at the same time connected to the quadrants of an electrometer. At any desired interval after the closing of the circuit the electrometer could be disconnected from the resistance, and the instant of disconnecting recorded by the chronograph. The deflection of the electrometer needle then showed the difference of potential between the ends of the non-inductive resistance at the instant when it was disconnected. By this means a sufficient number of points on the curve of rise of current could be observed to enable it to be drawn. The results obtained in these early experiments agree with those given in this Paper, and the method may be found useful in cases where the rise of current is too rapid to allow of the successful operation of the method since used. It is evident that a modification of this method with a ballistic galvanometer substituted for the electrometer could be easily arranged to give satisfactory results. The ordinary ballistic galvanometer and induction coil method can also be used with a break circuit arrangement, allowing the total time integral to be taken by steps. This method of experiment was not used after the preliminary results for which it was devised had been obtained. It was abandoned, partly because of its considerable complication, but mainly because a considerable number of separate experiments are required to obtain the complete curve, thus involving a corresponding number of independent magnetisations of the magnet.

"The arrangement of the apparatus used in the experiments, the results of which are here illustrated, is shown in the annexed diagram (Fig. 1). In this diagram M is the electromagnet experimented on; C, a commutator for reversing the battery, or, when the connection to it was as shown by the dotted lines, for simultaneously cutting out the battery and short-circuiting the magnet coils; B is the battery, and R a resistance of about one ohm in its circuit to prevent excessive current, when, by the operation of the commutator, it is for an instant short-circuited; G is a mirror galvanometer, nearly 'dead beat' and of short period; L, the galvanometer lamp; *Ch*, a chronograph, and S, a key for closing the circuit. The drum of the chronograph is 14in. long and 20in. in circumference, and it can be run at a rate of one turn per minute or of six turns per minute, the speed being in each case almost perfectly uniform. The galvanometer lamp stand was provided with cross-wires, the galvanometer with a light plane mirror, and the cross-wires were clearly focussed on the chronograph sheet by means of a lens placed between the lamp and the mirror. The chronograph sheets were, for convenience of experiment and subsequent reduction, formed of 'cross-section' paper, the cross-lines on which were one-tenth of an inch apart.

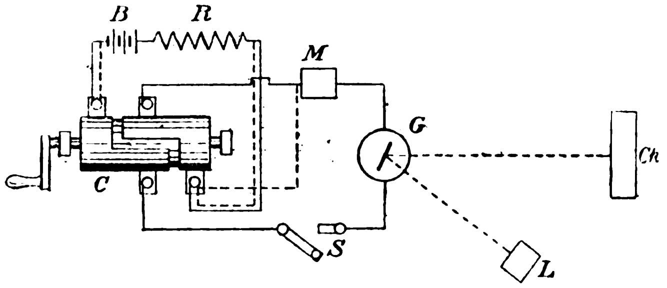

FIG. 1.

"The method of experiment is simply to hold the finger on the switch S and observe the motion of the chronograph until the image of the cross-wires comes to a particular line on the paper sheet; at this instant close the switch, and then follow the image of the cross-wires with a soft sharp pencil, dotting the line occasionally, but taking care not to influence the motion of the chronograph. When the deflection has reached a maximum, the commutator is suddenly turned as the image of the wires passes a known position and the cycle of reversal marked out on the paper. The chronograph is now stopped, and the complete curve lightly marked. The experiment is then repeated, the image of the wires being simply observed as it passes over the curve, and any disagreement noted. Any disagreement being corrected and tested, the

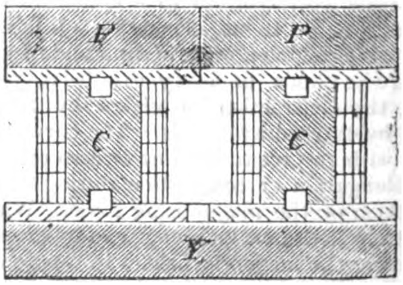

FIG. 2.

curve is ready for reduction. The time required to take a complete set of curves, check, and correct them, only requires a few minutes, after a little dexterity has been acquired in dotting out the curves. The curves obtained by this method have the advantage of being drawn to a large scale, the galvanometer sensibility being varied by means of shunts, so as to make the double deflection nearly cover the whole breadth of the chronograph sheet, while for many of the experiments made the length of the diagram extended several times round the drum. I am at present constructing an automatic recording apparatus on the principle of the Thomson recorder for the purpose of drawing diagrams for smaller masses of iron, where the interval of time is so short as to make the initial motion of the spot of light too rapid to be followed with certainty. Should this apparatus prove successful, I hope to apply it to investigate the effect of cyclic speed on the dissipation of energy, using a varying impressed E.M.F.

"The results here quoted were obtained from experiments on a large electro-magnet belonging to the Electrical Labora-

* "On the Measurement of the Magnetic Properties of Iron." By Thomas Gray. *Phil. Trans.* 1893.

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tory of the Rose Polytechnic Institute, Terre Haute, Indiana. I have, however, found it easy to trace curves for an ordinary 6,000-watt transformer, although the time is in this case considerably shorter than that required for the magnet. I hope to supplement the results here given by results for various transformers, as soon as they can be reduced. The electro-magnet was constructed in the shops of the Rose Polytechnic Institute, and was designed by my colleague, Dr. C. L. Mees, and myself, for convenient use in the instruction of students in magnetic measurements. It consists of two cores, C C (Fig. 2), each surrounded by four coils of insulated wire. The cores CC rest on a yoke Y, and on the top of the cores the pole-pieces P P rest. The length of the iron circuit can be varied by moving the cores further apart and pushing forward the pole-pieces. To facilitate this operation, a screwed rod is run from end to end of the yoke, sunk just beneath the surface ; one half has a right, and the other half a left-handed screw, which work in half nuts fixed in the cores. Thus, by turning the screw, the cores can be moved apart or brought closer together. A similar arrangement serves to move the pole-pieces, and to pull them apart after they have been strongly magnetised on closed circuit. When an air space is left between the pole faces, the magnetic attraction is resisted by distance pieces, placed between the poles. The necessity for the somewhat elaborate arrangement just described arises from the great weight of the pieces, the cross section of the iron circuit being about 50 sq. in., and the length of the yoke 40in. The cores and pole pieces were constructed of soft homo-

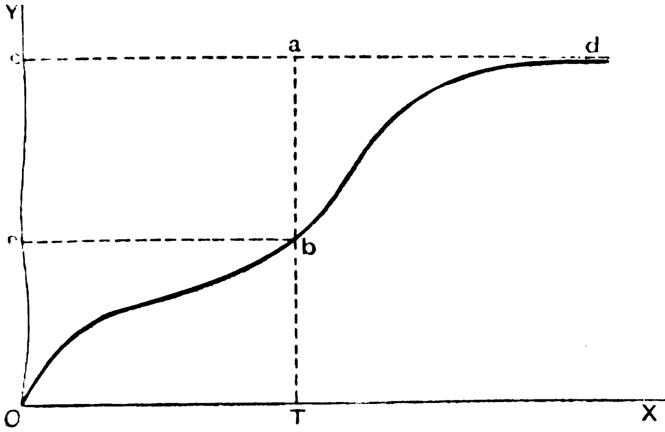

FIG. 3.

geneous iron, laminated in sheets one-twentieth of an inch thick. The insulation between the sheets and between the bolts and the holes is simply the oxidised surface of the rolled metal coated with shellac varnish.

"Let the impressed E.M.F. be E, the resistance of the circuit R and the current at any instant C. Then $E-RC=e$, the back E.M.F. on the magnetising coil due to induction. This is also equal to $L\,(dC/dt)$, and hence we have $e=E-RC=L\,(dC/dt)$ or $e\,dt=L\,dC$. Consider the curve $O\,b\,d$ in the diagram (Fig. 3), to be a curve showing the relation between current and time immediately after the magnetising circuit is closed. Let the distance along O X to any point represent the interval of time t_2-t_1 and the vertical ordinates the successive values of R C. Then the maximum vertical ordinate $Oc=E$, and the line ab corresponding to any time T is the value of e at that time. Hence the area $O\,b\,a\,c$ is the value of the integral $\int_0^T e\,dt$ or of $\int_0^{C_T} L\,dC$, the total change of induction from the time of closing the circuit to the time T ; the current being supposed zero when T is zero. By means of this curve the total induction produced by any current between zero and the maximum that the impressed E.M.F. is capable of producing can thus be studied. Again, by drawing tangents to the curve at points corresponding to different values of the currents flowing through the circuit, the value of dC/dt and, consequently, of $e/(dC/dt)=L$, the coefficient of induction at any instant, can be obtained for different values of the magneto-motive force applied, or by comparison with the curve of total induction, for different degrees of magnetisation. Similarly, if the curve of variation of current from maximum in one direction to maximum in the other direction, due to a reversal of the impressed E.M.F. be traced, the various changes of total induction, and of L through a complete cycle can be studied. The curve of total induction for the cycle forms generally, as is well known, a closed loop. The area of this loop is the difference of the values of $\int e\,C\,dt$ for the two halves of the cycle, and, consequently, is proportional to the energy dissipated in a cycle of magnetisation. This area includes the dissipation due to magnetic retentiveness, and also that due to currents set up in the iron or in conducting currents surrounding the iron. It is interesting to study these curves, as is done for a few cases below, for different conditions of the magnetic circuit.

"The curves in Figs. 1—6 show (Plate 5) the rise of current through the circuit of the electromagnet with different impressed E.M.F.s. The full line curves were obtained after the

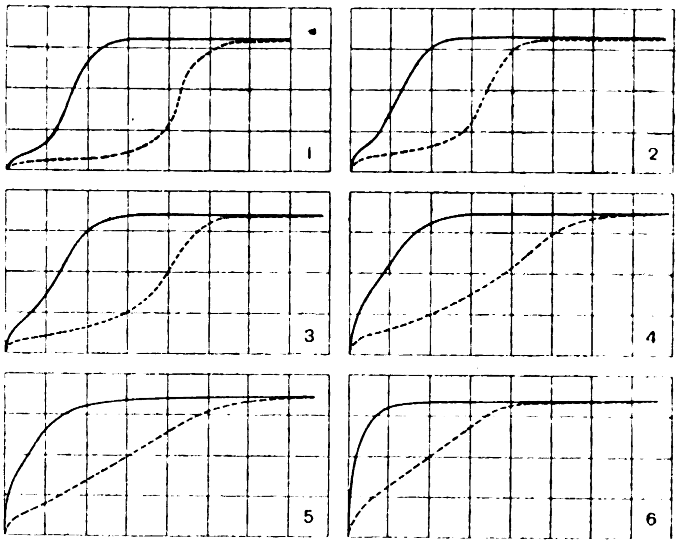

PLATE 5.—Curves showing time-rise of current for different E. M. F. on terminals. Full line, direct ; dotted line, reversal.

Fig. 1,	Ordinates.	1 Div. = 1 amp.	Abscissæ,	1 Division	= 2	seconds.
„ 2,	„	„ = $\frac{1}{2}$ „	„	„	= 4	„
„ 3,	„	„ = $\frac{1}{3}$ „	„	„	= 6	„
„ 4,	„	„ = $\frac{1}{6}$ „	„	„	= 12	„
„ 5,	„	„ = $\frac{1}{9}$ „	„	„	= 18	„
„ 6,	„	„ = $\frac{1}{18}$ „	„	„	= 36	„

magnet had been several times magnetised in the same direction as that produced by the current, while the dotted line curves show the rise of current when the magnet had been previously magnetised in the opposite direction by a current of the same maximum strength. The iron circuit was closed during these experiments, and had a mean length of about 265 cms. It will be observed from these figures that the time required to complete the magnetisation is nearly inversely proportional to the E.M.F. applied to the poles of the magnet, and, also, that the shape of the curve changes considerably with change of impressed E.M.F."

It is always difficult to lay one's finger on the weak link in an apparatus like that shown in Fig. 1, and, speaking off-hand, we should have anticipated an error of uncertain amount in the mass-inertia of the galvanometer needle and mirror, and the vagueness of such a thing as a "nearly dead-beat" instrument. However, the man who actually uses the apparatus soon discovers its weakness. A born experimenter—Mr. Gray is evidently that—will often overcome the most alarming difficulties, as in the present case, that of following up the image of the galvanometer cross wires on the chronograph by hand with a pencil.

The curves in Plate 5 call for no remark, and as they are the resultant of several effects—namely, coercive force and eddy currents in the iron core, stray induction threading the coils, and so on—we shall not follow Mr. Gray in his discussion of their shape and the variations in the times at which L for the whole circuit arrives at its maximum. This sort of induction coefficient, due to everything in the circuit which can affect the rate of change

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of current, may be called the gross coefficient of self-induction, and curves of its variation with time for a particular circuit are only of interest to those who have to use that circuit. In Fig. 12 (Plate 8) Mr. Gray shows the whole history of the circuit during the time occupied in reversing the current. The current-time curve is shown as a full line, while the dotted line is the value of gross L plotted with relation to current. The dot-dash loop is the cyclic power curve; its area gives the work done in hysteresis and eddy currents. It is obtained, of course, by plotting values of E – C R, that is to say, back E.M.F. for successive values of C and its area is equal to $\int e\,C\,dt$. The maximum value of the *induction density* on *the assumption that the whole amount of induction is in the iron core* is loosely described in the figure as "total induction." This maximum is obtained by measuring the area O *b d* c O in Fig. 3, and dividing it by the sectional area of the core.

Fig. 12 being obtained when the magnetic circuit was closed, the assumption we have italicised is, of course, very nearly true; but in Figs. 14 and 16 (Plates 9 and 10), which are similar sets of curves taken when the poles P P, Fig. 2, were separated by 0·5cm. and 2cm., the leakage induction is clearly very considerable, and the value given for maximum induction density, although as before,

$$\frac{\text{Maximum total induction threading the coils}}{\text{Sectional area of core}},$$

is now, as it stands, a meaningless and therefore misleading quantity.

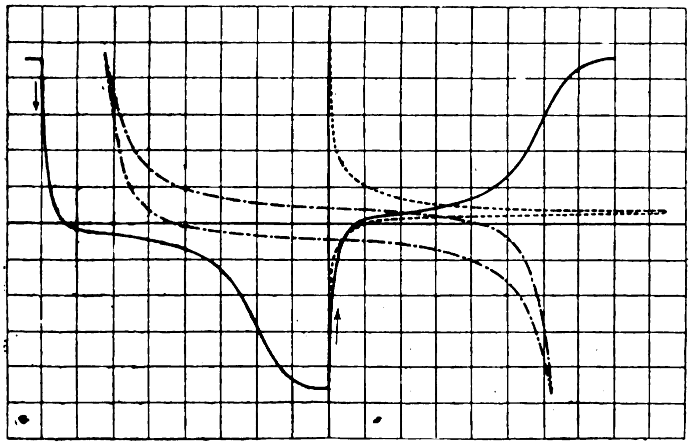

PLATE 8. FIG. 12.

Full lines = curves for reversal of current. 23 (28 ?) divisions = 10 amps.
Dotted lines = coefficient of induction L. One division of abscissæ 10^{11} cms. One division of ordinates = 5 volts.
Chain-dotted lines = Total induction (total = 15,200 C.G.S. units per square cm). Energy dissipated = $1{,}534 \times 10^6$ ergs.

Accordingly we find a large part of the remainder of the Paper devoted to the discussion of the supposed magic effect of an air gap in diminishing the hysteresis and eddy-current losses in the core. Commenting on the marked difference between Fig. 12 and Fig. 14, Mr. Gray remarks "we find, as one of the most noticeable features, the evidence they (the curves) afford of the great effect a small air space has on the magnetic retentiveness of the magnet," and goes on to say :—

"Of course, a direct comparison of the amount of energy dissipated in the cycle cannot be made from these curves alone, but a separate set of experiments, illustrated in Figs. 22-27, brings out the result that considerably less energy is dissipated on the open circuit for the same amount of total induction than is the case with the closed circuit. From the curve (Fig. 26) it appears that the energy dissipated per cycle on closed magnetic circuit for total density of induction of 13,200 C.G.S. units is 92×10^7 ergs, while the actual experiment on open circuit only gives 74×10^7 ergs, the air-space being only half a centimetre. Again, from the same curve, it appears that, for closed magnetic circuit and a total density of induction of 8,610 C.G.S. units, the energy dissipated per cycle is 4×10^8 ergs, while for the actual experiment, with two centimetres of air-space in the circuit, it is only 3×10^8 ergs per cycle. This is equivalent to a saving of about two and a-half foot-pounds of energy per cycle. That the dissipation of energy due to magnetic retentiveness becomes comparatively small when the distance between the poles is as much as half a centimetre, was proved by static experiments made for the purpose. These experiments showed that, for a total induction of 14,000 C.G.S. units per square centimetre across the air-space, the dissipation, as measured by the variation of the field in the air space, was only 590×10^6 ergs. The intensity of magnetisation here quoted was obtained with about 130 *volts* on the terminals of the magnet, and approaches near to saturation of the cores. When the circuit is open the dissipation of energy is largely due to Foucault currents in the iron, and, as will be seen from the values calculated and marked on the curves, it approaches towards being proportional to the square of the induction through the iron. This is a result which we should expect so long as the law of the variation of the induction is not very different in the cases compared. The practical bearing of the result here arrived at on the question of open *versus* closed circuit transformers is evident."

"Tell a lie and stick to it!" Dame Nature having cleverly deceived Mr. Gray in the current-time observations tells him a bigger lie when he appeals to her for confirmatory evidence by way of static experiments. Why Mr. Gray chose the air-gap as the place for the measurement of variations of induction is a mystery. By doing so he missed all the induction traversing a part only of the iron cores, and returning through the air without going near the air-gap, and consequently failed to find

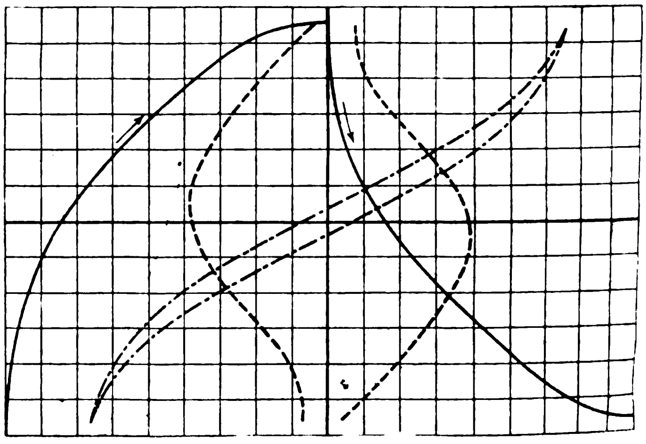

PLATE 9. FIG. 14

Magnet poles separated 5 millimetres. R = 11·5 ohms. Total induction per square cm., 13,200 C.G.S. units.
Full line, curve of reversal of current, 28 divisions = 10 amps.
Dotted line, curve of coefficient of induction L. One division of abscissæ = $34{\cdot}4 \times 10^9$ cms. 5·6 divisions of ordinates = 23 volts.
Chain-dotted line = total induction, ordinates ½ area of L curve. Energy dissipated, 742×10^7 ergs.

a considerable portion of the wasted energy. The truth is, the smallest air-gap causes a very large leakage of induction, as the following experiment carried out by Mr. Vignoles and the present writer in November, 1889, clearly shows. A ring of iron 10 cms. in diameter, and 1 cm. in sectional area, was wound with primary and secondary (ballistic) circuits with a small clear space left where the ring could be sawn through. Having first obtained the **B H** curve from the uncut ring, it was sawn across, leaving an air-gap 0·16cms. in length, and now, out of 15,000 thoms found in the iron at a point on the ring exactly opposite the saw cut, only 9,000 reached the air-gap. The remaining 6,000 cut across through the air from one side of the ring to the other. Had we determined the hysteresis loss from the B H curve of the air-gap the result would obviously have been far too low. Mr. Gray found the loss fall from 92 joules to 74 joules when he opened the magnetic circuit by 0·5cm. This diminution is fully accounted for if the average induction-density in the iron fell from 13,200 to 11,500, the remaining induction being easily accounted for by leakage, as we see from the experiment just described.

The remainder of the paper is devoted to observations of the effects on closing the secondary circuit of the magnet used as

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a transformer, and a discussion of the law of variation of hysteresis loss with induction-density. The author's conclusion on this point is best given in his own words :—

"The effect of varying the impressed E.M.F. on the dissipation of energy is illustrated in Figs. 22 to 25, the abscissæ of which are proportional to the impressed E.M.F., and the ordinates to the induction as calculated from the reversal of current curves which were similar to that shown in Fig. 12. Although the number of experiments here shown are not sufficient to allow any law to be accurately deduced from them, the

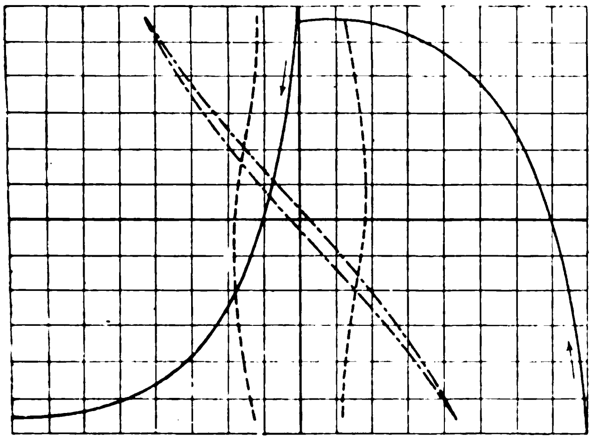

Plate 10. Fig. 16.

Magnet poles separated, 2 cm. Ordinates for L curve = 1 division to $34\cdot4 \times 10^{6}$ cms. Ordinates for B curve = 1 division to ½ area of L curve. Total induction per square cm. = 8,610 C.G.S. units. Energy dissipated, 298×10^{6} ergs.
Full line = curve of reversal of current. 28 divisions = 10 amps.
Dotted line = coefficient of induction L. 5·6 divisions = 23 volts.
Chain dotted line = total induction = per square cm., 8,610 C.G.S. units.
This Figure has been accidentally reversed in engraving, and should be read from right to left.

results are shown by the black dots in the curves Figs. 26 and 27. Fig. 26 is drawn from an equation of the form $e = \text{A E} + \text{B I}$, where e is the energy dissipated, E the impressed E.M.F., I the total induction, A and B constants. For this

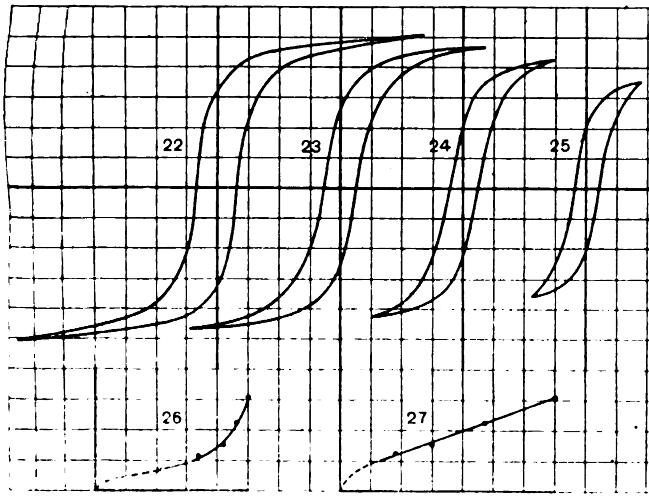

Plate 16.

For Figs. 22 to 25, Ordinates × 3,000 gives induction in C.G.S. units per square cm. Abscissæ ÷ $\frac{1}{10}$ gives effective E.M.F. in volts. Resistance of circuit = 11·5 ohms. Number of turns on magnetising coil = 3,840. Length of iron circuit, 265 cms.

Fig 22.—Dissipation = $1{,}534 \times 10^{6}$ ergs.
„ 23.— „ = $1{,}126$ „
„ 24.— „ = 771 „
„ 25.— „ = 598 „

Fig. 25.—Induction $\frac{1}{10}$ division = 300 C.G.S. units per square cm. Total dissipation = 75×10^{5} ergs.
Fig. 27.—Impressed E.M.F., 3 div = 10 volts. Total dissipation = $1{,}500 \times 10^{6}$ ergs.

particular curve A = ½ and B = 25,300. The curve shown in Fig. 27 has impressed E.M.F. for abscissæ and dissipation for ordinates, and is drawn to show that for the range of experiment taken the dissipation was practically proportional to the impressed E.M.F. Independent experiments indicate that the amount of energy dissipated in the secondary circuit when the magnet is used as a transformer, in the way above described, is nearly proportional to the impressed E.M.F., and hence this was assumed to be the case for the Foucault currents also. The other constants were then obtained by solving for them by means of simultaneous equations of the form $e = \text{A E} + \text{B I}^{x}$, the necessary data to form the equations being taken from the experimental results. It was found in this way that x was practically unity, not differing by more than 1 per cent. for the cases taken, and hence it is taken unity in the curve. The results of static experiments would indicate that the term B I^{x}, which represents the energy dissipated due to the retentiveness of the iron, should vary more rapidly than the induction, that is, that x should be greater than unity, about 1·6 for the experiments of Ewing and others. This result does not seem to be reached by the kinetic method here adopted, and an examination of recent work on the subject seems to confirm the results here arrived at."

In reading this passage it should be remembered that Mr. Gray's paper was written early in 1892; since then many doubtful issues have been finally set at rest, and among them we may consider it to have been conclusively shown by Mr. Steinmetz that hysteresis loss in iron varies as the 1·6th power of the induction-density. It is true that this law is based solely on experimental results, but we are confident that a rational explanation is almost within reach.

In concluding our notice of an interesting and novel experimental research it is only fair to say that Mr. Gray had discovered the unsound nature of his conclusions before the publication of the paper, and in a note added in June, 1893, he says that "the conclusions arrived at in the paper," with respect to variation of hysteresis loss with induction-density "are undoubtedly wrong." We have been too often led astray by some magnetic Will o' the Wisp, not to extend our sympathy to Mr. Gray in his struggles with the same tangled mystery, but we cannot avoid contrasting the feverish haste to publish of our own day, with the leisurely cautious reticence of Newton, and one is tempted to believe after all that much of our progress has been "crab-like—sideways."

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, January 26th.

Association of Technical Institutions.

2 30 p.m. Meeting at the Society of Arts for constitution of Association.

Physical Society.

5 p.m. The following Papers are down to be read: (1) "A New Mode of Making Magic Mirrors," by J. W. Kearten. (2) "Some Observations in Diffraction," by W. B. Croft, M.A. (3) "A New Photometric Method and Photometer," by J. W. Spurge.

Electro-Harmonic Society.

8 p.m. Smoking Concert at the St. James's Hall Restaurant (Banquet Room), Regent-street, W.

MONDAY, January 29th.

London Chamber of Commerce.

3 p.m. Meeting of the Electrical Trade Section at Botolph House, Eastcheap. Agenda: (1) Antwerp Exhibition, (2) Report of the Action of the Traction Committee, (3) Appointment of a Parliamentary Committee, (4) Others matters.

Society of Arts.

8 p.m. Cantor Lecture. "The Detection and Measurement of Inflammable Gas and Vapour in the Air," by Frank Clowes, D.Sc.

TUESDAY, January 30th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. The following Paper to be further discussed: "The Tunnels of the Dore and Chinley Railway," by the late Percy Rickard, M.Inst.C.E. Paper to be read (time permitting): "The Transport of Petroleum in Bulk," by Mr. Boverton Redwood, F.R.S.E.

THURSDAY, February 1st.

Institution of Mechanical Engineers.

7 30 p.m. Annual General Meeting at 25, Great George-st.

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SPECIAL NOTICES.

With this week's Number of "THE ELECTRICIAN" we publish (Gratis to Subscribers) a fine STEEL-PLATE PORTRAIT of Mr. ALEXANDER SIEMENS, President of the Institution of Electrical Engineers for 1894.

STEEL-PLATE PORTRAITS

Of Willoughby Smith; W. H. Preece, C.B., F.R.S. (President of the Institution of Electrical Engineers); Michael Faraday; Sir John Pender, G.C.M.G., M.P.; Sir William Thomson, F.R.S. (Lord Kelvin); C. H. B. Patey, C.B.; Dr. John Hopkinson, F.R.S.; Dr. Oliver J. Lodge, F.R.S.; Prof. William Crookes, F.R.S.; Prof. von Helmholtz; Prof. W. E. Ayrton; Lord Rayleigh, F.R.S.; Cyrus W. Field; Werner von Siemens; Sir James Anderson; Joseph Wilson Swan; and Mr. Alexander Siemens, have been issued as Supplements to "THE ELECTRICIAN."

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THE NIAGARA SCHEME.

"W-I-N-D-E-R—'Winder.' Now go and clean it," said Mr. SQUEERS; and having told us how he meant to build his dynamos and construct his subway, it might have been imagined that Prof. G. FORBES would merely go across the Atlantic and see the job through. But it seems that we have not come to the end of the preliminaries yet, for each week brings some interesting news about the Niagara scheme. Whether the whole will be completed or whether a part only will be set at work, and whether it pays or not concerns us but little. Most of our readers regard this undertaking only as a magnificent bit of electrical engineering. An alternator driven by a vertical shaft turbine is commonplace enough, but the modifications which are rendered necessary simply on account of the large scale give a great interest to the design. If present plans are carried out the Niagara generating plant will be the largest in the world, but it must be remembered that it cannot be compared either in magnitude or in usefulness with the one-man scheme of the original Deptford station. At Niagara there are to be several 5,000 H.P. alternators, and the first of these is, we suppose, in an early stage, if, indeed, it be actually in hand. At Deptford there were to be four 10,000 H.P. alternators, with 36in. shafts and 45ft. armatures, and considerable progress was made with the first machine before difficulties entirely unconnected with this part of the work caused the construction to be suspended. The ForthBridge cannot be expected to pay appreciable interest

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on the capital expended upon it, and the financial result is, indeed, a somewhat complicated matter; but even if it had ruined the railway companies who support it, its interest as an engineering achievement would not have been touched. It has been suggested that the value of a horse-power, day and night, at Buffalo is about £5, and that this will yield an income of £2,455,000 per annum. We have shown, more than a year ago, that this leaves but small margin, if any, for competition with steam, and both Mr. Swinburne and Mr. Crompton have recently alluded to the financial side of the question as though the payment of interest upon the capital expended on the plant—this interest being earned by income from power rental—were the only measure of success. In many undertakings this is the case. The familiar tide-mill problem, 200-miles-an-hour railways, and Mr. Thwaite's scheme for transmission of power from the coalfields must be considered from this simple standpoint. But it is not unlikely that the Cataract Construction Company is a land company, and almost precisely as tramways are put down in America for the purpose of increasing the value of land, rather than for the purpose of earning revenue, the economical or effective working of the Niagara plant may after all turn out to be a comparatively unimportant item of the whole affair.

Prof. Forbes has recently made four declarations about Niagara, solemnly prefaced by the words, "The following statements are true." The one of these which concerns us at present runs as follows:—"The Niagara enterprise is probably the first American enterprise that ever came to Europe saying, we have already subscribed our capital in America, and we are ready to exchange such portion of our cash as may be necessary to secure the brains to properly conduct our enterprise. I confess I am ashamed of my countrymen, and cannot imagine what is the animus which has led to so wilful a misconstruction of such liberality, foresight, and straightforward dealing." Now it happens that among the wild investments of one of our unfortunate English Trust companies, whose affairs have of late been receiving so much attention, we find shares in the Cataract Construction Company which have been recently valued at $1,205,207, being First Mortgage Scrip, together with three $50 Ordinary shares. We have no means of learning whether the valuation was made at par or at the purchase price; but we must conclude that either Prof. Forbes was mistaken on this point, or that his liberal and straightforward-dealing friends have already begun to unload for the benefit of his countrymen, of whom he is ashamed. Prof. Forbes, however, has his hands full of technical matters, and this little matter is probably outside his department.

In connection with the fact that the Westinghouse Company, of Pittsburgh, were not included among those to whom Prof. Forbes expressed his indebtedness in connection with the design of the plant, the letter, of which we gave an abstract on p. 292 of our last issue, is the more remarkable. There are generally two sides to a question, and even if Prof. Forbes makes no reply, the result will be watched with interest. This firm did not take part in the competition for designs, and it appears that it was not until Prof. Forbes' designs were laid before them that they declined to carry them out, and were requested to submit their own plans and specifications, which were accepted by the Cataract Construction Company. Hard things have been said about the competition for designs, and we have made a few inquiries on the subject. Out of six of the competing firms, three tell us that they went into the competition with their eyes open, and with the prize only in view, one firm says that they are not at all satisfied with their relations with the Cataract Construction Company, that their scheme "was sent in with the intention of supplying the plant," and that they sent one of their engineers to America on the business. Another firm sent in designs for the second competition when "no prizes were offered, but it was quite understood that the construction of the machines would be entrusted to one of the competing firms, or else that the machines would be made in America from their working drawings, for which they would, of course, be paid. . . . For the machines we sent in designs, which were very favourably spoken of by the experts, indeed the whole tone of their letters was such as to make anyone believe that the decision was practically for us. In the course of a long correspondence they obtained from us a large amount of useful information, for which we received—their thanks." The sixth firm declines to reopen the, perhaps, rather sore subject. From these replies we gather that Mr. Ferranti's attack, at the discussion on Prof. Forbes' Paper, was based on the complaints of only one or two firms, or on statements made by those whose disappointment had considerably cooled down by the time our inquiries were made. In any case, there is no reason to suppose that Prof. Forbes was concerned in this part of the affair. Another of the statements which Prof. Forbes recently made was that "it has been generally understood that no private undertaking has paid so much for engineering advice in advance of contracting as the Niagara project." This seems very natural, and it is perhaps equally natural that complaints should arise. According to a cablegram received from our New York correspondent, Prof. Henry Rowland, of Johns Hopkins University, having sent in a bill for $10,000 for services rendered to the Cataract Construction Company, and receiving only $3,500, sued the Company for $30,000. The result has been a "sensational trial," and a verdict for Prof. Rowland for $9,000; evidence being given on one side or the other by Mr. Coleman Sellers, Prof. George Forbes, Dr. John Hopkinson, Dr. Louis Duncan, Mr. Frank Sprague, and Mr. William Stanley, Junr. This is the latest bit of news about the Niagara scheme. We wish it every success, and hope that it will do somebody credit.

ALEXANDER SIEMENS.

Mr. Alexander Siemens, whose steel-plate portrait we publish this week, was born at Hanover in 1847, and was educated at the Lyceum and Polytechnic College there. In 1867 he came to England, and worked for a short time at the telegraph factory of Messrs. Siemens Brothers at Woolwich. In the following year he went to Berlin to study at the University, and remained there until 1870, with the exception of filling a temporary engagement, during which he assisted in constructing the Indo-European telegraph line from the Persian frontier to Teheran, and in laying the Black Sea cables at Kertch and from Sukhum Kale to Sotcha. He was next called upon to serve his country in the Franco-German war, and was present at the siege of Metz, and afterwards, under Prince Frederick Charles, joined in the operations against Orleans. He was wounded at the battle of Beaune la Rolande, and for his distinguished services in the field received the Iron Cross.

At the conclusion of the war Mr. Siemens was able to continue his scientific studies, and coming to England, became a pupil of the late Sir William Siemens. In 1873-4 he was conducting experiments for Sir William, at Birmingham, with a rotary furnace to produce wrought iron and steel direct from the ore. In 1875 Mr. Siemens joined the cable ship "Faraday," and took part in several cable-laying and repairing expeditions. Whilst the ship was stationed at Halifax, N.S., he built some blast furnaces at Londonderry, N.S., for the

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Steel Company of Canada, and superintended the erection of a rotary furnace at Pittsburg, Pa. Returning to England in 1877, he was employed in erecting regenerative gas furnaces for various purposes in different parts of England, among them being the first continuous working tank glass furnace erected in this country. In 1879 he became actively engaged in electrical work for Messrs. Siemens Brothers, and had to do with some of the first electric light installations, such as those at the Albert Hall, the British Museum, the Albert Docks, and the Blackpool Promenade. He also laid down an electric light plant at Godalming, the first town in England to so light all its thorougfares, and supply current to private consumers.

Mr. Alexander Siemens became a Director of Siemens Brothers and Co. some time ago, and is now the only Director residing permanently in England. In 1892 he contributed a Paper to Section G of the British Association at Edinburgh on "Electric Locomotives on the City and South London Railway." He has been for many years a member of the Institution of Electrical Engineers, to which body he has contributed several Papers of great interest to the profession, the most recent being that read on February 11, 1892, upon "Some Experimental Investigations of Alternate Currents." He was elected a Vice-President of the Institution four years ago, and is President for the year 1894.

OBITUARY.

ROBERT C. HALPIN.

The announcement of the death of Capt. Robert C. Halpin, R.N.R., D.L., which took place shortly after ten o'clock on Saturday morning last at his residence, Tinakilly (Wicklow), will be received with great regret in naval circles, in London and Liverpool, as well as in Ireland. The deceased gentleman, after an illness of over three months, died of blood poisoning.

Capt. Halpin, a native of Wicklow, was born in 1836, and at the age of eleven years entered the Mercantile Marines, attaining the command of the "Circassian" barque at the early age of twenty-two. In 1864 he was appointed chief officer of the "Great Eastern," chartered by the Telegraph Construction and Maintenance Company, of which Mr. (now Sir) John Pender was Chairman, for submarine telegraph cable laying, and owing to his energy and nautical capabilities was within four years given the command in succession to the late Sir James Anderson, on the occasion of the laying of the longest submarine cable in the world, that from Brest to St. Pierre. In 1869 he was entrusted with the sole command of the British Indian Telegraph Expedition, and laid the cables from Bombay to Aden and Suez. The steamships that were used on the occasion were the "Great Eastern" "Hibernia," "Chiltern," "William Cory," and "Hawk." In 1873-74 he commanded the Brazilian Submarine Telegraph Expedition, when the cable from Madeira to St. Vincent and Pernambuco was laid in the deepest water where such lines have been established. In the same years Capt. Halpin laid two other Atlantic cables with the "Great Eastern." He was then appointed Marine Superintendent of the Telegraph Construction and Maintenance Company. Since 1869 he had successfully laid over 20,000 miles of submarine telegraph lines. At various periods during his services at sea he was presented with valuable testimonials. The French Emperor offered him the Order of the Legion of Honour, and in 1874 the Emperor of Brazil presented him with the Order of the Rose. In the same year the captains and officers of the fleet of the Telegraph Construction and Maintenance Company entertained him at a banquet, and made him a presentation. The Governor of Bombay, the Governor-General of the Netherlands (India), the Governor of Newfoundland, the Chambers of Commerce of Liverpool, New York, Bombay, Pernambuco, &c., have also publicly recognised his great qualities. In 1876 he was appointed a nautical assessor in the High Court of Judicature and a member of the Local Marine Board of the Port of London. He also became a Junior Brother of the Trinity Corporation, was subsequently made a Commander of the Royal Naval Reserve, and a few years ago was appointed a Deputy Lieutenant of County Wicklow. In 1892 he was unanimously chosen as Chairman of the Wicklow Harbour Board, and was re-elected last year. His loss will be greatly felt amongst the poor in Wicklow and by various charitable institutions, especially the Royal Alfred Institution for the benefit of aged seamen, in which he took a warm and active interest.

The funeral took place on Tuesday last and was very largely attended. The detachments of Wicklow Militia, Constabulary, Coastguard, and the multitude of carriages which followed, made a procession three-quarters of a mile long—and hundreds of people followed on foot. The Coastguard men, by their special request, acted as bearers of the coffin. One who was present says: "No man could have been more popular with all classes, and the whole district seemed to be in mourning for him."

REVIEWS.

An Elementary Treatise on Fourier's Series and Spherical Cylindrical, and Ellipsoidal Harmonics, with Applications to Problems on Mathematical Physics. By Prof. Byerly, Harvard University. (Boston: Ginn and Co.)

There is a well-known partial differential equation, which is the same in problems on heat conduction, motion of fluids, the establishment of electrostatic or electromagnetic potential, certain motions of viscous fluid, certain kinds of strain and stress, currents in a conductor, vibrations of elastic solids, vibrations of flexible strings, or elastic membranes, and innumerable other phenomena. The equation has always to be solved subject to certain boundary or limiting conditions, sometimes as to space and time, sometimes as to space alone, and we know that if we obtain any solution of a particular problem, then that is the true and only solution. Furthermore, if a solution, say, of a heat conduction problem, is obtained by any person, that answer is at once applicable to analogous problems in all the other departments of physics. Thus, if Lord Kelvin draws for us the lines of flow in a simple vortex, he has drawn for us the lines of magnetic force about a circular current; if Lord Rayleigh calculates for us the resistance of the mouth of an organ pipe, he has also determined the end effect of a bar of iron which is magnetised; when Mr. Oliver Heaviside shows his matchless skill and familiarity with Bessel functions in solving electromagnetic problems, he is solving problems in heat conductivity or the strains in prismatic shafts. How difficult it is to express exactly the distribution of strain in a twisted square shaft, for example, and yet how easy it is to understand thoroughly when one knows the perfect fluid analogy. How easy, again, it is to imagine the electric current density everywhere in a conductor when transmitting alternating currents when we know Mr. Heaviside's viscous fluid analogy, or even the heat conduction analogy.

Much has been written about the correlation of the physical sciences; but when we observe how a young man who has worked almost altogether at heat problems, suddenly shows himself acquainted with the most difficult investigations in other departments of physics, we may say that the true correlation of the physical sciences lies in the equation of continuity

$$\nabla^2 u = a^2 \frac{du}{dt}.$$

There are many men who are pretty much in my position with regard to these investigations, and possibly many physicists who know even less about them than I do.

I had the honour of attending a course of lectures on Fourier's method in heat problems delivered by Lord Kelvin to an advanced class in Glasgow twenty years ago. My carefully-corrected notes, illustrated by the solution of many interesting problems with accurately drawn curves, mysteriously disappeared just after the end of the course, and many a time since have I felt that the loss of these notes was a loss to all the average mathematical physicists of the world, for I should certainly have published them long ago. I had worried over Maxwell before I went, and I remember that in the beginning Thomson seemed to know less of Fourier than I did myself, that he felt

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his way in a stumbling fashion for about two lectures, and then for the remainder of the course he was not only perfectly master of the subject, but by his enthusiasm, his knowledge of our ignorance, his pains to put things before us in such ways as he thought we could best understand, his numerous easy examples, his evasion of mathematical difficulties by giving physical proofs, and above all by his making us work out numerical examples and show our results in curves, he established himself, in my mind, as a teacher in the position which he must ever retain. I do not know how a man of leisure who has fair mathematical ability can refrain from making that sort of pilgrimage which I made to Glasgow. I shall thank God all my life for that most glorious session, during which Thomson was never once obscure, during which not one day passed without the publication to his students of valuable and otherwise unpublished information. I have known him to be very obscure in delivering a "popular" lecture or other address; but let him lecture to advanced students, with plenty of time to meander into all parts of his subject, and his lectures are one long delight, and such a great delight that I sometimes wonder how I resist the temptation to give up all my affairs in London for one more session at Glasgow just to listen to elementary lectures on subjects that I have been in the habit of teaching.

How few are the working mathematicians who know the use of Fourier's integral or spherical harmonics or Bessel functions. How many are the men who have possession of the English translation of Fourier's treatise, and who yet understand nothing of Fourier's method. How many are the men, like myself, who feel disgusted at their ignorance of a method of analysis which seems so all-important in modern mathematical physics, and which looks so hopelessly above their mathematical powers when studied here and there from occasional scientific Papers. Parenthetically I may remark that the writers of mathematical Papers are the most selfish and unsympathetic people in the world. I remember once being honoured during three months to converse almost every day with one of the great mathematical physicists. During that three months he was engaged almost continuously on an interesting problem, and I understood fairly well what he was doing. Now the whole of his investigation is published in two pages of the Mathematical Society's *Journal*, and of that publication I do not understand one word. The passion for having perfection of compactness and generalisation seems to be so intense in some of our leaders that one can only compare it with the old-fashioned habit of philosophers to publish their discoveries in such riddles as really hid their results from other philosophers, and yet enabled them later on to obtain all the credit they desired.

Everybody of my way of thinking will be delighted to know that Prof. Byerly, of Harvard, has just published "An Elementary Treatise on Fourier's Series and Spherical, Cylindrical, and Ellipsoidal Harmonics, with Applications to Problems on Mathematical Physics," which seems to be exactly what we have long wanted. I am speaking quite carefully and soberly when I say that to sit down for the first time to look through that book is like taking the first long drink at a fountain when one has just passed through a desert. And it has come unexpectedly, too; one heard nothing about its being in preparation. There are many of our leaders who might have done it, but they probably thought it below their dignity to write an elementary treatise—at all events, they did not do it, whereas Prof. Byerly, in doing it, has done a very great service to all average mathematical physicists. Here they are, those beautiful solutions of Fourier, so clearly given that anyone can understand them if he has done what so many thousands do in the differential calculus. Prof. Byerly first attacks a few problems, and shows that in all of them it is necessary to expand functions in series of terms of certain normal forms, and the first chapter is the most interesting in the book, and the first problem of the first chapter gives one the most pleasure. The first normal forms considered are sines and cosines of angles; the next are spherical harmonics, and the next are Bessel functions. It becomes evident to the reader that it is this development of a function which has become important in the solution of problems. Chapter II. shows how to develop a function in Fourier's series (or series of sines and cosines), and Chapter III. discusses the convergence of such series, showing in beautiful illustrative curves how by taking one, two, three terms, &c., successively, we approach nearer and nearer to the real function. These two chapters are very interesting, and yet I think that Prof. Byerly with all his knowledge of what a beginner ought to be taught has erred a little here and elsewhere in giving too much. I may be mistaken, but I think that I would have asked the student to draw curves himself, and refer elsewhere to exact proofs of convergence of series, and these 38 pages would have been reduced to three. On second thoughts, however, I must say that I should regret the absence of the beautiful successive approximations of pages 63 and 64. How skilfully the author has used these curves in drawing the interesting conclusions of page 65!

Chapter IV. introduces us to Fourier's integral, and to all the most interesting problems which require the Fourier developments for their solution. As the last three chapters dealt with problems needing the Fourier developments, so Chapters V. and VI. deal with developments in sperical harmonics and Laplacians, and Chapter VII. deals with problems requiring developments in Bessel functions. In Chapter VIII. we have ellipsoidal harmonics, with some information about Toroidal harmonics. In Chapter IX. we have an excellent summary of the history of the subject, by Dr. Maxime Bôcher, a colleague of the author, with a list of works of reference; and in an appendix there are certain tables of Zonal harmonics, hyperbolic functions, roots of the Bessel equation, and tables of the Bessel functions of the zeroth (used by Fourier before Bessel's time), and first orders, which might with advantage have been more elaborate.

This book suits me very well, and will be enjoyed by my advanced students, but, as I have already remarked, a much smaller book, giving the more elementary parts of the subject, with exact instructions for the working of a few good illustrative exercises, is still wanted if the results of investigations are to be brought within the power of use of the practical engineer (I mean that kind of working engineer who has not an ignorant contempt for theory, for there are such men, just as there are great mathematical physicists who have not an ignorant contempt for the workshop method of investigation). It is only given to a few to be able to solve an altogether new problem, but I would have everybody able to apply to his own special cases the results of an investigation already published. To do even more than this it is almost enough if one is able to develop any given fuction of x in one or other of the series already referred to. To develop in a Fourier's series is quite easy, and the numerical work is not very long. I gave an example in *The Electrician* of February 5, 1892. There, an arbitrary function of t, from the values $t=o$ to $t=T$, was developed in sines and cosines, and by the same method any arbitrary function of x, from $x=o$ to $x=c$, may be developed. When c is taken infinitely great the Fourier's series degenerates into a Fourier integral. If a function is represented by a curve in the usual manner, Prof. Henrici's beautiful analysing machine will give the Fourier series without mathematical work of any kind. I am in hopes that his success with this machine may induce him to design another, in which for any curve we may develop a series of Bessel functions. To do it numerically the process is not unlike the Fourier development; but, unfortunately, my students have hitherto found that the tables of Bessels available, even when extended by their own interpolations, are not nearly so good or handy as Bottomley's tables of sines and cosines are for these better-known functions. Tables such as are given by Dr. Lommel are excellent if one does not mind the labour of interpolation; but for real practical work the tables ought to be like Mr. Bottomley's. I believe that Prof. Lodge, of Cooper's-hill, has long been preparing tables of Bessel functions, and I am in hopes that he will prepare tables of Bessels of the second kind; but it is evident to everybody who has used Bessels in alternating-current problems, that something further must be done, such as taking the sum of the odd terms by themselves, and the even terms by them-

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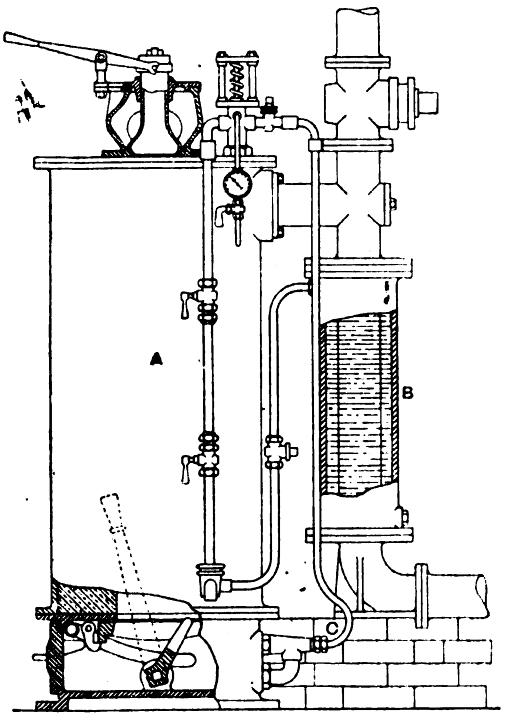
selves, of the series $J_0(ip\sqrt{i})$, where i is $\sqrt{-1}$. The real part has been called *ber p* by Lord Kelvin, and the multiplier of i in the imaginary part *bei p*. We want, as I say, plenty of tables or analysing machines, and a general simple teaching of methods of solution of problems to practical engineers, and there may then be a chance of great progress. Most of the worshippers at the numerous shrines to the goddess of stupidity (to whom I also fearfully offer up sacrifices) will sneer at the idea that practical engineers should be taught to practise these methods of analysis. And Dugald Dalgetty, who could actually extract a square root, or Cassio, who "was a great arithmetician," or much more one of the Latin or Greek sages, who could multiply by "the trireme method," would have sneered at the idea that a board school child might learn in a week to do what used to be done only by old men after years of study.

Howsoever these things be, in bidding, for the time, good-bye to Prof. Byerly's book, I offer him thanks from a very grateful heart, and in this matter I venture to think that I represent a number of people who wanted such a treatise, and who knew very well the sort of thing they wanted.

JOHN PERRY.

THE "PARAGON" GAS PRODUCER.

Already the prediction of many competent engineers is being fulfilled—that the gas engine will form a useful adjunct to, and ultimately compete largely with, the steam engine for



Roger's "Paragon" Gas Producer.
A, Gas Producer and Steam Generator. B, Gas Cooler and Feed Water Heater. C, Air and Steam Injector.

the generation of electric power. Of the difficulties which surround the use of gas motors of large power we have often spoken, and we are confident that the work which is now being done by first-class engineering firms will go a great way towards their removal. But there is another difficulty, namely, that attending the preparation of the gaseous fuel. Town gas is expensive, and is really not intended to be used as a fuel. The efforts of the gas companies to produce a rich illuminant necessarily conflict with the supply of suitable or cheap gas for use in a mechanical motor. To meet the demand for a cheap gaseous fuel more than one form of water-gas producer have been devised, which generate a non-luminous gas by the passage of steam over or through a fire of coke or anthracite. One of the latest of these inventions is the "Paragon" gas producer, made by Mr. H. J. Rogers, of Watford, which is illustrated in the accompanying diagram.

In introducing this new gas producer to the public the inventor has had in view a saving in space, and a saving of time and attention required in producing gas at a rapid rate for working gas engines of large power. In order to obtain this result he has constructed an apparatus in which the process of gas making and the generation of steam are carried on in the same apparatus, instead of in two separate producers as at present. The gas is made by passing jets of superheated steam and air through incandescent coal or coke. A small generator of about 2ft. 6in. in diameter, and about 5ft. high, will make nearly 1,500ft. of gas per hour at a cost of about 3d. to 4d. per 1,000 cubic feet. There is a special arrangement for clinkering the fire bars without opening the door of the ash-pit, and a special valve has also been constructed of improved design for facilitating the process of feeding the furnace with fuel, and also for examining the state of the fire and for clinkering purposes from above, in addition to that already described for clinkering from below.

Another speciality of this apparatus is that the gas in passing from the producer is cooled by coming in contact with the feed water, which in its turn is heated by coming in contact with the gas on its passage to the gas holders.

INSTITUTION OF ELECTRICAL ENGINEERS.*

MR. ALEXANDER SIEMENS' PRESIDENTIAL ADDRESS.

(Concluded from page 301.)

By far the most important connection between mechanical and electrical engineering is, however, the transmission of power, which has of late acquired so much prominence. If the first stage of the development of the electrical industry was closely connected with telegraphy, the second step may be said to have been taken when electric lighting was introduced, and now it seems that transmission of power is the problem which electrical engineers have to grapple with in the near future. The success of electric tram lines has undoubtedly contributed to direct general attention to the transmission of power by means of electricity; but great care will have to be exercised so as not to start in a direction that can lead to no practical results. Many schemes have been started to introduce electricity as the motive power on the main lines of railway, and to accelerate at the same time the speed of the trains very considerably, even up to 200 miles per hour. It would be rash to say that such a speed will not be attained some day; but, in my opinion, none of these schemes can be carried out on a commercial basis with the means at present at our disposal. Trebling the speed of the trains necessitates a radical alteration in the laying of the permanent way, a thorough reconstruction of the carriages, and demands an amount of power that we have no means at present of estimating accurately, nor have we motors that could produce it with a moderate weight. Even if these obstacles are overcome, the enormous capital outlay could only be justified if a very frequent service was kept up, as in the case of successful electric tramways. In most schemes it is, in fact, proposed to run single carriages at short intervals between important towns; but up till the present time it has not been possible to convince capitalists that such a service would pay, either between Vienna and Buda-Pesth, or between Chicago and St. Louis, which are the most notable instances of such schemes.

Leaving these ambitious projects out of consideration, enough scope remains for the development of electric traction in the country to render a healthy activity in this branch of our industry probable for a number of years; and the report of the Hybrid Committee which sat last year has removed, let us hope, a very serious obstacle to electric traction. As the rules which the Board of Trade has drawn up in accordance with the instructions of this Committee are still under consideration, it would obviously not be in order to criticise the version that has been published; it would, however, be hampering the industry if too many details were too accurately prescribed. In this connection it must not be forgotten that in the past the industries of this country have been developed, to the great advantage of the nation, with very little legislative interference; and it would at present be premature to make the regulations regulating electric traction too stringent, as the working out of this branch of electrical engineering is by no means completed.

Besides traction there is the distribution of power, in which mechanical engineering is of the greatest influence on the successful application of electricity. It is, of course, a purely electrical problem to deliver your current either at a standard voltage, or in a constant quantity, at all points of your network of mains; but the application of the motors to the work they are required to do, and the determination of their dimensions, involve principally mechanical considerations. How much there is still to be done in

* Delivered January 11, 1894.

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this respect was made apparent during the discussion of Prof. Forbes's Paper on the proposed utilisation of water power at the Niagara Falls. Although the prevailing opinion seemed to be that for transmission to a great distance alternate currents only can be utilised, I believe that of the actually-established long-distance transmissions the greater part are worked with continuous currents. No hard-and-fast rule can apparently be laid down that either the continuous or the alternate current should be preferred in all cases where power has to be transmitted to a distance; and, in judging of the merits of the two systems, the proper conclusion can only be arrived at if the commercial aspect of the case is allowed to decide the question.

The installation of rotary-current motors at the Frankfort Exhibition, driven by the water-power at Lauffen, was undoubtedly an engineering success, and served very well for the purposes of an exhibition; but nobody has attempted to do every-day work on the same lines, for the simple reason that it would have been much cheaper to produce the power in Frankfort by steam engines than pay the commercial interest on the outlay that had been necessary to establish the transmission from Lauffen. The generating plant of this installation is now used for the lighting of Heilbronn, and there are a few other instances where rotary currents are used for long-distance transmissions; but, as I said just now, it would be wrong to generalise by preferring either the one or the other method of transmission in all cases.

Another great field for electric motors is just being opened by their introduction for distributing power in works, with a view of abolishing shafting, leather belts, and other intermediate gearing, and of giving each lathe or other tool an independence that cannot be attained under the present system. A most interesting Paper on this subject was read by M. Castermans before the Society of Engineers in Liége in August, 1892, in which he compares in detail several proposals for distributing power in a new small arms factory, that has since been erected at Herstals. The result he arrived at was that with electrical motors he could exert on the working machines 70 per cent. of the power generated by the main engine, while the next best other method gave only 63 per cent., when the shops were working at their full capacity.

In these problems, again, mechanical engineering questions decide whether the application of electricity is justifiable; and it is quite apparent that an electrical engineer requires to be well versed in a variety of subjects if he wishes to keep in the front rank. Fortunately for our profession, the question of technical education generally has received particular attention during the last quarter of a century; and omitting all reference to other occasions when this subject has been brought before this Institution, I will only remind you of the eloquent address of Prof. Ayrton, which no doubt is still fresh in your memory. It will, therefore, not be necessary for me to repeat his lucid exposition of the transition from the former system of pupilage to the modern one of educating the budding engineers in colleges and their laboratories, which has supplemented, and to a great extent supplanted, the old one. No doubt this altered system of education is capable of producing a class of men who are well adapted to explore the untrodden fields of applied electrical energy, where the problems constantly demand a thorough knowledge of scientific principles; but, in combination with this, an equally extensive acquaintance with practical possibilities is requisite. This most important co-operation of science and practice is essential for all real success, and no doubt it appears to be superfluous to insist on the necessity of bearing this in mind; but a perusal of patent specifications will at once convince you that either the one or the other factor is sadly wanting in many would-be inventors. Years ago it was science that was most conspicuous by its absence in these documents; but in the present time it is very often obvious that the inventor has no clear conception how his invention could be carried out so as to make it useful to mankind, and even fails to see the obvious impossibility of realising his ideas in the way he claims in the specification. As usual, it is very difficult to steer the middle course; and if the scientific man had for years to cry in the wilderness because his pursuits did not receive the proper attention in the education of engineers, it seems now to be the turn of the practical man to warn students that there is something more to be learned besides scientific truths before they can aspire to be recognised as engineers. It has always appeared to me that at school the mental powers should be principally exercised in a way to make them fit for learning, and that at the same time they should become accustomed to the careful consideration of a problem in its various aspects. Although it has been the fashion of late to deprecate the study of Latin and Greek, I am quite certain that the attack is made from quarters where the mental training which the study of these languages entails is not appreciated at its right value, nor is the enormous advantage considered which their knowledge gives in the study of modern languages. After the mental powers have been prepared in this way, it is of no great consequence whether most of the details of the school teaching are speedily forgotten or not; the essential point is that the student should have acquired a good method of learning, so as assimilate to the best advantage the course of training he attends at college. While the teaching at school has a general character and embraces chiefly subjects that ought to be known to all classes, at college the various professions are differentiated, and in each branch the students learn the general principles that ought to govern them in their future career. Formerly it was possible to let the course of scientific studies embrace all that was known in any particular branch; in fact, the general principles and the interdependence of the various branches were not, and partly are not yet, properly understood. To attempt a similar course at the present time is simply impossible, and the danger that has to be avoided in our scientific colleges is the tendency to teach our profession too much in detail. Besides overwhelming the professors with work, such a course is apt to create in the students the conviction that on leaving college with a first-class certificate they know all that can possibly be known, and that anything that does not fit in with theory of their pet professor must necessarily be condemned.

A fault into which young men are liable to fall, when they come full of honours from college, is that they consider the passing through workshops beneath their dignity, especially when they have attended for the prescribed time in the workshop of the college. They quite forget that the practical conditions that prevail in works where machinery is made for sale differ entirely from those of a laboratory, where the only aim is to give the students an opportunity of acquiring manual skill.

Another class of students commences practical work with the greatest interest, and the fixed determination to introduce with all possible speed the various improvements which the difference of the practical work with which they come in contact from the teaching at college suggests to them. On all these students it cannot be impressed too much that the practical training is of quite as much importance as the scientific course at college; in fact, in most cases the conclusions of pure science have to be modified by practical considerations before a useful application of science can be produced.

For this reason it is highly desirable that the teaching at engineering colleges should be confined to general principles, as far as the applications of science are concerned, but that the students should become thoroughly well acquainted with the mental tools that are used in scientific investigations, such as mathematics, the general principles of chemistry, and of the branches of natural philosophy. While the student is trained afterwards in practical work, he has time to select what special branch of the profession he wishes to devote his life to, and no doubt he will find that his college studies have to be supplemented by reading up the various technical works referring more particularly to the selected branch. If he has been able to acquire a certain knowledge of modern languages, he will find his labours lightened very materially by having a much larger range of literature to select from.

In this respect electrical engineering has been especially fortunate, for it has, more than any other profession, an international character, and this Institution has, from the very commencement, counted among its members distinguished electrical engineers of many nationalities. It is quite true that after a time the principal foreign nations formed their own electrical institutions; but the international character of the profession has been kept up by the congresses which have met from time to time with a view of regulating electrical matters of international importance.

At the official congress which met last year at Chicago, an international system of units of measurement has been settled, or, rather, readjusted, for the electrical engineers have from the beginning enjoyed the immense advantage that their units of measurement have been the same in all countries. Not only has this circumstance greatly promoted the inter-communication between the various nations, but the character of the electrical units facilitates the demonstration of the inter-dependence of the various forms of energy, and simplifies the calculations of the engineering profession. If a proof were necessary of the utility of having the same units understood in all civilised countries, it is only necessary to observe the conditions and the tendencies that prevail in other matters of international interest. It is chiefly owing to telegraphy that the conditions of modern life differ so essentially from the state of things before the means of quickly communicating with distant parts were at the service of the community at large. Through the ever-increasing network of telegraph wires all mankind is drawn together, and the mutual reaction of the affairs of distant nations is very well illustrated by the newspapers of all countries vieing with each other to bring the latest news from all parts of our globe, and by the effect this news produces at home. Not only are industrial enterprises greatly aided by the possibility of watching their progress in distant countries as easily as it was formerly possible to follow the fortunes of works in the next county, but the distribution of the commodities of life can be regulated in such a way that an extraordinary demand in one country can be met by an extraordinary supply from another one.

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Under such conditions of inter-communication it is not to be wondered at that attempts have been made—and, in fact, have been to a great extent successful—for facilitating the intercourse between nations in various directions where an international agreement could do away with existing difficulties. One of the most important international conventions is the Postal Union, into which most nations of our globe have entered, and whose influence is brought home to us every day. In another direction an effort has lately been made to make the mode of reckoning time more uniform, and the result is that Greenwich time has practically been adopted in a great many civilised countries, by making the local time either the same, or differing from Greenwich by one hour or by multiples of an hour. An even more important agreement among many nations has existed now for more than a quarter of a century by their adopting the metrical system of measurement; and it is well worth while seriously to consider the effect of this concerted action on the part of foreign nations, as it forms an ever-increasing obstacle for the successful competition of English manufacturers. An ideal system of measurement should be based on units which can be reproduced at any time and at any place with mathematical precision, and you all know that the metrical system was intended to embody this desirable condition. From various causes, into which I need not enter here, the attempt has failed; even the kilogram does not bear the relationship to the linear units which it originally was intended to have, so that the bases of the metrical system are now an arbitrary metre and an arbitrary kilogram. All the same, its very general adoption has proved a very great convenience, and there is little doubt that the introduction of international electrical units has been accomplished with such facility because they are based on the metrical system.

When we recollect that it was a German professor who suggested the absolute system of measurement, that the British Association first established practical electrical units, that the metrical system is of French origin, and that the electrical system of measurement was elaborated by discussions between engineers and scientific men of all nations at the various congresses, we cannot wonder that a very perfect system has been the outcome, and that its general adoption in all countries has followed without discussions, although the formal recognition may not yet have been pronounced in all cases. Even in this system it has been found necessary to settle one of the units—the ohm—in an arbitrary manner, as it was recognised that for practical purposes it was better to have an arbitrary but fixed standard, than to correct the unit every time that an improvement in methods or in instruments admitted of determining it with greater accuracy than before. It is well worth while to reflect on the lesson which this fact conveys, viz., that, in spite of the earnest endeavours and the painstaking collaboration of most competent men, it has not been possible to follow out in practice the dictates of pure science, but that a compromise was found to be inevitable.

The conclusions to which this consideration of the influences that have shaped the course of electrical engineering leads us, may well awake in us the hope of an ever-increasing activity and of an ever-growing importance of the applications of electricity; but we must not forget that we can only succeed if we understand how to adapt our work to practical requirements without losing sight of scientific laws. For this reason nothing can further the interests of our profession more than a free and frequent interchange of ideas between the engineers, who carry out the practical applications, and the scientific men, who investigate the nature of electricity. In the past this Institution has been the arena in which many subjects have thus been discussed to the advantage of everybody concerned; and it is the duty of all its members to contribute, either by reading Papers or by criticising those submitted by others, to the development and to the ever-increasing importance of the Electrical Engineers.

TECHNICAL EDUCATION.*

It is now fully admitted that the education of an engineer should be twofold, and that neither instruction in theory nor experience in practical work should be omitted from it. This point is so fully conceded that it is quite unnecessary to elaborate it. But there is still great diversity of opinion as to the method of carrying out the partition, and probably the conflicting claims of the college and the workshop will never be settled. The years at the command of the neophyte do not suffice for him to learn all that is to be acquired in either department of his professional knowledge, and hence at each step in his career he finds matter for regret that he did not devote more time to the particular branch with which he is dealing. To-day he realises that with greater mathematical skill and a deeper knowledge of physics he could greatly lighten his labour, and to-morrow he sees that a wider experience in practical construction would have saved him from mistake and from loss of reputation. Thus his opinion of the respective values of theory and practice is swayed from side to side by the exigencies of his work, at least until a lengthened acquaintance with his profession has furnished more ample materials for judgment. Possibly by that time the conditions of science and of teaching have so far altered as to vitiate the premises upon which he bases his conclusions.

Temperament again, acts very curiously on the judgment; from the same facts two men of different natures will arrive at diametrically opposite conclusions. The sensitive conscientious man, full of anxiety for his client's interests, will have his pride in a piece of fairly successful work clouded by the reflection that he could have done it better if his education had been different. On the other hand, the gaze of the thick-skinned, self-sufficient individual rivets itself on those features in which the class of knowledge in which he is most proficient is displayed, and he congratulates himself, and the world in general, that he never wasted much of his time in the class-room or the workshop, as the case may be. Both these attitudes of mind may, and do, lead to error. The truth is only arrived at by a due weighing of the advantages of a certain type of education over its disadvantages, and as there are neither balances nor standard weights for the purpose, it is almost impossible to attain an exact result.

Without going to the length of indorsing the cynical definition that "Youth is a mistake and old age a regret," it must be conceded that later years always show that many of our early efforts were misdirected, and that this is true of education as of other things. It cannot be otherwise. A youth's ignorance of his mental nature is usually only exceeded by his want of knowledge of the actual conditions he will have to meet in the world. Under these circumstances he chooses a calling (let us say that of an engineer), or it is chosen for him by a parent who probably knows less of the latent powers of his mind than he does himself. If he comes of well-to-do people, he goes through the accepted course of study and apprenticeship, and then fares him forth, like a knight-errant, to win fame and fortune in the battle of life. He should not fail for want of weapons, for he literally bristles with them, like the villain in a transpontine drama. Each branch of engineering he has studied under a separate professor, while he has acquired practical knowledge and manual dexterity in some important manufacturing establishment. Now, if the youth have in him the makings of a first-class engineer, he has probably followed a satisfactory course. His ability will soon be recognised, and he will be able to guide and shape his career along the lines which best suit his temperament and utilise his acquired knowledge. But if he fall a good deal short of this, as nine out of ten must do, and, instead of being able to choose his path in life, has to take what presents itself, or, worse still, finds he has made a mistake in adopting his calling—no unusual occurrence—much of his highly-specialised knowledge becomes almost useless, and he has to recommence his education under less advantageous conditions.

Seeing, then, that there are two highly uncertain factors to be taken account of by every young man—namely, his own mental powers and the opportunities he may find or make for himself in the professional world—it becomes a question how far it is wise for him to adopt a system of education that is based on the assumption that he is to be a leading light in Great George-street, and sit at the council table of the Institution. Surely it would be better for him to aim rather at cultivating the powers of his mind than at acquiring detailed knowledge. This is a view we have advocated for years, and we were glad to find it confirmed last week by Mr. Alexander Siemens, in his Presidential Address to the Institution of Electrical Engineers. Mr. Siemens is well qualified to stand between the professors and the so-called practical men, and to divide the educational territory between them. He is the representative, in England, of the greatest engineering family ever known. Not only were Dr. Werner von Siemens and Sir William Siemens leading engineers in the sense that they were the heads of immense establishments, and that they devised and directed important works of great magnitude, but they were also acknowledged leaders of science, directing and moulding the opinions of their time in subjects quite outside of their professional duties. Probably few men have made greater use of science for utilitarian purposes than they, or owed more to it in a pecuniary sense, and yet they were constantly making excursions into subjects that did not afford, and could not furnish, any return except intellectual pleasure. Apart from family traditions, however, Mr. Alex. Siemens may claim to know more than most engineers of the influences of a scientific education. In a German university, and later in the German Army, he became acquainted with two of the most elaborate systems of education that exist. Further, as the head of a large industrial undertaking, employing an extensive staff, which must be constantly recruited with new blood, he has before him men trained in many different ways, and he can compare the effects of the different systems. As the result of his experience he says:—"It is highly desirable that the teaching at engineering colleges should be confined to general

* From *Engineering*, January 19, 1894.

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principles as far as the applications of science are concerned, and that the student should become thoroughly well acquainted with the mental tools that are used in scientific investigations, such as mathematics, the general principles of chemistry, and of the branches of natural philosophy." It is only right to add that he does not arrive at this conclusion by the same train of reasoning as ourselves. He says:—"In most cases the conclusions of pure science have to be modified by practical considerations before a useful application of science can be produced." The two sentences taken together are a severe criticism on professorial engineering, and the implication is much more serious than anything we have ever written on this subject.

Before the college comes the school, and an attempt is often made by anxious parents to mould the course of instruction so as to comprise the elements of professional knowledge. In doing this they strike at the very roots of a boy's mental growth. While the intellect is yet tender, they ante-date the narrowing, cramping effect of a specialised calling. Just as the modern system of construction produces workmen who can do one thing only, and are without the slightest claim to the appellation of mechanics, so does a severely-specialised education turn out men capable of only few ideas, and those but simple. The school is, or should be, the gymnasium of the mind; in it every faculty should be trained by exercise into fair proportions and healthy growth. Symmetry, and not hypertrophy, is what is to be aimed at—the co-ordinate action of the various branches of the intellect under the control of the disciplined will. We never ask what economic results the athlete has effected during his training, how much material he has transported, or how much timber he has sawn. It is to the future we look for the fruits of his exercises and self-denial. It is equally absurd to judge of a boy's progress by his acquired knowledge. If he have learned to meet and attack a problem, or a hitherto unknown science, with a skill and determination like that with which the trained fencer faces a new antagonist, his education is of the highest order, even if he have less useful knowledge than the "third standard" boy of the Board School. As Mr. Siemens put it: "It has always appeared to me that at school the mental powers should be principally exercised in a way to make them fit for learning, and that at the same time they should become accustomed to the careful consideration of a problem in its various aspects. . . . After the mental powers have been prepared in this way, it is of no great consequence whether most of the details of the school teaching are speedily forgotten or not; the essential point is that the student should have acquired a good method of learning, so as to assimilate to the best advantage the course of training he attends at college."

Though the forgetting of school learning may be relatively unimportant, it is, we fear, the sign of inefficient teaching. There are few powers of the mind more important than memory. Without it the student is continually spinning a rope of something that is little better than sand. To the man of the world a good memory is of the utmost importance, as the bulk of his knowledge is not to be found in text-books, and much of it cannot even be written in his notes. A good memory is absolutely necessary for correct reasoning and rapid decisions. How strong and capable we should all feel if the whole that we have ever learned were at our "fingers' ends!" Even if we knew where to find the half of it, we should be the gainers. The value of memory is only second to that of perception, and hence its acquisition should rank high in the schoolmaster's scale. Its cultivation involves its exercise, and, therefore, the process of rendering the mind retentive must store it with knowledge. A trained memory cannot coexist with an empty head. It is not merely retentiveness, however, that the teacher should aim at developing. Of equal importance is an orderly method of thinking. If it be the habit of the mind to arrange all the facts of a series in connected natural order, it ceases to be a labour to remember them. The first suggests the second, the second hints the third, and so on in easy sequence through the entire train. The fact wanted may be the last of the chain, but, like Fair Rosamund in the recesses of her intricate bower, its discovery becomes certain from the moment that the clue is found.

The necessity of great attention being paid to the training of the memory of boys is rendered more urgent by the fact that immediately they leave school many influences combine to destroy, or at any rate to pervert, its operation. Firstly, there is the system of note-taking at professor's lectures. This is often carried to such an extent that the whole attention is concentrated on the mechanical operation of putting the spoken words on to paper while their sense never reaches the brain. The effort to understand, which is the best aid to remembering, is not made; afterwards the subject is read up from the note-book, but the mental impression is less sharp than if derived from the teacher's lips, aided by his gestures and facial expression. Again, the system of cramming cultivates a temporary or spurious memory, which, while most valuable for the passing of examinations, and also for some other purposes, weakens the permanent memory. It is surprising what a load the brain may be made to carry if it have the assurance that the cargo may be jettisoned at an early date. This is seen in the case of barristers, who will in a short time obtain complete mastery over an intricate case, and will forget every detail of it with equal celerity. Such a habit, however, cannot be indulged in with impunity, and before it begins every care should be taken to lay up a store of mental strength to withstand its debilitating effects.

Mr. Siemens recommends the study of Latin and Greek. He says:—"I am quite certain that the mental training which the study of these languages entails is not appreciated at its right value" [by those who deprecate it], "nor is the enormous advantage considered which their knowledge gives in the study of modern languages." We fully agree that one who has not undergone the stern mental discipline required to obtain a facility in the composition of Greek and Latin verse has no idea of its value. A bright, but not over industrious, schoolboy, once asked, in our hearing, "What use is Latin in making steam engines?" and got, as reply, the question, "What use is a grindstone for drilling a hole?" The lad saw the point at once, and replied, "Oh, I suppose you mean Latin sharpens one's mental tools." The truth of this has been demonstrated through many generations. But, with new studies opening out on all sides, it is in the highest degree probable that there may be some of an equal value from an educational point of view, and which would bring a more direct advantage. We have heard the plea that Latin aids the study of modern languages many times before, but the fact remains that all well-educated Englishmen in the past were thoroughly taught the classics, and that only one in a hundred could speak any language but his own. It is worth while trying if we cannot grind our brains on living tongues. We fancy that a German treatise on "Mysticism," or on "The Relation of the Finite to the Infinite," would afford as much material for painstaking research and methodical labour as most people need, while the cultivation of readiness of wit and of an incisive style might be well effected by the study of French classics. Whether this be so or not, a very serious effort should be made to determine whether other studies cannot be made of equal mental value with Latin and Greek. In saying this, we are not contradicting our contention that the great object of the school period is to learn how to learn, and that the kind and amount of knowledge acquired are secondary. But life, especially educational life, is short, and secondary results are too important to be entirely overlooked. We fully believe that it is possible to arrange a curriculum in which the dead languages bear only a moderate part, and yet which shall be potent for cultivating all the faculties of the mind, and bringing them into full and healthy activity. At the same time such a course would have the added advantage that it would open a world of delights to those undergoing it. Not only would it unlock for them the literatures of one or more European countries, but the whole universe would bear a different meaning from that which it presents to the youth who has spent nearly all his time on the classics. Science would show them that the world was full of order and symmetry, bidding them admire the wonder and beauty and mystery of every object surrounding them. History, fiction, and the drama would open to them the most interesting and profitable of all studies—man—while drawing and music would cultivate their artistic perceptions. Except in the case of the inveterate dullard, some one of these subjects must have awakened attention and roused enthusiasm, which it must be confessed Latin and Greek seldom do, and there is no aid to mental culture equal to enthusiasm. At present educational systems are in a state of transition, but it is quite easy to see, firstly, that classics are regarded with decreasing interest, and, secondly, that their study will never cease to form some part of a liberal course. The uncertain point is how much attention ought to be bestowed upon them.

THE BOARD OF TRADE ELECTRIC TRAMWAY REGULATIONS.

The usual Council and Committee meetings of the Tramways Institute were held at the offices of the Institute, at 18, Eldon-street, E.C., on Thursday last week, to consider various matters, the agenda including a discussion on the draft electric tramway regulations recently issued by the Board of Trade.*

Mr. CARRUTHERS WAIN, the President of the Institute, occupied the chair, and in opening the proceedings said: I am quite sure you will all learn with regret of the death of Mr. Reckenzaun, one of our members and a well-known electrician.

Proceeding to the discussion of the electric clauses Joint-Committee's report, and the Board of Trade regulations,

The CHAIRMAN said that the question to be discussed in regard to these electric clauses was a very simple one. He had a report of the proceedings before him. The Institute appeared by counsel before the Joint-Committee, and the Joint-Committee reported, and that report was a favourable one for electric traction. That was followed upon by the

* See *The Electrician*, November 24, 1893, p. 96.

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Board of Trade with very serious regulations. The document had been sent by the Secretary to every company, and the result had been that they had received certain replies—for instance, the Blackpool Surveyor had written, saying that the whole of the conditions rendered electrical traffic impossible and unworkable. In addition to that, there had been a conference of the Electrical Traction Committee of the London Chamber of Commerce, where all these things were discussed one by one. Mr. Crompton was in the chair, and a deputation from that Committee was formed and waited upon the Board of Trade to know whether they could not afford some explanation of the very ambiguous expressions contained in the regulations, and they would have the pleasure of listening presently to the remarks that would be made by Mr. Sellon on the matter. They were all interested in this subject very much at the present time. The question of electrical traction or some other new form of traction was important, and he felt sure that they would have an interesting discussion on the matter.

Mr. STEPHEN SELLON said that he would commence his observations with what happened at Liverpool. It would be recollected that upon that occasion he read a Paper before the Convention on the question of electric traction, and, although at that time certain tramway companies did not care to consider the question of any different mode of mechanical traction, they all agreed, with a view to the use of electrical traction in the future, that it was as well to safeguard their position, and there was in the result a unanimous vote of confidence. Now as to what had happened since that date. He had appeared before the Board of Trade, by counsel, on behalf of the Institute, but he had, unfortunately, been unable to show to the Committee that the whole of the tramway companies interested in the matter were represented. The great object to be secured by their institution was that the telephone clauses should be abolished from the regulations in reference to the conditions of electric traction. They had had a tremendous amount of labour and trouble in the matter. Mr. Wain, the president, had given leave for the secretary of the institute to circularise every single corporation in the country and every single tramway company in the country that could possibly be interested in the future of electric traction. That circular laid before them showed very clearly that it was desirable that application should be made to the Board of Trade that other clauses should be substituted in lieu of the telephone clauses, and there was also the question of making the Committee's recommendations retrospective. Well, he regretted to say that the answers that he had received to this circular had been very small indeed. It seemed almost impossible to interest the tramway companies of this country in the matter of future traction of the tramways. Whatever they might be ready to do in the future they replied now they "were not ready to discuss the matter at the present moment," and so on. He regretted that they showed such a small amount of common sense. He had been working hard for a considerable time in endeavouring to obtain the abolition of these telephone clauses. Mr. Alfred Dickenson, who was an authority upon these matters, would tell them that it was absolutely impossible to maintain the conditions of electric traction under the regulations that these clauses sought to impose. Having alluded to the present condition of the Glasgow Tramway Company, he said that, having discussed the question of the telephone clauses, they now came to the question of the report of the Joint Committee and the regulations of the Board of Trade. The Board of Trade informed him that they would only promote a general Act to abolish these old telephone clauses, and make the ruling of the Committee retrospective upon the district showing that there was a universal concensus of opinion that these clauses should be struck out. Now he could only reply to the Board of Trade that the support that he had received from the tramway companies was very small in comparison to the amount of the tramway's interest, and therefore the Board of Trade would not agree to bring in a Bill to abolish the clause at the present moment. Well, they had had a good deal of discussion at the Conference that day. They had discussed questions of paving, traction, and the Tramways Act of 1870 and its hardships. They had also discussed the question as between tramway companies and Corporations, and in nearly all cases the only answer that they could say to them was, "Serve you right." It would be the same in regard to the question of the future of electric traction if the tramway companies did not combine together against the hardships that it was sought to impose upon them in this direction. He then proceeded to refer to the accusations that had been brought against tramway companies working with electricity that they disturbed the telephone wires, that they upset railway signalling, and did damage to the mains of the gas and water companies. The result of the sitting of the Joint Committee in regard to the telephone companies contentions, was that they had stated that the telephone companies had their own remedy, which was a very simple one. They could adopt the duplicate wire system. As to railway signalling, the Joint Committee saw a little more difficulty there, but fortunately there was this point that if it was dangerous for them that the wires should be near, it was equally dangerous in the case of the railway companies' wires that might themselves be affected by a storm or electrical disturbance. After alluding to the satisfactory working of the South Staffordshire system, he said that as regarded the complaints of gas and water companies, they might equally well be directed against the wires of the telephone companies themselves. He then proceeded to stigmatise in very strong terms the report issued by the Board of Trade in this matter. The Committee, he said, sat for 14 days, and the report of that Committee really said that under no conditions need they trouble about the telephone companies, they must protect themselves; and now the Board of Trade by its draft regulations made the report of the Joint Committee unworkable. Really what they required before they could understand the regulations of the Board of Trade was that the Board of Trade should send the key to them. He asked the Board of Trade for further information, and the Board of Trade replied to him asking him to kindly point out the matters upon which he disagreed with the regulations. He replied that he disagreed with them all. Mr. Sellon then proceeded to pass certain severe strictures upon the National Telephone Company, and said that it would be remembered that the counsel stated before the Committee that the telephone was "an instrument for the purpose of hearing every other person's voice except the one that you wanted to listen to." It was claimed by the National Telephone Company that the telephonic system in London was quite as good as any other town—Berlin, for instance; but in Berlin, he would like to point out, the telephones were under the control of the Government, and if an unfortunate subscriber complained to the Government that his telephone did not work, their only answer was to send a man to cut it off, which was not what they required of the National Telephone Company. What they desired to do, he said, was to protect the telephone interest against the tramway interest. After again alluding in strong terms to the National Telephone Company and its management, he said that their object that day was to consider the tramways interest. He simply asked that they would all assist him in the formation of a committee for the protection of the tramway's interest, so that they might go to the Board of Trade and show that the tramway companies were really interested in this matter of electrical traction as against telephone companies. He desired to state that out of about 90 tramway companies in England only some 10 of them had got electric powers, and he supposed that for that reason the other 80 did not reply to the letter that was circulated.

Mr. WAUGH said he knew of companies that wanted to change their systems for electrical systems, but they could not do it.

The CHAIRMAN: Why?

Mr. WAUGH: Because they cannot raise the money.

Mr. SELLON said that he believed the reason why money could not be raised for these electrical systems to be tried was that, as in the case of the North Metropolitan Company, there was a clause in the Act by which they could be compelled to remove the electrical installation within a week.

Mr. ELLIOT: 24 hours, in one instance.

Mr. SELLON said that he believed Mr. Preece, if he had his way would insist upon a metallic return throughout with regard to the telephones.

Mr. PLATT remarked that he thought it the duty of every tramway company to subscribe the £1. 1s. Mr. Sellon had asked for towards his expenses.

Mr. A. DICKINSON said that he had listened with very great attention to the remarks of Mr. Sellon, and he thought that a great deal of the want of support on the part of the tramway companies was due to their lack of knowledge in electrical matters. It was really ignorance that accounted for their apathy. It was ignorance on the part of tramways and corporations that was the fault. However, the draft regulations of the Board of Trade were as difficult to understand as to work under them. Clause 10 was impracticable.

"The insulation of the line and of the return when insulated, and of all feeders and other conductors, shall be so maintained that the leakage current shall not exceed one-hundredth of an ampere per mile of tramway. The leakage current shall be ascertained daily before or after the hours of running when the line is fully charged. If at any time it should be found that the leakage current exceeds one-tenth of an ampere per mile of tramway, the running of the cars shall be stopped until the leak has been localised and removed."

Having read the clause he observed that the Board of Trade said that a company should not work with one hundredth of an ampere leakage he stated that he had worked with 300 amperes leakage for a whole day (laughter). He asserted that if the regulations were reversed and made to state that they should not work unless there was a leakage of 300 amperes, the majority of tramway men would not be any the wiser. He did not think he was throwing any slur upon his friend, the secretary, in supposing he did not understand what that meant. He hoped his words would not be misunderstood, but he maintained it was utterly useless to circulate such reports amongst tramway companies, and what he desired to suggest was that they should form a technical committee of that Institute to consider and report upon such electrical matters.

Mr. SELLON quite agreed with this view, and said that the fact that counsel appeared in the matter—and won the day—was solely due to the interest shown in the question by the electrical traction companies who instructed the counsel, and not to the tramway companies.

Mr. DICKINSON: It is a great shame.

Mr. ELLIOT: What can you do if people will not support you?

The CHAIRMAN: Well, it certainly seems that the thing to be done is to appoint a committee—a small committee is always better than a large one—and I will suggest, subject to any amendment that may be moved, "That Messrs. Stephen Sellon, A. P. Smith, Alfred Dickinson, and John Waugh, with the President, be appointed a committee to draw up an explanation of the draft regulations submitted by the Board of Trade, and circulate it amongst the various tramway companies associated with the Institute." That I think will be a practical issue of the subject discussed to-day.

Mr. WAUGH: I second that.

Mr. WHITING asked if the Committee would issue amended regulations.

The CHAIRMAN: Yes; certainly. The old and the new in parallel columns.

A MEMBER suggested that Mr. Hesketh, the borough surveyor at Blackpool, should be added to the committee, as that was a tramway with electrical powers.

The CHAIRMAN: Certainly. Well, I will move the resolution in this form, "That a committee, consisting of the following gentlemen, Messrs. Stephen Sellon, A. P. Smith, Alfred Dickinson, John Waugh, W. Hesketh

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and the President be appointed to deal with the electrical clauses and the draft regulations submitted by the Board of Trade, and to take such steps as they may think desirable in the interests of the tramway companies."

Mr. WAUGH seconded the motion, which was carried.

After some further discussion, a vote of thanks was accorded to the President, and the proceedings terminated.

LEGAL INTELLIGENCE.

The Medical Battery Company (Limited).

Mr. Hannay resumed at Marlborough-street on Monday last the hearing of the charges of conspiracy to defraud made against Cornelius Bennett Harness, of the Medical Battery Company, J. M. M'Cully, and C. B. Hellier.

ALICE JANE BEATTIE said she was a member of the Royal British Nursing Association, and held a diploma from the London Obstetrical Society. In August, 1892, she had a severe illness, and for the consequent extreme exhaustion she consulted seven or eight medical men, who for the latter part of the time did her no good. Dr. Heywood Smith recommended her to go to 52, Oxford-street. She paid a reduced fee of £5 for treatment for three months. The fee was reduced because she belonged to the nursing profession. She was treated by Dr. Laird and attended by Nurse Higgins. She had a belt which she wore, and after three months she was able to resume her duties as a nurse. She was quite satisfied that the treatment she received at Oxford-street cured her. She volunteered to give evidence in the case.

Cross-examined by Mr. Gollan: She did not go to Oxford-street dressed as a nurse. She paid £5 and got a receipt. The nurse she saw at the Medical Battery Company did not diagnose her complaint. She was treated with massage and electricity, and sat on the statical chair, and used to visit the place about twice a week. She wore the belt all through the day for three months. Occasionally during that period she left off wearing it. She wore it next to her skin, and it did not chafe her in any way. The sum first mentioned for the treatment was from £12 12s. She asked to have the fee reduced as she was a nurse and had suffered from a long and expensive illness.

Similar evidence was given by Miss JESSIE BOND, the actress, who stated that in October, 1890, she was suffering from nervous exhaustion, weakness, and loss of voice. She paid 50 guineas for the treatment, which lasted over 12 months. For that sum she was, in addition, supplied with two belts. She thought she went to the establishment quite 50 times.

Mrs. JANE CRAWSHAW, daughter of Colonel Mountjoy Martin, of the 2nd Life Guards, also gave evidence in the same sense. She wished to pay for the treatment, but Mr. Harness declined to take any fee, saying that he had derived great benefit from the persons she had recommended to him, and that she could always have treatment without payment.

M'CULLY said he wished to crave the indulgence of the magistrate for a few moments. The case had been before the Court 14 times, and there was not a tittle of evidence against him. He could hold his head up before the whole world, and asked in the name of all that was English and right that he should be liberated.

Mr. HANNAY said he could not then allow such a course. Probably the whole charge would be disposed of when the case again came on for hearing, and most likely he would then give his decision one way or the other.

The further hearing of the case was adjourned till next Wednesday.

Sheffield Café Company v. Bakewell.

An action which involved a novel point of patent law was heard before his Honour Judge Ellison at the Sheffield County Court on Friday last. A claim was made by the Sheffield Café Company against William Bakewell, electrical engineer, of Shortridge-street, Attercliffe, to recover £10 damages. The claim was originally for £17. 18s., £9. 10s. for 76 lamps given up to the Edison Swan Company; £5. 5s., charges of Messrs. Ashurst, Morris, Crisp, and Co., solicitors to the company; and £3. 3s., charges of Messrs. Clegg and Sons, solicitors, of Sheffield. Of this sum £7. 8s. was abandoned, and the claim reduced to £10. Mr. W. E. Clegg appeared for the Café Company, and Mr. Arthur Neal for the defence.

Mr. CLEGG, in opening the case, said that his clients sued to recover damages by reason of the defendant having wrongfully supplied to them a number of electric lamps which were infringements of valid patents. By his having done this plaintiffs were prevented from using the lamps and put to expense. The case should have come on on November 23rd, but some negotiations had taken place with the result that the original claim of £17. 18s. had been reduced to £10. The facts were somewhat peculiar. It appeared that some time in June, 1892, defendant saw plaintiffs' manager, and said he had an incandescent lamp of German origin equal to the one the company were using. This he could sell to the company at 2s. 4d. In consequence of that statement orders were given to him from time to time until he had supplied to the company some 140 lamps, the last being delivered on April 17, 1893. On May 1, 1893, the plaintiffs received a letter from Messrs. Ashurst, Morris, Crisp, and Co., solicitors to the Edison-Swan Company, in consequence of which they communicated with the defendant. The letter they received pointed out that all the incandescent lamps made by the Edison-Swan Company were marked with their name, and any such lamps not so marked were an infringement of their patent, which comprised every form of electric incandescent lamp. Defendant when this letter was read to him said he thought that the patent for these lamps had expired, and that he had a right to sell them. Upon further investigation plaintiffs found that the patent had not expired, and that it had consequently been infringed by them. They accordingly gave up to the Edison-Swan Company some 83 lamps and paid the solicitors their charges rather than run the risk of an injunction and damages granted against them. Defendant it appeared had also to make terms with the Edison-Swan Company. Plaintiffs now sought to recover from Mr. Bakewell the money paid for a consideration which had failed. The latter had offered to refit the café with Edison-Swan lamps at the expense of the plaintiffs, giving his services for nothing, but declined to pay any damages.

In reply to a question from the Bench, Mr. NEAL said that most of the facts were admitted, so that it would be unnecessary to call many witnesses.

Mr. WHITEHEAD, general manager of the plaintiff company, was subjected to cross-examination by Mr. Neal. He stated that the average life of these incandescent lamps would be, he thought, less than 18 months. Some of the lamps given up to the Edison-Swan Company had been in use for some time, but others were quite new. It was not a fact that defendant had given him the choice of two kinds of lamps—the Edison-Swan and the Zurich. The former they were already using, so that it was not likely he would do so.

Mr. BAKEWELL, called by Mr. Neal, stated that he had submitted two lamps to the plaintiffs' manager, and that the latter chose the cheaper.

By Mr. CLEGG: He styled himself an electrical engineer, yet he did not know that these Zurich lamps were an infringement of the Edison-Swan patent. If Mr. Clegg had had any experience in this matter he would know that there were a great many big electric companies who had made the same mistake, and had had to suffer for it.

Mr. NEAL: I do not think there is any legal principle which will affect this case.

His HONOUR: There is that principle of selling an article injurious to the purchaser, and the question is whether an article which is an infringement of a patent is not an injurious article in the hands of a person who is not entitled to use it.

Mr. NEAL: There is no evidence that this lamp was an infringement of the patent laws.

Mr. CLEGG: I thought that was admitted. If my friend is going to raise that point I can soon get someone down from the Edison-Swan Company who will put the matter beyond all doubt.

Mr. NEAL said that perhaps that point would not arise. His client, on the evidence as it stood, was equally an innocent person with the plaintiff. He had sworn that he had shown to Mr. Whitehead two lamps, and that Mr. Whitehead chose the cheaper one. If there was any *tort* at all committed it was committed then, and Mr. Whitehead was a party to it. Both of them were infringing the right of a third party, and if so neither was entitled to indemnity from the other.

His HONOUR asked where was the warranty on which the plaintiff depended.

Mr. CLEGG contended that defendant was an electrical engineer, who held himself out to the public as a person well acquainted with everything connected with electricity. That being so, it was his duty to know the state of patents with regard to electric lamps, and he held out an implied warranty that he had a right to sell these lamps, and that the purchaser would be right in using them.

His HONOUR: It may be there is no infringement.

Mr. CLEGG: I understood my friend to admit that. You see his client himself admitted it by paying a sum of money to the company.

Mr. NEAL: Oh, no; I do not admit it. We paid costs in order to avoid an expensive law suit.

His HONOUR: I think it would be better if the case stood over for a fortnight. I shall then have time to look up the law on the subject.

The action was accordingly adjourned.

BOOKS RECEIVED.

"Professional Papers of the Corps of Royal Engineers." By Captain W. A. Gale, R.E. Vol. XIX. (Chatham: W. and J. Mackay and Co., 176, High-street.)

"*Proceedings* of the Royal Society of Victoria." Vol. V. (Melbourne: Stillwell and Co.)

Annuaire pour l'An 1894. Par le Bureau des Longitudes. (Paris: Gauthier-Villars et Fils.)

"Electro-Dynamic Machinery." By A. E. Kennelly, F.R.A.S. Vol. I. (New York: D. Van Nostrand Co. London: E. and F. N. Spon, 125, Strand.)

"Electric Waves." By Dr. Heinrich Hertz. Translated by D. E. Jones. Price 10s. net. (London: Macmillan and Co.)

"Production et Utilisation Rationnelles de la Chaleur Intensive du Gaz (Combustion sans Fumée)." By A. Bandsept. Paper read before the Association des Gaziers Belges.

"The Electric Transformation of Power." By Philip Atkinson, A.M. (London: Crosby, Lockwood and Son.)

"An Epitome of the Law and Practice connected with Patents for Inventions." By James Johnson and I. Henry Johnson, Assoc.Inst.C.E. Second edition. Price 2s. 6d. (London: Longmans, Green and Co., Paternoster-row.)

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CORRESPONDENCE.

INSULATION RESISTANCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your very interesting articles on insulation resistance there is, I notice, but one slight mention of special standards of insulation for alternating currents. Now, if we adopt Mr. Human's series of standards for different voltages, we ought, as a logical sequence, to take into consideration the maximum E.M.F. of an alternating current, and not the square root of the mean square; and as the former is approximately 1·4 times the latter, we ought to raise the minimum values of insulation resistance for any given number of lamps lighted by alternating currents to 50 per cent. above the minimum values given for the same number of lamps lighted by continuous currents.

Mr. Human's plan is extremely useful, though, in my opinion, the standard he has selected is too high; half the value would, as you suggest, give a safe and practical series of figures.

With regard to the question of moisture, it would be an element of safety to insist that no test be made when the relative humidity of the air is above a certain fixed percentage, and that the hygrometer form part of the testing office apparatus.—Yours, &c., CHAS. A. GAWTHORP.

January 19, 1894.

EJECTOR CONDENSERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Our attention has been drawn to a very interesting article on page 267 of your issue of January 12th, concerning the Willans engines, where mention is made of the great and deserved success of their exhibit at the late Chicago Exhibition. As a considerable portion of the technical press has spoken in terms of unqualified praise of the performance of these engines in America, it may interest some of your readers to know that a new departure was made in regard to the condensing plant by fitting the 360-H.P. and the 135-H.P. engines with our patent ejector condensers. Considering the prejudice which exists in many engineering circles concerning this class of condenser, it is satisfactory to know that no hitch was experienced by adopting this—as many would consider—somewhat daring innovation, the deservedly-high reputation of the Willans engines being sustained in this instance as in all others.—Yours, &c.,

35, Queen Victoria-street, T. LEDWARD AND Co.
London, E.C., January 19, 1894.

LIGHTNING EXPRESS RAILWAY SCHEME.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The remarks made in his Presidential address by Mr. Siemens on the subject of high-speed electric railways appear to have produced the impression among many that such schemes are far without the bounds of practical engineering. He does not discriminate; he includes all rapid transit schemes under one common ban.

Now, on November 9th and 11th last, shortly after the announcement was published that we had undertaken to develop the experimental work in connection with Mr. Behr's lightning express single-rail railway scheme, Mr. Siemens signed and addressed to this Company letters in which he offered to supply our requirements as regards the electrical portion of the work, and to place the experience of his Company at our service.

We think, therefore, in view of such public pronouncement as that referred to that we are justified in publicly calling Mr. Siemens' attention to the discrepancy between the expressions of the speech and of the letters.—Yours, &c.,

THE THAMES IRON WORKS AND SHIP BUILDING COMPANY (LIMITED),
C. E. GROVE, Electrical Engineer.

January 23, 1894.

THE BRIGHTON AND HOVE COMPANY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am glad to notice in one of your leaderettes of the last issue of *The Electrician* a retraction of your statement in regard to the value of our plant; but while appreciating your disavowal of any intention to undervalue our machinery, or to assail the prestige of the manufacturers, I would like to draw your attention to the fact that the tenor of your explanation somewhat confuses the matter. In expressing your regret, you mention that you "referred to the Corporation offer," which offer, you proceed to state, was "to purchase the Company's *undertaking* for the sum of £5,000. . . ." I may point out to you that our arrangement with the Corporation is for the disposal to them of our *goodwill only*, and it practically amounts to this, that the Corporation are paying £5,000 compensation to the Company in consideration of their ceasing to supply current within the Borough of Brighton. This arrangement does not come into effect until September 30th of this year.—Yours, &c., G. W. SPENCER HAWES,

Brighton, The Brighton and Hove Electric
January 24, 1894. Light Company (Limited).

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1894 Edition of "'THE ELECTRICIAN' ELECTRICAL TRADES' DIRECTORY AND HANDBOOK" is in preparation, and will shortly be published. *New names, alterations of addresses, &c., should be sent in at once.* Full printed particulars can be obtained, post free, from "The Publisher," *Electrician* Office.

"ELECTROMAGNETIC THEORY," by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application to the Publisher.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.) Prospectus on application to the Publisher.

TENDERS INVITED.—Tenders are required for an electric light installation at the Chancelot Roller Flour Mills, Edinburgh, specifications for which can be obtained of the Secretary, Scottish Co-operative Wholesale Society (Limited), 119, Paisley-road, Glasgow.

——— Tenders are invited for the supply and erection of an electric lighting plant for lighting a portion of the left side of the port of Rouen. Specifications and particulars may be obtained from M. Cadart, engineer, 52, Quai du Mont Riboudet, Rouen, and tenders must be sent in by March 12th.

BANKRUPTCY.—At the Salford County Court, on Friday, Mr. Walter Rowbotham, electrical engineer, of Salford, who became a bankrupt in 1890, applied for his discharge, which was granted, subject to a suspension for three months.

——— Mr. Osmond Yeadon Rhodes, trading at 130, Albion-street, Leeds, as the Yorkshire Electric Engineering Company, has filed a deed of assignment. The liabilities are given at £236, and the assets at £80.

——— The statement of affairs prepared by Mr. Free Chilton, electric, cycle, and general engineer, Luton, shows liabilities £256, and assets £12. The debtor ascribes his failure to the loss of an action for slander brought against him, which cost him over £200.

LIQUIDATIONS.—Two petitions for the compulsory winding-up of Elmore's Patent Foreign and Colonial Copper Depositing Company (Limited) came before Mr. Justice Wright, in the Chancery Division, on Wednesday, but were, by consent, allowed to stand over again, Mr. Assheton Cross, who appeared for the Company, stating that during the proposed interval it was hoped that a satisfactory arrangement would be come to. Counsel for the petitioners expressed their belief that the Company was making a *bonâ fide* endeavour to meet its liabilities. The petition was therefore allowed to stand over, with leave to the petitioners to apply to the Court in the event of dissatisfaction with the Company's proceedings.

——— A petition has been presented for the winding up of R. Bolton and Co. (Limited), and is down for hearing on the 31st inst.

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Removal Notice.—Mr. G. H. Congdon has removed from Palace Chambers, Westminster, to Trafalgar House, Great Newport-street, W.C.

Site for Disposal.—Mr. F. Hazell, land agent, 117, Victoria-street, London, S.W., has extensive freehold wharf land between Albert and Battersea Bridges, London, with 400ft. frontage to a dock, to be let or sold.

Voltmeters.—Mr. R. W. Paul reports that during the past year a large number of Ayrton and Mather electrostatic voltmeters (a description of which appeared in our issue of June 9th last) have been manufactured and supplied to the principal electric lighting companies, amongst which are the Metropolitan, City of London, London Electric, Brush, and Laing, Wharton and Down Companies, as well as the Bristol and Derby Corporations, and several foreign firms. Mr. Paul announces that he has in process of manufacture instruments on the electrostatic principal for lower readings.

Anderson-Aetna Insulators.—Mr. Robert W. Blackwell, of 39, Victoria-street, Westminster, writes us with regard to the Note relating to the Liége-Herstal electric line which appeared in our last issue but one, and to the letter from Mr. William Dierman which appeared in our last issue, to say that he supplied to the Compagnie Internationale d'Électricité, of Liége, the insulators and suspension devices employed in its erection, and the trolleys with which the cars were fitted. These are all of the "Anderson-Aetna" type, well known in the United States.

Messrs. Crompton and Co.—This firm send us a *résumé* of the work done during 1893, which includes the lighting of the Southampton Docks for the London and South-Western Railway Company, which was carried out on the low-pressure direct-current system, so as to facilitate the use of motors. The installation consists at present of 60 arcs for outside lighting, and 1,000 incandescents for shed lighting. The Great Eastern Railway Company's terminus at Liverpool-street, and the adjoining premises, have been supplied with the electric light by Messrs. Crompton, who are carrying out important alterations in connection with the extensions now in progress. This contract will now number 200 arcs and 7,000 incandescents. The system is the same as that adopted at Southampton, the mains consisting in great part of bare copper strip carried on insulators. A contract for the Bradford Joint-stock Bank comprises twenty warehouse elevators, each driven by a separate motor, the supply being taken from the Bradford mains. Each elevator is constructed to lift 11 cwt. at a speed of 120ft. per minute. The Southend Corporation have entrusted a further order to Messrs. Crompton and Co. for plant required for the electric tramway on the pier, the additions consisting of a second Paxman engine and boiler and three additional cars. At the Crystal Palace the firm have carried out the complete lighting of the main nave and courts, &c., with 90 arcs, the current being supplied from three Crompton dynamos, the lamps being ten in series and three in parallel. This is probably the first time such an arrangement has been successfully carried out—at least, on such an extended scale. For the Hove Electric Lighting Company large extension orders have been received and carried out, both for the Crompton bare system of mains and for the permanent plant and buildings now nearing completion. The Local Authority contracts secured by the firm during the year include orders from the Corporations of Brighton, Dewsbury, Hull, Glasgow, and Lancaster, and from the Hove Commissioners. For the Compagnie Hydro-Electrique, of Antwerp, a contract is in hand for mains for about thirteen miles of streets on the Crompton bare underground system. Large orders for plant have been received from the local lighting companies of Southampton and Oxford, and from the London and India Joint Dock Company for arc lamps for the new lighting arrangements at the Albert Docks. The record for the year also includes a large number of private installations, and the supplying of Crompton plant and apparatus to the agents of the Company at home and abroad.

Messrs. Latimer Clark, Muirhead and Co.—In the Chancery Division on Thursday last an application was made by Mr. Kenyon Parker (on behalf of debenture holders) for the appointment of a Receiver and Manager in the matter of Latimer Clark, Muirhead and Co., electrical engineers. The Company did not oppose, and Mr. Justice Chitty made an order appointing Mr. James Worley receiver and manager, and giving him liberty to borrow or provide a sum not exceeding £4,000 at 5 per cent. for the purpose of carrying on the business of the Company, the sum so borrowed to be in priority of the debentures.

London and Lancashire Electric and General Engineering Company (Limited).—This company report that during the past year, although only the first of its existence, it has been well employed in both mechanical and electrical engineering work. A new system of water-tight tubes and joint boxes, designed by the Company's manager, Mr. C. N. Russell, especially for use in wiring paper mills, breweries, &c., has kept the firm busy. A number of lighting installations have been carried out by the firm during the year.

Telescopic Ladders.—Messrs. J. H. Heathman and Co., of Endell-street, London, W.C., have had on show during the past week a pair of telescopic ladder towers, with bridges 6ft. wide and 26ft. long, to rise and fall, for use in all ceiling work. The ladders can be so used that ceilings can be worked upon from 14ft. to 26ft. high.

Financial Review of Electricity for 1893.—Our contemporary, *Lightning*, in its issue of the 18th inst., gives some interesting figures in a financial review of the past year, from which it will be seen that the capital invested in electric supply undertakings, which at the end of 1892 stood at £4,271,875, was increased during 1893 to £5,264,071, or nearly £1,000,000 sterling for the year.

Electric Ventilating Fans.—Messrs. Ernest Scott and Mountain have just completed a large electrically-driven fan, designed to deliver 30,000 cubic feet of air per minute at a water pressure of 5in. The fan is driven by a 40-E.H.P. Tyne motor running at 700 revolutions per minute, and is intended for use in connection with a new system of induced draught on board steamers and for land boilers. The capacities of the fan have been thoroughly tested, and are stated to have given satisfaction.

English Arc Light Carbons.—We have received the following from the India Rubber, Gutta Percha and Telegraph Works Company (Limited):—

"106, Cannon-street, London, E.C.,
"January 22, 1894.

"Our attention having been drawn to a statement made in several of the electrical newspapers that "all carbons used in England for arc lighting have hitherto been imported from abroad," we should be obliged if you would correct this statement, which is inaccurate. We have been engaged for over fifteen years in the manufacture of carbon rods for electric lighting. These carbons have been made under English patents, and at our works at Silvertown we have a complete plant in daily operation for the production of such carbons for electric lighting.—Yours, &c., "Wm. J. Tyler, Secretary."

Aberystwyth.—Messrs. Bourne and Grant have purchased ground and buildings in Mill-street, and are adapting the premises for electric lighting purposes. The Corporation has, we understand, received the amount incurred in obtaining the Provisional Order.

Bedford.—The Board of Trade have decided that the Urban Sanitary Authority of Bedford has shown no sufficient grounds for handing over the Provisional Order to the Bedford Electric Light Company (Limited).

Berwickshire.—Messrs. Graham and Morton have just completed a contract for the installation of the electric light at Swinton House, Berwickshire, the residence of Mr. John McNab. The contract includes E.P.S. accumulators, and the plant includes a 9-H.P. Crossley gas engine. The contract comprises about 150 incandescents.

Bournemouth.—The Town Council are making an application to the Board of Trade for a licence empowering them to carry on electric lighting works for public purposes. The local electric light Company are not opposing the licence, and the London and South-Western Railway Company have withdrawn the objections of which they had previously given notice.

Bristol.—Messrs. Crompton and Co.'s extensive installation of the electric light at the Merchant Venturers' School, Bristol, is now almost complete. The whole of the building is not at present supplied with the current, as it is the intention of the authorities to allow the students of the electrical engineering department to undertake each year the wiring of one or more rooms until the whole are completely supplied. Considerable additional comfort to the students is anticipated from the introduction of the electric light, more particularly in regard to the evening classes.

Cathedral Lighting.—In the course of an interview, the Clerk of the Works at St. Paul's Cathedral, London (Mr. C. J. Harding), stated that the electric light, which will doubtless ultimately be adopted for lighting the Cathedral, will be supplied by plant placed in the crypt of the Cathedral. Several of the Cathedral authorities are not enthusiastic concerning the introduction of electricity, except for the fact that gas has been found most destructive to the decorations.

Church Lighting.—The proposal to light St. Jude's Church, Southsea, by electricity has met with an adverse decision from the Southsea Vestry, who have postponed consideration of the matter for six months, "just to see how the new illuminant answers."

Clacton.—The Local Board have recently received a proposal with regard to lighting the town by electricity, which they have negatived, but would be willing to consent to a reasonable proposal for a local company to obtain a Provisional Order, on condition that provision is made for the Board ultimately purchasing the undertaking upon reasonable terms if they should so determine.

Cowpen.—The contract between the Lighting Company and the Local Board expires on February 12th, and public tenders are to be invited for lighting the district for a term of years.

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DEWSBURY.—The guardians have received an intimation from the Local Government Board approving of the plans for the scheme of electric lighting proposed to be carried out at the workhouse, but the Board thought it desirable that the guardians should reconsider their decision in this matter, as it was probable that extensive alterations would be necessary in the infirmary buildings in the near future. After discussion it was proposed to notify the Local Government Board that the scheme of the guardians was a comparatively inexpensive one, and should therefore be proceeded with, and asking that the period for repayment of the loan proposed to be raised for the purpose be extended to thirty years. A proposal that tenders be invited for the necessary work, which is estimated to cost between £2,000 and £2,500, was adopted.

EDINBURGH.—The Lord Provosts' Committee of the Town Council have accepted an estimate for the removal of buildings at Denver Place, the site of the proposed central electric lighting station. Sketch plans, which have been prepared by the borough engineer, have been submitted and approved generally.

——— The Town Council held a further meeting on Tuesday to consider as to whether the Council's permission should be given to the transfer of the lease of the Edinburgh telephones by Messrs. Dick, Kerr and Co. to a local company. Mr. K. Anderson strongly disapproved of the proposed transfer, and contended that the chief object of the Council in granting the lease to Messrs. Dick, Kerr and Co. was that they should be responsible for the tramway undertaking. After a lengthy discussion, the proposals of the Lord Provost's Committee to draw up conditions under which the sub-lease is to be granted was approved.

FORGERY.—At Taunton Assizes, Henry Everard Hunt, electrical engineer, late manager of the Taunton Electric Light Works, pleaded guilty to forging two promissory notes for about £300. Everything was done to mitigate the penalty, but Mr. Justice Williams sentenced the prisoner to twelve months' hard labour.

FRAUD.—Robert Mann, employed as local manager at Ipswich by the National Telephone Company, was charged with having made false entries in his account books with intent to defraud, and, after a long hearing, was sentenced by Mr. Justice Cave, at the Ipswich Assizes, to eighteen months' hard labour.

GLASGOW.—Electrically-lighted private carriages, the property of two well-known Glasgow citizens, have recently created some interest. At a lecture a few weeks ago delivered by General Roberts, these carriages were used for the first time publicly, and showed somewhat conspicuously against the carriage of Lord Kelvin, who was a visitor on the occasion, and whose carriage was not lighted electrically. One of the owners of the carriages is Sir W. Renny Watson, who, besides being by profession a manufacturing engineer, is chairman of the Glasgow and South-Western Railway Company. The carriage is fitted with three small glow lamps, one of which is placed in the roof and the other two on the outside of the carriage, in lieu of the ordinary side lanterns. A Lithanode Company's battery is used, placed under the driver's seat. The driver has control of a small switch for turning the current off and on for the side lights. The owner of the second carriage is Mr. J. M. Thomson, who is also a mechanical engineer, a member of the Town Council and of the Corporation committee on gas and electric lighting, and an enthusiastic advocate of the electric light. Messrs. Anderson and Munro have carried out the electrical work.

GUILDFORD.—At their meeting last week the Town Council adhered to their intention of objecting to the application of the Holloway Electricity Supply Company (Limited) for powers to undertake the supply of electric current within the borough. In the report of the General Purposes Committee, discussed at the same meeting, it was pointed out that the Council may shortly take into serious consideration the question of themselves undertaking the lighting of the borough by electricity.

LARNE.—The Town Commissioners have received a communication from Mr. J. W. M'Ninch, solicitor to the Board, from the terms of which they have come to the conclusion that they cannot safely enter into a contract for the lighting of the town with Mr. Norris, the liquidator of Messrs. J. E. H. Gordon and Co. A proposal has, however, been made to Mr. Norris, which may prove a solution of the present difficulty.

LEEDS.—The Yorkshire House-to-House Electricity Company (Limited) have, in consequence of the increasing demand for current, decided upon extending the Company's works, and the necessary tenders are now being invited. It is proposed to instal two additional 400 I.H.P. engines, with other plant to correspond. Mr. R. Hammond is consulting engineer, and the architects are Messrs. Milnes and France, Bradford. Commencing on April 1st next, the Company have decided to make reductions in the price per unit as follows:—Up to 1,000 units, 7d. per unit; beyond 1,000 up to 1,500, 6¾d.; up to 2,000, 6½d.; up to 2,500, 6¼d.; beyond 2,500, 6d.; subject to discounts of from 5 to 20 per cent., and subject to further discounts for prompt payments. By the new price list, a consumer using above 2,500 units, and paying his account within one month, obtains his current at 4½d. per unit. The works in Whitehall-road, Leeds, will only have been in operation eleven months at the date of the reduction coming into force.

LEEDS.—The Leeds Photographic Society held their annual exhibition of lantern-slides in the Albert Hall, Leeds, last week, when about 250 slides were shown upon a 22ft. screen by means of an arc lamp in the lantern, and this method of lighting was pronounced a decided improvement upon anything previously attempted by the Society, who have from year to year adopted various methods of lighting, more or less successfully. It will be remembered that a fatal accident recently happened in using an oxygen bottle lantern, and doubtless audiences attending these shows will feel greater security when the electric light is adopted, as in the case at Leeds. The lamp used was designed by Mr. Borland, and fits on the ordinary tray of the lantern in a similar manner to the limelight burner. The exhibition was a success, the whole of the screen being fully illuminated, notwithstanding its large size.

LLANDRINDOD WELLS.—In reference to the proposed electric lighting of this district, the Local Board have received a proposal from a contracting firm to put down a temporary plant as an experiment, and they have discussed the proposal. The Board have again deferred the consideration of the matter.

LONDONDERRY.—Citizens who are interested in the veterinary inspection of cattle are urging the Londonderry Port and Harbour Commissioners to introduce at once the electric light, which has already been sanctioned by the Veterinary Department of Dublin Castle. It is feared that unless Londonderry promptly takes the matter in hand, breeders and shippers will transfer their business to Belfast, where veterinary inspection by electric light is permitted. A suggestion was made that it was desirable that the Port and Harbour Commissioners should approach the Corporation, with the object of inviting them to undertake the lighting of the quays by electricity.

——— The Electric Lighting Committee of the Corporation discussed on Tuesday the desirability of applying to the Local Government Board for an advance of a further sum of £5,000 in connection with the electric lighting scheme, which is to be extended, the extensions including a further 60 arc lamps beyond the 160 already in position. The electric light has to face severe opposition in Derry, but so far the estimated cost has been so nearly confirmed by actual practice that the opponents of the electric lighting scheme have made little headway. The Corporation's contribution to the local gas company's funds is £2,500 a year, and it is estimated that the working expenses of the electrical installation will only be about £1,400.

MANSION LIGHTING.—Her Grace the Duchess of Montrose was present at the recent inauguration of the electric light at Chatsworth, and, as a result, has decided to entirely rearrange the electric lighting at her London house in Belgrave-square. The work has been placed in the hands of Mr. B. Drake, of Messrs. Drake and Gorham.

MONTREAL.—In the summer of 1893 a meeting was called at Montreal of prominent members of the electrical profession, and it was decided to form an electric club. This club has now been duly inaugurated, and we have this week received a copy of the constitution and by-laws. The club consists of gentlemen actively engaged in various branches of electrical work, and third and fourth-year students at the McGill University, &c. Associates comprise managers of electrical firms and members of other branches of the engineering profession.

NEWPORT.—The Parliamentary Committee of the Corporation held an adjourned meeting on Tuesday afternoon last to consider the report on the electric lighting scheme, which was referred back to them by the Council, to enable them to make further inquiries into the tenders received, with particular reference to the tenders of Messrs. Crompton and Co. and Messrs. John Fowler and Co. Nothing was definitely decided, except that the committee are instructed to accept the invitation of Messrs. Crompton and Co. to visit the works just completed by them at Chelmsford, and also, if possible, one of their latest installations in London. It is anticipated that a definite recommendation will subsequently be adopted by the Committee, and placed before the Council for acceptance.

NORTHAMPTON.—An exhibition of domestic and other electrical appliances has been held in the Town Hall during this week. This was the first electrical exhibition of any kind held in the town, and attracted considerable attention. It was held in aid of the funds of two deserving Northampton charities. Mr. H. J. Dowsing (of Messrs. Crompton and Co.), and Mr. W. E. Heenan, Manager of the Northampton Electric Light Company, gave an attractive demonstration of cooking by electricity, and explained the uses of a variety of electrical appliances, motors, cooking stoves, &c. Short lectures were delivered at intervals by Mr. Dowsing, to the delight of large audiences. There is probably no

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feature of such shows in which the public take a greater interest than in the application of electricity to domestic uses.

OSWESTRY.—The draft Provisional Order of the Oswestry Electric Lighting Company has been under the consideration of the local authorities, and certain objections and suggestions made by the Town Clerk have been forwarded to the Board of Trade for their consideration. The Town Council recommend—(1) That the Board should satisfy themselves as to the ability of the Company to carry out the works; (2) that all works of opening up and reinstating streets should be done by the Corporation and not by the Company, and at the expense of the Company, and that the latter should deposit £100 as a guarantee that the expenses incurred should be paid, and that there should be a like provision for the water mains; (3) that the cost of lighting the street lamps should not exceed 5 per cent. profit on the Company's capital; (4) that a strict audit of the Company's affairs should be provided as specified; (5) that the Corporation should be at liberty to take over the works at 30 and 35 years instead of 42 years; and (6) that additional streets should be lighted beside those in the original draft. In a discussion which arose at the last meeting of the Council, when the proposal came up for ratification, it was especially stated by all the members who spoke that opportunity should be given to the local company to proceed energetically with the work, and that no obstacle should be placed in their way by the local authorities.

PLYMOUTH.—In order to provide an alternate means of lighting the magazines and shell rooms of large vessels, in case the bulkhead electric light should break down from any cause, the Admiralty are carrying out experimental trials with various patterns of electric hand lamps. The Cambridge Gunnery School at Devonport are trying the Bristol lamp, the Pitkin lamp, and a portable lamp made by Mr. Marsh. A report is to be prepared and submitted to the Admiralty.

RADCLIFFE.—The Local Board has instructed Mr. F. F. Bennett, M.I.E.E., of Messrs. Bennett and Druce, Preston, to prepare a report and estimates, and to recommend a system of electric lighting for the district.

SHERBORNE (DORSET).—An interesting lecture was given on Monday last at Horsington by the Rev. J. D. C. Nickham, assisted by Mr. W. Goodland, of the Sherborne Electric Installation. A number of exhibits were shown, including high-tension apparatus, Bristol accumulators, experimental fuses, &c. Reference was made to the recent discovery of petroleum springs near Horsington, which are, we learn, to be energetically developed.

STIRLING.—The Caledonian Electric Supply Company, whose application for a Provisional Order for the lighting of Stirling meets with the opposition of the Town Council, have applied to the Board of Trade, asking that the consent of the Council should be dispensed with, on the plea "that the memorialists believe and aver that the Corporation has no *bonâ fide* intention of applying for an Order next year, with a view of working the same." The memorial points out that two similar applications have been refused by the Council in former years. Answers are to be lodged by the Town Council in due course against the memorial.

VENTNOR.—The Works Committee of the Local Board have requested the Town Clerk to obtain information regarding the introduction of the electric light into the district, and he is to prepare a report for the next meeting of the Works Committee.

WOKING.—As no tender other than that of the local electric lighting company was received for the public lighting, that Company's tender has been accepted.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

January 1, 1894.

4. A. E. SCHURR. Leigh-on-Sea. Improvements in electricity meters. (J. Cauderay, Switzerland.)
6. G. BINSWANGER. London. Electrically-heated brands and stamps.
12. A. W. STEWART. Dumbarton. Improvements in electrical indicators.
46. W. R. SYKES, Jr., and A. G. EVANS. London. Improvements in electrical apparatus for controlling traffic on single lines of railway.
57. W. A. JOHNSTON, A. W. BROWNE, and J. C. DAVIDSON. London. Improvements in electric-motor apparatus.*
62. J. A. KINGDON. London. Improved method of and apparatus for synchronising alternating-current dynamo-electric machines, and switching them on and off mains.
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January 2, 1894.

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COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Company (Limited).

The forty-third half-yearly ordinary general meeting of the Eastern Telegraph Company (Limited) was held yesterday (Thursday) at Winchester House, Old Broad-street, under the presidency of Sir John Pender, G.C.M.G., M.P.

The SECRETARY (Mr. George Draper) read the notice calling the meeting, and the minutes of the previous meeting, which were confirmed by the present meeting and signed by the Chairman. The report of the Directors was taken as read.

The CHAIRMAN stated that the gross revenue for the half-year under review, to September 30th last, had amounted to £369,967, or an increase of £17,576. Analysing the receipts from various sources they found an increase of £28,123 in the message receipts. There was an increase in the traffic with most of the different places, the principal being in the traffic with the Cape, India, and beyond. The total ordinary expenses for the half-year to September 30th amounted to £98,106, or a decrease of £691. The general expenses in London had been £9,255, or an increase of £135, and the working expenses at stations had been £75,707, or an increase of £1,221. Several of the items under this head showed substantial decreases. The principal increase was in salaries and wages of their staff at stations, £2,439, there being an increase of thirty-two clerks compared with the corresponding period of last year. This, together with the operation of the scheme to provide regular promotion to deserving *employés*, which had been fully explained at previous meetings, accounted for the increase under this head. Comparing the other items in the revenue account, they found a reduction of £989 for special repairs to buildings at Alexandria, &c. The repairs being completed, this account was now closed. There was also a decrease of nearly £1,000 in the amount carried to maintenance ships' reserve fund. They had carried as much to this account as in the previous half-year, but the difference had been subscribed by other companies hiring this Company's ships from time to time. The expenses attending repairs and renewals of cables had amounted to £31,906, or a decrease of £5,730. They had received during the half-year over £20,000 for the hire of their ships for cable-repairing purposes. They had also been fortunate in not having to expend so much cable in effecting repairs, so that although they had had five ships more or

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less busily employed during the half-year, the cost of maintaining communication had been less than for some years past. After providing the usual amount for interest on debentures and debenture stock they were able to pay the usual interim dividend for the half-year at the rate of 5 per cent. per annum, and to carry forward the substantial sum of £86,252, which was the largest amount they had ever carried forward. He thought they would be satisfied that economies had been effected, and that the whole concern had been very closely and carefully watched. They had applied a further sum of £35,505 from the reserve fund in reduction of the cost of the Aden-Bombay No. 3 cable and other expenditure, so that their capital expenditure on account of cables, landlines, &c., practically remained at the same figure as it did eight years ago. The total amount applied from the reserve fund from time to time now amounted to £1,922,000. This was a very large sum to take from the reserve fund, but it was practically working for the benefit of the Company. They had duplicated and triplicated their cables without increasing their capital, and they had thus placed the Company in as strong a position as it was possible for it to enjoy. They still had a large reserve fund. He thought they would regard the statement which he had made as a very encouraging one, but it had not been arrived at without great attention and care on the part of the staff and those who managed the staff. The Directors had been very modest in their demands as regarded any increase of remuneration. On the death of the late Managing Director the management of the Company was to some extent reconstructed. The arrangements made had entailed on the Company an additional charge of over £300, a very small sum, although he thought that the efficiency of the Company had been maintained and strengthened in every way by what they had done. The Directors were now working for at least £1,000 less than they were entitled to by the Articles of Association, but they might hereafter ask the shareholders to approve of a larger sum for the Board. At the same time he hoped he would be in a position to justify their making such a request, because they would not ask for anything further unless they improved the position of the shareholders simultaneously. They would find on reference to paragraph 5 of the report that the cables connecting Lisbon and this Company's general system with the Islands of the Azores was laid and opened for traffic in August last. This Company had taken a large interest in that cable, but, as he had told them before, they had received a *quid pro quo* by getting an extension for ten years of the exclusive rights which they had possessed for many years at Lisbon. They would, probably, be able to add to the revenue of the Company by the Azores cable. The Eastern and South African Company had laid the cable from Zanzibar to Seychelles and Mauritius. That Company received for this work a subsidy of £28,000 a year. The Eastern Company were, however, practically holders of all the stock in the South African Company. He could not tell them much of the results of the working of this cable yet, but so far as it had gone it had not disappointed them. They had effected an important saving by a change they were making in the Levant. The Island of Zante had been subject of late years to violent volcanic eruptions. Fortunately, their station had so far always been saved, but if another outbreak occurred it might be interrupted, and thus cause serious inconvenience to the working of their system. They, therefore, decided to remove the work done at Zante to the island of Syra, where they also had an important station. They estimated that this would effect a saving of from £1,700 to £2,300 a year, and he thought they would have greater stability and security for their general system. The work which he had at the last two or three meetings informed them was in hand had now all been successfully carried out, and had added strength to their position, and had helped them to reach the sound and proud position occupied by them at the present time. Telegraphy, too, must go on. It would be their business to strengthen the system as much as they could, and wherever the British flag flies, wherever British commerce could show that it was to the benefit of this Company to be connected with it, they would make a great effort to make such connection. They had succeeded so far in connecting almost every part of the civilised world with their system. Their existence had been a comparatively short one, for they had not yet been 25 years in existence. They had, however, done an enormous work, the value of which was best tested by the opinion the investing public held of it. The £100 Four per Cent. Debentures issued by their Company were worth that day about £116 in the market. He had given them a very rosy description of the Company's position, but at the same time they had skeletons in their cupboard, as well as other people had. They had, for instance, the difficulties of the exchange, and the silver question very materially affected the remittances they received from abroad. They endeavoured to meet this by inducing the countries to allow an increase in the rate when they lost by exchange, but they could never do this to the full extent. They had to give a thoroughly efficient service, while at the same time they could not be too exacting upon commerce. As long, however, as the Directors could submit such a satisfactory account as that which related to the past half-year's working, he thought that the shareholders would agree that the Company was doing fairly well. He concluded by moving—

"*That the report and accounts of the Directors to September 30, 1893, submitted to this meeting, be and are hereby received and adopted.*"

The VICE-CHAIRMAN (the Marquis of Tweedale) seconded the motion.

Mr. BAINES said he thought that the shareholders ought to receive something to represent the large amount which had been expended on the property out of the reserve fund, and he thought that shares might be issued for the purpose. The shareholder would then be able to get the benefit of the improved position of the Company if he chose to sell. The property had increased in value, but the shareholders had nothing to represent it. He also inquired whether, in the event of war, the cables were in any way neutralised.

Mr. JOHN NEWTON said he considered that the addition to the directors' remuneration mentioned by the chairman was a very modest one, although if it had been proposed 20 years ago he would probably have opposed it. However, having had 20 years' experience of what the directors had accomplished for them he now desired to say that he entirely agreed with the increase. He referred to the sound investments forming their reserve fund, and contrasted them with what had been acquired by directors of certain other companies, of whom so much had been heard of late. He thought that the reserve fund and the market value of the shares constituted a substantial representation of their property, and this had arisen from the satisfactory dividends that had been paid. He was interested in some of the shares at the low prices of 7¼ to 8, at which they used to be quoted.

The CHAIRMAN, in reply, said that the legal adviser of the Company informed him that the suggestion made by Mr. Baines was illegal. Large dividends were desired generally by shareholders, but he would point out that they were working a system respecting which they had a good deal to learn yet. They could see how a railway was working and where it was undergoing depreciation, but they could not say so much yet with reference to submarine cables. It was, therefore, wise in the interests of the shareholders, and prudent on the part of the Directors, to increase the reserve fund, so that they might not be placed in the position, if they required to renew a cable, of not having the means to carry out the work. As Mr. Newton had intimated, the shares had about doubled in value; but the shareholders could not have their property doubled in value and the increase of dividend at the same time. They paid a steady dividend of 5 per cent., and at the end of their year they had hitherto given a bonus of 1½ per cent. He thought they would continue this, and he would be delighted if they could prudently increase the bonus. With reference to the question asked by Mr. Baines, he (the Chairman), many years ago, went and saw a gentleman of very high position at the Foreign Office. He asked that gentleman whether he would agree to sign a document, getting the nations of Europe to neutralise the cables in time of war. The reply he received was, "I will sign it to-morrow; but if a war occurred the naval or military officer who commands at the spot would break it." He only hoped, however, that they would not be destroyed, although there was the power to do so. He thought the cables would be used to a very great extent either in war or peace; but they were made for peace.

The resolution was then carried unanimously.

On the motion of the Marquis of Tweeddale, seconded by Mr. George Garden Nicol, Sir John Pender was unanimously re-elected to his seat at the board, as was also, subsequently, Mr. Charles W. Stronge, C.B., on the motion of the Chairman, seconded by Lord Sackville A. Cecil.

Mr. JAMES GIBB afterwards proposed, and Captain Goodsall seconded, the re-election of the retiring auditors, Messrs. Deloitte, Dever, Griffiths & Co., and Messrs. Walton, Jones & Co.

The CHAIRMAN remarked that their accounts were audited not only every six months, but, practically, continuously by the firms in question.

Mr. BAINES then proposed, and Mr. W. Griffith seconded, a vote of thanks to the Chairman, Directors, and Staff for their efficient administration of the Company's affairs.

The resolution was carried unanimously.

The CHAIRMAN, in acknowledging the vote, said that there was nothing pleased him more than to find that the shareholders appreciated the work done by the Directors, and he was glad to find their work recognised, especially by those shareholders who in former days used to hit very hard in their criticisms. They had a machine which was working harmoniously in all its parts.

(We shall publish a full report of this Meeting in our next issue.)

Direct United States Cable Company (Limited).

The thirty-third ordinary general meeting of this Company was held at Winchester House, Old Broad-street, on Tuesday, "to receive the report of the Directors and the accounts for the six months ended December 31st, 1893, and to transact other business of the Company." The chair was taken by Sir John Pender, G.C.M.G., M.P.

The SECRETARY (Mr. T. Finnis) having read the notice convening the meeting and the minutes of the previous ordinary general meeting, which were confirmed,

The CHAIRMAN said: Gentlemen, you have had the report in your hands for some days, and I presume you will take it as read, but before I ask you to adopt it, I will, as usual, go over some of the details of the last six months' working, so that you may probably have a better idea of what we have been doing than even the report gives you. The revenue for the half-year to December 31st last, after deducting out-payments amounted in round pounds to £41,052, and the working and other expenses, including income tax, to £19,060, leaving a balance of £21,992 as the net profit for the half-year, making, with £819 brought forward from the previous half-year, a total of £22,811, which has been appropriated as follows:—Interim dividend of 3s. 6d. per share for the quarter ended September 30th last, £10,624. 5s.; interim dividend of 3s. per share for the quarter ended December 31st last, £9,106. 10s.; balance carried forward, £3,080. 10s. 10d.; making a total in round figures, as above, of £22,811. The revenue, as compared with that of the corresponding period of 1892, shows a falling-off of £2,577, owing to the severe commercial depression which has prevailed, and to the interruption of several of the Atlantic cables. The expenses in London remain practically unaltered. They are, on the whole, within £72 of the same amount as in the corresponding period of 1892. The expenses at stations show as follows: Increases of £177 in wages, £66 in rent and taxes, £26 in travelling, and £52 in repairs, these increases being chiefly due to the working

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of additional stations. On the other hand there are reductions of £54 in maintenance, £31 in petties, £64 in printing and stationery, and £123 in agencies, these disbursements on the whole showing an increase of £38 for the six months. In the remaining expenditure the only difference to note is an increase of £80 in income-tax, due to the higher rate of assessment. A comparison of the half-year's expenditure on the whole, but excluding the item of income-tax, shows the total to be within £2 of exactly the same amount as in 1892. It may, perhaps, be mentioned here, that, differing considerably from railway and many other companies, this Company is bound not only to keep the whole of its through system in full and continuous running order, but also to keep it all times fully and efficiently manned, whether business be brisk or slack. Consequently the ordinary working expenditure is not affected so largely as might be supposed by fluctuations in traffic one way or the other. As a matter of fact, however, the Company has carried considerably more traffic during the past six months than it did in the same period of 1892, although its share of the joint receipts has been less. The reserve fund, increased by the interest on the investments £3,979. 18s. 3d., now stands at £271,395. 10s. 10d. The investments, standing in the balance sheet at a cost of £234,152. 13s. 7d., are worth at present market values about £257,000, or 10 per cent. above cost. You will therefore see that the investments, as far as they are concerned, have been well made, and have stood the test of the bad times through which we have passed, and that they are to-day 10 per cent. better than when we invested in them. Before asking you to approve of the report, after having given you these details, I think it is also desirable to give you practically as much information as we ourselves possess, not only with regard to the present and the past, but also with reference to the future. I may mention that the December period, which is only the first half of our financial year, is always much more profitable than the period to June 30th. Notwithstanding this, and even with the reduced dividend, we are only able to carry forward to the poorer half-year, be it remembered, a balance of £3,080, or, allowing for the amount brought into the account from the previous half-year, a balance of only £2,261, and this without any provision whatever for the reserve fund. Now, you are aware that our shares are £20 shares, and the market price of them to-day is £11. I think it is right that I should tell you, looking to the coming year of Atlantic traffic, that every provision is being made for conducting the traffic in a thoroughly satisfactory way. Two new cables are going to be laid down. The Anglo-American Company are going to lay down one and the Commercial Company the other, so that, as far as the public service is concerned, it will, perhaps, be done more efficiently, if that be possible. I believe that the cable which is to be laid by the Anglo-American Company will probably be the best that has ever been laid in the Atlantic. It will be a very large carrier, and I hope that it will add to the "pool." The exchequer is the thing, after all, that we have to look to, because it is through that exchequer that I appear before you to-day in declaring our dividend. I may also mention that during part of the last year, out of the ten cables working in the Atlantic, several have been interrupted, and four are down at the present time, three of them being "pool" cables. If these cables had been working and earning and adding to the "pool," probably we should not have reason to reduce your dividend to-day by the ½ per cent. that it is diminished by; but I always think it is better to be wise, if we can, beforehand, and I thought, and my Board entirely agreed with me, that by reducing our dividend now, and carrying forward a larger sum, we should strengthen the value of your property more than if we had paid you a dividend "up to the hilt." We believe that the latter course would rather have lowered the value of your property instead of strengthening it, as we believe it will be now by the larger sum we carry forward, These three cables being out of working order have materially affected the earnings of the "pool," but, in view of the new cables that are about to be laid, I am hopeful that we may, perhaps, show a better result in the current year. I do not want to be too sanguine, and I do not like the look of things just now. We have not got through all our troubles commercially; and while we have held our own probably better than most other companies in existence in London during these hard times, still I do not like the continued depression. Although we may see some slight signs of improvement at the present time, still it will take a considerable time to get back into our old prosperous days. When I last addressed you I referred to the state of things in America. It was very bad then, and things have been very much worse since, but I think we see now a little more sunshine appearing, and I am hopeful that the traffic between America and this country may be benefited in consequence of that improvement. I have had a letter from one of the shareholders, and only one letter, but I think it is right that I should refer to it here. This gentleman complains very much about our reducing our dividend from 3½ per cent. to 3 per cent. He thinks that we ought to have done many things before we reduced our rate, but no one can eat his cake and have it too. If we have maintained, as I hope, the value of your property, you cannot have it in dividend as well, but this difference in dividend is not thrown away or wasted. You see where it is. This gentleman speaks of the miserable dividend we are paying, but I have gone into this matter, and I find that the bulk of the present shareholders possess their shares at something nearer £10 than £20, and consequently there has been no "miserable dividend" paid to our shareholders. During all this time we have paid upon the £20 shares a dividend averaging 4 per cent., and that upon £10 to £12, within which prices the great majority of shares have been acquired, gives from, say 8 per cent. to 6⅔ per cent., and that has been the return paid by us during the past 16½ years. The gentleman who has written this letter proposes to come to our next half-yearly meeting and take you all into his confidence, and get you to turn against the Directors for the great mistake, as he regards it, that they have made in reducing the rate of dividend to-day; but I would tell him that we who sit on this side of the table have to look ahead. I say that it was more prudent to carry this amount forward, and to pay the smaller amount of dividend, seeing that it is not a bad dividend on the cost of the shares. I may also go back and say a little more about the history of this Company. When the present Board joined it, the Company had been four years in existence, and no dividend was paid at all, and a debt of something like £100,000 was incurred. What have we done since we became your Directors? We have not only paid you for a large portion of the time 5 per cent. upon the £20 share, but we have passed through some hard times. The sixpenny tariff, for instance, cost us £25,000, the removal of our cable to Halifax cost £23,000, and we have had some heavy repairs. Remembering also the reserve fund that we have formed, and that we possess to-day, I think that our record on this side of the table is one that ought to be applauded rather than depreciated. At the same time we do not object to being pulled up if we are retrograding in any way, but I am quite sure that the step we have taken at the present time, seeing that the money is not wasted, is a step which the common sense of the body of the shareholders will approve. As you are carrying these figures away with you, I may also mention a few more, for I think it is worth while for you to know them. Since we took over the Company in 1877 we have paid in dividends £783,159; we have paid for cable repairs £165,000; the debentures and loans we have wiped out amount to £100,000; and the reserve fund amounts to £271,395. Those sums added together make a total of £1,319,554. This is a very good statement to make, I think, and one which I feel quite sure will be appreciated by the body of the shareholders. Before closing my remarks I may say a few words with respect to the position and prospects of cables in the Atlantic. I have already said that there are four cables down, and that there are six which are in operation. I believe that these six cables, working duplex, as they ought to do if they are in perfectly good order, are about equal to the work of the Atlantic at the present time. The putting down of the new cables is burdening capital with the amount of their cost, which will be nearly £1,000,000 for the two. At the same time the telegraphing public will benefit, although I do not myself think that a field which is over-supplied with the machinery that is necessary for conducting the business has a bright prospect of a large increase. Looking at the history of telegraphy, its progress for a time was something like 10 per cent. per annum, but during the past 20 years, with the changes we have seen in the tariffs, and in one thing and another, we have never yet got up to the £1,000,000 which we thought ought to have been attained many years ago. We are at a sort of standstill at the present time, and that standstill must continue as long as we have more cables in the Atlantic than are required for doing the work; but at the same time, it is almost as impossible to give up telegraphing across the Atlantic as it is to stop time from moving. Telegraphing has become a great necessity now, and we have touched a point in rates so low that the capital invested, in my opinion, looking at the number of cables that there are likely to be, will not meet with a very largely increased dividend. I shall be satisfied if we can maintain the position we hold at the present time. The time will come when we may require to lay another cable too. Our cable is getting to an age which must make us look to the laying of another. I think that, looking at the value of our stock and at the fact of our reserve fund amounting now to nearly £300,000, there is no cable in the Atlantic at the present time that holds a better position than ours; and if the time should come when the rates have to be lowered, I think that our system is worked in a way so economical that we shall always be able to take a leading part and obtain our share of the Atlantic traffic. I think I have now made nearly all the remarks I had to submit to you on the present occasion. As a rule I look to the bright side of the picture, and looking at the bright side of it to-day, so far as regards the work to be done in the Atlantic by the cable companies, I believe it will be well done, and done in such a way as will conduce to the benefit of the shareholders as well as to that of the telegraphing public. I now have to move the following resolution:—

"*That the report of the Directors, dated January 9, 1894, together with the statement of accounts to December 31, 1893, annexed thereto, be and the same are hereby received and adopted.*"

Mr. E. M. UNDERDOWN, Q.C., seconded the motion.

Mr. RUSSELL ENDEAN said that he had listened with much patience to the Chairman's statement and explanation why the dividend had diminished, but he would propose an amendment that the dividend on this occasion should be 3s. 6d. per share, as usual.

The SOLICITOR (Mr. Godlee) said that the shareholders could not increase the dividend recommended, according to the Articles of Association of the Company.

The CHAIRMAN: Perhaps you will give us your reason for wishing to increase the dividend.

Mr. ENDEAN said that the difference of giving a dividend of 3s. or 3s. 6d. was covered by about £1,500, and if there were ample funds to give the 6d. extra dividend, and still to carry over a balance of more than £1,500 to next half-year, there could be no particular reason why 3s. 6d. should not be paid this quarter, as usual.

Mr. UNDERDOWN: Article 95 says, "No larger dividend shall be declared than is recommended by the Directors; but the Company in general meeting may declare a smaller dividend."

The CHAIRMAN: Probably your opinion might be a guide to us next six months; but we who are sitting at this side of the table consider matters very carefully. We have shown you what the Board has done during the past 16½ years. We have worked faithfully and honestly for you, and we have built up a concern which is valuable. Surely we must be the best judges as to whether it is a wise proceeding to reduce or to increase the dividend at any particular time. We have not thrown away your money; you see where it is. The small amount that you refer to would be very small indeed in the pockets of the shareholders; but it is a largish portion for us to add to the reserve fund. There is another reason for what we have done. After all, this as an investment is a little uncertain. We cannot control cables laid in the Atlantic. It is not like a railway, and we must

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look ahead. There has been a great deal of talk about our reserve funds. Our reserve funds, however, have been the making of these companies, and I am quite sure that you will find your property stronger through carrying this amount forward than even if you got your 3½ per cent.

Mr. ENDEAN said that if the dividend had been 3s. 6d., as usual, this time, no ill effect would possibly have been seen as regarded the market price of the shares, but in his opinion the giving of a 3s. dividend only, coupled with the statement just made by the Chairman relative to the prospects of Atlantic telegraphy, must operate to reduce the value of the shares, if they operated at all; and, therefore, he considered it most important that there should be no reduction in the dividend on the present occasion.

The CHAIRMAN: Does any other shareholder wish to ask any question? If not, I will put the resolution, but first let me say that there is no greater pleasure that a Board can have than to add to the dividend, and it gives them a considerable amount of thought when they reduce it. We have reduced it this time by a very small amount, but during the hard times we have passed through we have had on more than one occasion to draw something from our reserve fund in order to supplement the dividend. We have been particularly careful of the interests of the shareholders, and particularly anxious to give them as full a dividend as we considered ourselves justified in paying. The investments forming the reserve fund, to which I have referred, and which are stated in our report, are all good, and of better value than when we bought them; and you will also find that during all the hard times that we have passed through, this Company's shares stood the test of the market, while the shares of other companies went down "hand-over-hand." He then put the resolution, which was carried unanimously. Continuing, he said, I may add, gentlemen, that the present is only an interim dividend. I shall be delighted when we get to the end of this year if we can recoup what we have taken away from you this time. You may depend upon it that it will be a very great pleasure to us if we can do it.

Mr. JOHN NEWTON proposed a vote of thanks to the Chairman and Directors. No one else had thought proper to make any remark with respect to the reduction in the dividend, and for his own part he was glad that the Directors had taken the view they had, and had thus strengthened the value of the Company's property.

Mr. ENDEAN seconded the motion, which was carried unanimously.

The CHAIRMAN: On behalf of my colleagues and myself I thank you. I may say that we have had a good deal of experience in managing telegraph companies, and upon the whole I think that those which we have had to do with have been, in the main, very successful. It is a grand thing to have a good account at your bankers, and it adds immensely to the stability of a company. It encourages not only those who are managing the concern, but it is also very encouraging to shareholders to know that there is a reserve in case of any hitch taking place. We are in such a position that in the event of a hitch occurring we are prepared to meet it.

The proceedings then terminated.

St. James' and Pall Mall Electric Light Company, Limited.

The following is the report of the Directors of this Company for the year ended 31st December last, to be submitted to the shareholders at the meeting to be held at the Offices, Carnaby-street, Golden-square, London, W., on Tuesday, the 30th inst., at three o'clock:—

The Directors annual report for 1893, and the accounts accompanying the same, have been duly placed before the Board of Trade.

The judgment in the action brought against the Company by Dr. John Hopkinson in connection with the infringement of his three-wire patent was only delivered on January 14, 1893, the day of the issue of the last annual report. The Company, in resisting Dr. Hopkinson's claim, were acting in conjunction with the London Low Tension Supply Companies generally. The Directors, after fully considering the effect of this judgment in consultation with their experts, deemed it better to compromise with Dr. Hopkinson rather than run the risk involved in further litigation. They are happy to report that a compromise was effected on very favourable terms, under which the plaintiff waived his costs and granted a licence to the Company for the remaining term of the patent and any extension thereof. The cost of the licence and the proportion of law expenses attributable to this Company, amounting together to £4,446. 8s. 9d., is considerably less than the additional sum that would have been expended on the mains had the Hopkinson system not been adopted. This expenditure has therefore been carried to capital account. During the year the Company has also been involved in litigation with certain holders of founders' shares, who claimed a moiety of £2,000 forming the basis of the "Redemption Fund." This they successfully litigated, and one-half of the £2,000 has been divided amongst them. The other thousand pounds has been carried to the "Ordinary Shareholders Undivided Profit Account." The decision of the Court prohibits the Directors from following a policy which all four judges who heard the case approved, and which was directed to conserving the assets of the undertaking for the benefit of the shareholders generally. It is obvious that the ordinary shareholders should not be asked to build up a Redemption Fund in which it is possible that the founders might ultimately participate to the extent of 25 per cent. under clause 122 of the Articles of Association of the Company. An action brought by the Windham Club was settled upon terms satisfactory to the Company.

Having regard to the increasing demand for current, and for other reasons, it has been deemed necessary to arrange for an enlargement of the Carnaby-street Central Station, and in view of this the Company has purchased land on the north and south sides of that station. Plans for this extension are being got out. The Directors are considering the issue of debenture stock under the Company's borrowing powers to provide the necessary capital.

At the commencement of the year, the Company which possesses concurrent powers in the Parliamentary area allotted to this undertaking, started a system of competition which the Directors regret to report led to a reduction of price of supply with a consequent decrease of income. This reduction the Directors resisted as long as they could prudently do so, but it became clear in the spring of the year that unless they were prepared to lower the cost of supply they would lose the business that had been built up during the last few years. It is an encouraging feature, however, that the number of the Company's customers has largely increased. From this and other factors working in the Company's interest, the Directors believe they may safely hazard the opinion that the diminution of dividend is temporary only, and that in future years the income of the Company will justify a larger return to the shareholders.

The coal crisis which has affected so many classes of trade detrimentally has not affected this Company, for the reason that they had previously secured a contract, continuing until the end of March next. They are also pleased to rep rt that the cost of producing the current has not been increased, but is something below the figures of last year.

The shareholders will observe that the securities representing the "Capital Reserve Fund" have been altered. This was done to enable the Company to enjoy a larger rate of interest than they could under the original investment. It will also be noted that, although the "Redemption Fund" no longer exists, the securities representing it had not been sold. The amount is invested in Bank stock, which has depreciated, and the Directors, being of opinion that this depreciation is only temporary, do not feel it desirable to realise at existing quotations

The year has been one which has given the Directors much extra work and considerable anxiety, and they trust that the fruits of their efforts to protect and conserve the interests of the Company may show themselves in future years.

The net earnings of the Company during the past year have amounted to £10,552. 2s. 7d. Of this sum £3,500 was distributed in July last in payment of an interim dividend at the rate of 7 per cent. per annum for the half-year ending June 30th, on the preference shares. The balance £7,052. 2s. 7d., together with the undivided profit of £63. 16s. 2d. from last year's account, and, the £1,000 carried from the "Redemption Fund Account" to "Ordinary Shareholders Undivided Profit Account" leaves £8,115. 18s. 9d. now to be dealt with and the Directors propose to divide this amount as follows:—

	£	s.	d.
A dividend at the rate of 7 per cent. per annum on the Preference shares for the second half of the year	3,500	0	0
A dividend at the rate of 4½ per cent. per annum for the year on the Ordinary shares....................	4,495	10	0
Forward to "Ordinary Shareholders' Undivided Profit Account"................................	115	19	7
Carried forward to "Founders' Undivided Profit Account" per last year's report and accounts	4	9	2
	£8,115	18	9

The Directors consider that the amount set aside for depreciation in addition to the expenditure on renewals, repairs and maintenance is sufficient.

The Chairman, Mr. Eustace Balfour, and Mr. Latimer Clark, F.R.S., retire by rotation, and being eligible, offer themselves for re-election as Directors, and the Directors propose to nominate Mr. Bennett Fitch, M.I.C.E., for election as an additional Director. The Auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and, being eligible, offer themselves for re-election.

City and South London Railway Company.

The following report of the Directors of this Company will be submitted to the half-yearly ordinary general meeting, to be held at Winchester House, E.C., on Thursday next, February 1st, at 12 o'clock:—

The receipts from all sources for the past half-year have amounted to £22,821. 7s. 9d., and the cost of working has been £14,761. 11s. 3d., leaving a profit of £8,059. 16s. 6d. Inclusive of the balance brought forward from June 30th last, the net revenue account shows an aggregate total of £8,927. 10s. 7d. After making provision for the debenture and debenture stock interest, a balance remains available for dividend of £4,792. 8s. 10d. Out of this sum your Directors recommend the full dividend of 5 per cent. per annum be paid on the Preference shares, and that a dividend at the rate of § per cent. per annum be paid upon the Consolidated Ordinary stock, leaving a balance of £1,063. 13s. 10d. to be carried forward to the next account.

The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway in each half-year:—

Half-year.	Number of Passengers.	Receipts (including season tickets). £	s.	d.
Ended December 31, 1890 (11 days)......	165,000	1,568	3	9
" June 30, 1891	2,412,343	19,403	6	9
" December 31, 1891	2,749,055	19,798	16	6
" June 30, 1892	2,813,162	20,931	4	2
" December 31, 1892	3,117,602	22,002	17	5
" June 30, 1893	3,146,656	22,458	6	9
" December 31, 1893	3,095,351	22,067	14	10
Total since the opening of the line...	17,497,169	£128,230	10	2

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The traffic for the past half-year was prejudicially affected by the long continuance of exceptionally fine weather, and by the closing of Kennington Oval for the purpose of relaying the turf, so that no football matches have been played there this season. These causes, added to the general depression of trade, have caused a slight diminution in the number of passengers carried, but notwithstanding this the general revenue receipts show a small increase over the corresponding period of last year, and the cost of working has been further reduced in spite of a considerable addition which has again been made to the local rates.

The locomotives, rolling stock, generating and other plant have been adequately maintained, and are in efficient working condition. The additional rolling stock referred to in the last report is in course of delivery. The new sidings at the Stockwell Station are now in use and prove a great convenience in working the traffic. The alterations at the King William-street Station are nearly completed. These will greatly enhance the comfort and convenience of passengers, and, at the same time, provide a ladies' waiting room, and a room for left luggage and parcels, which will be a source of revenue to the Company.

In the course of the half-year £32,200 of the terminable 5 per cent. mortgage debenture bonds have been paid off, and are being re-issued as 4 per cent. perpetual debenture stock.

The Bill promoted by this Company for the extension to Islington and other purposes received the Royal Assent on August 24th last. The Parliamentary expenses incurred in connection with this Act were largely increased by it having been carried over from one Session to another owing to the dissolution of Parliament, but having paid dividends in the meantime on the Ordinary stock, the Company is now relieved from the obligation to provide the Parliamentary deposit, whereby a very considerable saving will be effected.

The Directors retiring by rotation are Messrs. Sampson Hanbury and Spencer Barclay Heward, who are eligible for re-election. Mr. James Loriner is the retiring auditor and is eligible for re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

DENISON AUTO-TELEGRAPH MACHINE SYNDICATE (LIMITED).—This Company was registered on January 18th, with a capital of £1,000, in 20 shares of £50 each, to purchase or otherwise acquire the letters patent of the Denison Auto-Telegraph Machine, for the United Kingdom, France, and Belgium, and for such other countries as the Company may think desirable, and to carry on the business of telegraphists, electrical engineers, manufacturers of and contractors for the sale, supply, letting on hire, erection, and maintenance of machinery for the purposes of utilising the said invention. The subscribers are:—James McLean, (2 shares); C. C. P. Ray, (2 shares); H. Kronheim, (1 share); C. Nolda, (1 share); L. R. Herzberg, (1 share); H. Baseley, (1 share); J. Korach, (1 share).

FOWLER, LANCASTER AND CO. (LIMITED).—This Company was registered on January 23rd, with a capital of £50,000 in £10 shares, to acquire by purchase or otherwise, and take over as going concerns, the businesses carried on by Fowler, Lancaster and Co. (Limited) and the Birmingham Telegraph Factory (Limited), Birmingham and elsewhere, to construct, manufacture, hire, let, license, purchase, sell, equip, maintain, work, use, and let on hire, electric light or power plant, or fittings, telegraph and telephone instruments and appliances, cables, wires, or other apparatus and things connected with or relating to the generation, accumulation, distribution and utilisation of electricity, and the transmission of messages, and generally to carry on the business of electrical engineers, contractors and manufacturers. The subscribers are:—T. G. McLauchlan, C. H. T. Bikker, Edward W. Lancaster, George E. Stembridge, C. O. P. Pemberton, George M. Fowler, W. Hand, with one share each. The first Directors are to be appointed by above-named subscribers.

FROGGATT'S ELECTRIC LIGHTING COMPANY (LIMITED).—This Company was registered on January 17th, with a capital of £3,000 divided into 1,500 Preference, or "A," and 1,500 Ordinary, or "B," shares of £1 each, to enter into and carry into effect an agreement already prepared and expressed to be made between Thomas Froggatt, of 55, Thomas-street, Kennington Park, London, S.E., of the one part, and the Company of the other part, for the acquisition by the latter of certain patents, patent rights, licences, concessions, and the like connected with or relating to electric lighting or advertising, or to the application of electricity, to develop, turn to account and deal with the said patents, and to carry on any business connected with electric lighting and engineering. The subscribers (with one share each) are:—L. Green, J. C. Hulbert, C. P. W. Pearce, Thomas Froggatt, jun., F. W. Hackforth-Jones, J. C. Genge, T. Froggatt. The first Directors are:—Adriano de Murrieta (Chairman) and Cristobal de Murrieta (nominated by the Preference shareholders), and Thomas Froggatt (nominated by the Ordinary shareholders).

CHARLES CHURCHILL AND CO. (LIMITED).—The annual return of this Company, made up to December 1, 1893, has been filed. The nominal capital is £6,000, divided into 140 Preference shares of £25 each and 50 Ordinary shares of £50 each. 103 Preference and 40 Ordinary shares have been taken up, of which 50 Preference and 40 Ordinary were issued as fully paid. Upon the remaining 53 Preference shares the full amount has been called, and £1,325 paid in respect thereof.

CRYSTAL PALACE DISTRICT ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to December 1, 1893, has been filed. Out of a nominal capital of £100,000 in £1 shares, 28,586 have been taken up, and 14,166 issued as fully paid. On the remainder £17,430 is said to have been paid; £3,264 has been received on 3,264 forfeited shares.

DISTRICT MESSENGER COMPANY OF PARIS (LIMITED).—The statutory return of this Company, made up to December 22nd, has been filed. The nominal capital is £200,000, divided into 112,000 Preference shares of £1, 80,000 Ordinary of £1, and 400 Founders' of £20 each; 67,875 Preference, 30,082 Ordinary, and 400 Founders' shares have been taken up, of which all the Founders', 20,000 Preference, and 20,000 Ordinary, were issued as fully paid. Upon the remaining 47,875 Preference and 10,082 Ordinary shares a call of 15s. per share has been made, resulting in the payment of £1,841. 5s., and leaving £41,626. 10s. as yet unpaid.

CITY NOTES, &c.

BALFOURS AND COMPANY (LIMITED).—The winding-up order was made against this Company in July last, when the accounts showed a deficiency of £3,682 to creditors, and to contributories of £20,867. This Company was associated with the promotion of the Alliance Aluminium Company, which is also in liquidation, and also of the "Postal Undertaking," for the automatic sale of postage stamps and post cards.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—Notice is hereby given that the coupons in this Company's Five per Cent. Debentures (1884 issue), due on the 31st inst., will be paid on and after that date, at Parr's Banking Company and the Alliance Bank, Bartholomew-lane, London, E.C. Coupons must be left with the Bankers three clear days for examination.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended January 21st, were £947, as against £973 for the corresponding period of last year, being a decrease of £26. The total receipts for the half-year amount to £2,877, as against £2,978 for the corresponding period of 1893, a decrease of £91.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announce that on Monday next, the 22nd inst., they will open a branch station at 449, Strand, London, W.C., opposite Charing Cross railway station, for the receipt and despatch of telegrams to India, China, Australasia, South America, Spain, Portugal, Greece, Turkey, and every part of the Submarine Telegraph System.

ELECTRICAL FINANCE.—Dr. Rosenthal, a representative of the firm of the Berlin Siemens and Halske, and Herr von Koenen, hitherto a leading official of the Seehandlung and an authority in financial matters, are, it is stated, about to establish a banking business in Berlin. This establishment, in which Messrs. Siemens and Halske are to be sleeping partners, will mainly direct its operations towards the financing of the electrical undertakings of the latter firm.

MANGANESE BRONZE AND BRASS COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend of 6s. per share, free of income-tax, payable on the 1st prox.

ROBEY AND CO. (LIMITED).—Letters of allotment and regret for the issue of £125,000 Four-and-Half per Cent. First Mortgage Debentures have been posted.

SALT LAKE AND OGDEN GAS AND ELECTRIC LIGHT COMPANY (LIMITED).—It is announced that the second ordinary general meeting of this Company is to be held at Winchester House to-morrow (Saturday) at 12 o'clock, "when the Board hopes to be able to present accounts and declare a dividend."

SUBMARINE CABLES TRUST.—Notice is given that on and after 1st prox. the sum of £1. 5s. (balance of the coupon due October 15th last) will be paid by Messrs. Glyn, Mills, and Co., Lombard-street, E.C. Coupons should be left with the bankers for four clear days.

VENEZUELA TELEPHONE AND ELECTRICAL APPLIANCES COMPANY (LIMITED).—Coupon No. 7 of the Five per Cent. First Mortgage Debentures of this Company, due for payment on January 31st, will be paid from that date at the Consolidated Bank (Limited), Threadneedle-street, or at the Banking House of Messrs. Westindorp and Co., Amsterdam.

VICTORIA (BRITISH COLUMBIA) ELECTRIC RAILWAY AND LIGHTING COMPANY (LIMITED).—Messrs. Sperling and Co., of 8, Austinfriars, E.C., have this week issued a prospectus inviting subscriptions for £100,000 Five per Cent. Debentures of £40 each in the above Company, at the rate of £98. 15s. per cent. The Debentures are redeemable in 1932 by the application of a sinking fund and annual drawings. The Company (the prospectus states) has for fifty years the sole right to work and organise electric cars, &c., in the city of Victoria, British Columbia.

WATERLOO AND CITY RAILWAY COMPANY (LIMITED).—A meeting of the proprietors of the London and South-Western Railway Company is announced to take place at the offices at Waterloo Station, London, on the 8th prox., at 12 o'clock, at which it will be proposed that an agreement be entered into between the London and South-Western Company and the Waterloo and City Railway Company in respect of the working, maintenance, and management of the railway authorised by the Waterloo and City Railway Act, 1893, and for the supplying, by the London and South-Western Company, of electrical energy, plant, and machinery, and for the guaranteeing by the company of dividends and interest upon the share and loan or borrowed capital of the Waterloo and City Railway Company's stock. Should this proposal meet, as it doubtless will, with the support of the proprietors, the Waterloo Company will have little difficulty in obtaining all necessary capital for their undertaking, as the stock of the London and South-Western Railway Company is considered a gilt-edged security, and any undertaking fostered by its Directorate is assured of success.

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WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts for the week ending January 19th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,530.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the two weeks ended January 15th were £2,292, as compared with £2,525 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Jan. 17.		Price Wednesday, Jan. 24.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Jan. 24. Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	12/6	Anglo-American	43	45	43	45	6 2 3	Jan., Apr., July, Oct.	44½	43¼
£2,932,680	Stock	25/0	Do. Preferred	81	82	79½	80½	6 16 8	"	82½	80½
£2,932,680	Stock	5/0	Do. Deferred	7½	8	7½	7¾	..	..	7¾	7½
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	99	102	100	103	3 17 8	January and July	102	..
130,000	£10	3/0	Brazilian Submarine	11¼	11¾	11¼	11¾	5 10 8	Mar., June, Oct., Dec.	11½	11¼
£18,700	£100	5%	Do. 5 per Cent. Bonds	101	104	101	104	4 16 2	January and July	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	108	–
£10,000,000	$100	7%	Commercial Cable Capital Stock	130	140	130	140	5 0 0	Jan., Apr., July, Oct.	..	–
16,000	10	8/0	Cuba Submarine	11½	12½	11½	12½	6 8 0	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	..	..
60,710	20	8/0	Direct United States Cable, 1877 xd	11	11½	10¾	11	6 7 3	Jan., Apr., July, Oct.	11 3/16	10 15/16
400,000	10	2/6	Eastern xd	15	15½	14⅞	15⅛	4 5 11	" "	15¼	14¾
70,000	10	6%	Do. 6 per Cent. Preference xd	15¾	16¼	15¾	16¼	3 13 10	" "	16⅛	15 15/16
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	115	..
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	108	111	108	111	4 10 1	February & August	..	..
250,000	10	2/6	Eastern Extension xd	15½	15¾	15½	15¾	4 8 11	Jan., Apr., July, Oct.	15 11/16	15⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	115	118	115	118	3 7 10	February & August	117½	116
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	101	104	101	104	4 16 2	January and July	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	101	104	101	104	4 16 2	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103	106	103	106	3 15 6	February & August	..	–
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	106%	109%	106%	109%	3 13 5	May and November	..	–
180,227	10	1/3	Globe Telegraph and Trust xd	8¼	8¾	8½	8¾	5 2 10	Jan., Apr., July, Oct.	8¾	8⅝
180,042	10	6%	Do. 6 per Cent. Preference xd	15¼	15¾	15¼	15¾	3 17 5	" "	15¾	15⅝
150,000	10	5/0	Great Northern	19¾	20¼	20	20½	4 3 9	Jan., April, and July	20½	20⅜
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 14 4	March & September	..	..
17,000	25	12/6	Indo-European	41	44	41	43	5 16 3	May and November	..	–
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	3 6 8	" "	..	–
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	105	108	5 11 1	March & September	..	–
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red" 1942	101	104	101	104	3 16 11	..	..	..
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	..	..
3,381	£100 Cert.	35/0	Submarine Cables Trust 6 per Cent.	114	115	114	119	5 0 10	" "	..	..
15,609	10	5/0	West African Telegraph	5½	6½	5½	6½	7 13 10	January and July	..	..
£249,900	100	5%	Do. 5 per Cent. Debentures	100	103	100	103	4 17 1	March & September	..	..
30,000	10	2/0	West Coast of America	1½	2½	2	2½	..	January and July	2⅜	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	97	101	97	101	7 18 5	June and December	..	..
88,321	10	1/0	West India and Panama	1	1½	1	1½	..	..	..	..
84,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10¼	9¾	10¼	5 17 1	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 7	June and December	106	..
64,242	15	4/6	Western and Brazilian	6	6½	5¾	6½	3 12 3	May and November	5 13/16	..
33,129	7½	4/6	Do. 5 per Cent. Cumulative Preferred	5¼	5¾	5¼	5¾	..	..	5½	–
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¼	1¾	1	1½	..	..	..	–
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	104	107	104	107	5 12 2	February & August	..	–
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	104	107	104	107	5 12 2	" "	..	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do. 6 per Cent. Sterling Bonds	102	105	102	105	5 14 3	March & September	105	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	–	–	–
[illegible]	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	–	–
220,000	£1	4·76d.	Oriental Telephone and Electric (11s. paid)	¼	⅜	¼	⅜	5 6 5	Yearly	–	–
484,597	5	2/6	National	4⅝	4⅞	4¾	5	5 0 0	June and December	4⅞	4¾
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14	15	14½	15½	3 17 5	" "	14 15/16	14¾
15,000	10	6%	Do. 6% Cumulative 2nd Pref. (fully paid)	14	15	14	15	4 0 0	" "	14⅝	14½
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¼	5½	5¼	5½	4 10 11	..	5⅝	5 5/16
925,017	£100	4½%	Do. Deb. Stk. 4½%	112	114	112	114	3 18 11	January and July	113½	112½
58,000	5	1/0	United River Plate	1½	2	1½	2	..	" "	–	–
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	–	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11¼	11¾	11¼	11¾	–	..	..	–
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	13	13½	13	13½	..	–	13⅜	13⅛
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	–	–
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	–	–	–
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	–	–
8,322	£5	..	House to House Electric	..		..		–	–	–	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		..	–	–	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	–	–
30,000	£5	1/9	Liverpool Electric Supply (£3 10s. paid)	4½	4¾	4⅜	4½	..	–	–	–
15,000	£5	2/6	Do. (fully paid)	6½	6⅞	6½	6⅞	..	–	..	–
111,000	5	..	London Electric Supply	½	¾	½	¾	–	..	..	–
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	8½	8¾	8½	8¾	2 5 7	..	8½	8⅜
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	104	108	104	108	4 12 7	June and December	..	–
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	–	–	..	–
19,980	£5	9½%	St. James' and Pall Mall	6	6½	5¾	6½	..	–	..	–
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	–	8½	8¼
59,900	5	1/6	Westminster Electric Supply (fully paid)	5¼	5¾	5¼	5¾	3 0 10	–	5⅝	5 9/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	2/1	Brush Electrical Engineering	2⅝	2⅞	2⅝	2⅞	6 5 4	–	2 13/16	2¾
90,000	2	6%	Do. 6 per Cent. Preference Non-Cumulative.	2	2¼	2⅛	2⅜	5 1 1	–	2¼	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	104	106	104	106	4 4 11	March & September	..	–
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	4	4½	3½	4½	..	January and July	..	–
12,139	5	..	Edison and Swan United	–		–		–	–	–	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		–	–	..	–
120,000	2	..	Electric Construction	½	1	½	1	..	–	⅝	–
12,845	2	..	Do. 7% Cumulative Pref.	1	1½	1	1½	..	–	–	–
91,195	2	10/0	Elmore's Patent Copper Depositing	⅛	⅜	⅛	⅜	..	..	–	–
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	–	–	..	–
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	23	24	23½	24½	5 2 0	February & August	24½	23½
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	..	–
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	–	–	–
16,000	£10	..	Do. 8 per Cent. Preference	–		..		..	December and June	–	–
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/16	5/16	3/16	5/16	..	..	..	..
78,949	5	3/6	Swan United (£3. 10s. paid)	2¼	2¾	2¼	2¾	..	May and November	2 3/16	..
37,350	12	12/0	Telegraph Construction and Maintenance	36	38	36	38	4 9 1	March and July	37½	37
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	103	106	103	106	4 14 4	January and July	105½	–
37,514	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		–	–	–	–
41,098	£5	..	Do. Preference (fully paid)	–		–		–	–	–	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	¾%	City and South London Railway	28	33	28	33	2 5 5	May and November	..	–
37,500	£10	–	Liverpool Overhead Railway	4⅞	5⅛	4⅞	5⅛	–	–	–	–

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THE ELECTRICIAN:

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NOTES.

With such good material to start upon as that which was given in the *Pall Mall Gazette* in October last, the announcement on November 8th of the arrest of Harness, and the charge of conspiracy to defraud, seemed to betoken the end of the electropathic belt quackery. But after the first day or two of the long trial, it was evident that the case was a very poor one, and many of the witnesses did as much harm as good to the prosecution. Sufficient time and money have now been spent by private individuals to show that when these private individuals either prosecute or defend, the laws of this country or the procedure of its courts of justice are incompetent to deal with such practices as those which have proved so lucrative to the Medical Battery Company. It has been found impossible, owing to these causes, to utilise certain evidence which has been selected and prepared in a manner incomparably superior to that of this abortive prosecution. There is a general impression that there is an official of the Home Department, called the Public Prosecutor, and it has been hinted that he derives great comfort from the habitual use of an electropathic belt. The former, and consequently the latter, supposition is without foundation. Circumstances in 1872 led to the appointment in 1879, by special Act of Parliament, of such an official at a salary of £2,000 per annum, with six assistants. But in 1884 this appointment, so far as it related to the salary, and a few other details, was revoked, and it was ordered that the duties should be performed by the Solicitor to the Treasury. What are now known as Treasury prosecutions are chiefly of a purely financial character, and it is possible that the department shirks, while Harness pretends to court, a scientific investigation. We have little sympathy with his victims, for they throw away their money in the face of the unanimous opinion of all medical men of repute. The graver cases of extortion and of blackmail are to be distinguished from these, and here the Treasury need be less concerned with scientific details; the chief difficulty would be to induce witnesses to make their follies public. But perhaps we have, after all, heard the end of the business.

Notwithstanding that the "Report of the Action of the Traction Committee" was on the agenda paper for the meeting of the Electrical Trades Section of the London Chamber of Commerce on the 23rd ult., the attendance was so small that the meeting was adjourned till last Monday. The adjourned meeting was very thinly attended, and it might have been imagined that such confidence is placed in the ability of the Traction Committee that no one but a few telephone men cared to come to hear their report. The members of this Committee were, however, well enough aware that no report was to be issued, and those who came expecting to hear it had to content themselves with a statement from the Chairman that one of the privileges of the Chamber is that members may form special-purpose committees, even for objects diametrically opposed to the interests of other members of the same section, and may subscribe and spend their own money on such special purposes, and that the Traction Committee had taken this course. We are glad to hear that the Committee is busily engaged on the discussion of the proposed regulations from the practical and commercial point of view, and that a Committee of the whole Council of the Institution of Electrical Engineers is giving attention to them as well.

Although not making much noise, the Committee is not resting on its oars: far from it. The Board of Trade draft regulations, which we published in our issue of November 24th, have been submitted to exhaustive examination, and on Wednesday a lengthy conference, between Sir Courtenay Boyle, Sir Thomas Blomefield, and Major Cardew, and the members of the Committee, was held at Whitehall Gardens, at which the amendments suggested by the Committee were brought to the notice of the Board of Trade as a preliminary to more formal action. The sentiments expressed on either side were brimful of peace and goodwill, and the Chairman, who had evidently scarcely anticipated escaping with a whole skin, congratulated himself and the meeting upon the mild tone which had prevailed. When, however, we state that the obnoxious Regulation 14, which, in face of the letter and of the spirit of the Report of the Joint-Committee, places electric traction under the heel of the telephone interest, was passed over as too important and too delicate a matter to be discussed at such a friendly and informal round-table conference, all this amicability, following hard upon so much pugnacity elsewhere, gives no cause for bewilderment. One may wrangle over details; but one only fights over principles, such as those involved in Regulation 14.

At the present stage we do not think any useful purpose would be served by the publication in full of the suggested emendations of the Traction Committee, a large proportion of

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which merely relate to matters of drafting, verbiage, and definition, and which will in all probability before long be deprived of their *raison d'être* by the issue of verbally amended draft regulations. But it may not be premature to state that amongst the more important suggestions of the Committee was the deletion of the last paragraph in Regulation 5, in which it is laid down that where an earth connection at the power house is within 6ft. of any pipe, and permission cannot be obtained to connect on to it, a non-conducting screen must be provided. It was intimated, however, that the Board of Trade considered this a very valuable provision, and its omission could not be entertained, although amendments were invited. Sub-section 1 of Regulation 6 lays down that the current passing from the earth connections to the generator is not at any time to exceed 10 amperes ; it was urged that this inextensible maximum might well be altered to "a certain percentage of the total output ;" but here again no great hope was held out of an alteration in the principle of a definite maximum earth current for all lines from one car upwards.

Regulation 9, providing for the breaking up of the line into half-mile insulated lengths, was thought to place "a very serious restriction upon electric traction," and Regulations 10 and 11, fixing the maximum leakage current at $\frac{1}{100}$th of an ampere per mile of tramway, and the minimum insulation resistance of "all lines, insulated returns, feeders, or other conductors laid below the surface of the ground" at 10 megohm-miles, were considered impossible of application to conduit systems. With regard to the last two regulations, the Committee was informed that these had been intentionally drafted stringently, with a view, we suppose, to determining the traction man's limit of elasticity. Objection was also raised to the proviso that the separate lengths of metal conduits shall be jointed, so as to secure metallic continuity throughout, but a reminder of the recent Bournemouth accident, due, we understand, to a neglect of this very precaution, silenced the objectors. The conferees then separated—to fight again another day.

A PROMINENT article in the *Pall Mall Gazette* of Tuesday last calls attention to the lax way in which ships are commonly wired for electric lighting, the absence of any Board of Trade regulations, and the non-enforcement of the "amiable suggestions" made by Lloyds. A slightly alarmist tone is adopted throughout the article, which is well calculated to attract attention. Seeing that there are staffs of surveyors in connection with marine insurance companies, and that the suggestions already issued by Lloyds' Committee need only to be slightly amended and transformed into positive and thoroughly enforced regulations, there does not at first sight seem any reason for appealing for help, as the Englishman in a difficulty is always ready to do, to the already much over-worked Board of Trade. But the wiring is bad enough even on some of the large liners, and the companies who own them "insure themselves." As life is concerned as well as property, and in a much more serious way than in house lighting, the Board of Trade, who already possess a large staff of marine surveyors, might have this duty added ; but there is no sense in having the work of inspection done twice over. The *Pall Mall Gazette* makes the good suggestion that "at least one engineer and one deck officer of every ship's crew should of necessity be certified as possessing theoretical and practical knowledge of electricity and the dangers involved in its unprotected use." Whether deck officers should go through a text-book and a course of amateur joint-making is perhaps doubtful, but one of the numerous documents which has to be signed before a ship is cleared might be a certificate of sound wiring and good insulation.

AT the annual meeting of the St. James' and Pall Mall Electric Lighting Company, held last Tuesday, the Chairman, while announcing very satisfactory progress, expressed his regret at sundry conflicting and damaging tendencies. Now, it is curious to notice that these tendencies, which the Chairman called upon the shareholders to deplore, are counted virtues among plain men. Firstly, the consumer had cultivated thrift ; and becoming more economical of his light, had reduced his "little bill" something like 25 per cent. As a set off against this, however, an increase of 25 per cent. in the number of lamps wired was announced. Secondly, the consumer had evidently been inquiring into the relation between "price per unit" and "cost of production," and had made up his mind that the supply company could well afford to reduce the former quantity. And he had very successfully enforced his claim, with the result of still another reduction in the bill. Lastly, Nature had been kindly to the consumer, and her smiles meant woeful loss to the Company; for the past winter had been one notably destitute of fogs, and such fogs as had occurred had selected Sunday for their appearance, so that the lucky consumer had been taking sunshine gratis, instead of electric light at 6d. per unit. But, to the Company, all these things meant a reduced revenue ; and the shareholders viewed them in the light of a lessened dividend.

IN a series of articles in the *Electrical World*, of New York, Mr. R. A. FESSENDEN describes a method which he has devised for preventing the escape of heat from any electrically-heated object. There does not appear to be very much novelty about the actual method proposed by Mr. FESSENDEN, and the principles upon which it is based have long been known ; but some interest attaches to the series of experiments which Mr. FESSENDEN has been making. The method consists in intercepting the heat, not by means of a badly conducting jacket, as is usually done, but by means of a series of highly-reflecting and badly-radiating surfaces. By this means the heat which is radiated from the hot body is largely intercepted and returned to that body by the first or innermost reflecting shell ; and the remnant which escapes the influence of the inner baffler is caught by an outer one, and, in like manner, is partially reflected back. In the experiments carried out by Mr. FESSENDEN it was shown that with a couple of polished tin boxes, arranged in the form of a nest, with the hot body in the very centre, and with but a quarter of an inch between the outer and inner boxes, radiation was checked to an extent which could only be equalled by a thickness of one and a-quarter inches of asbestos.

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It is more than probable that these results would have shown even more in favour of the reflecting jacket had the air been largely exhausted from the space between the two boxes. The arrangement would then have resembled Prof. Dewar's vacuum jacket, with a mercury mirror deposited on the surface of the confining vessel. Instead of exhausting the space, Mr. Fessenden might have provided that the circulation of the air should be prevented; for air, even at atmospheric pressure, is a very good non-conductor of heat if convection currents within it are prevented. Considered as a practical method of retaining heat within a heated body, such as an electric oven or furnace, we are, however, afraid that some difficulty might be met with in keeping the nest of polished surfaces in a continual state of efficient brightness; while the necessity for perfect heat insulation between the successive jackets would render it a by no means easy matter to provide a door for communicating with the interior. Still, in some classes of work it might be found not only more efficient, but also more convenient, to employ these anti-radiators in place of, or even in conjunction with, the non-conducting lagging which is ordinarily used.

The magnetic permeability of oxygen in the gaseous state has long been shown to be greater than that of air in a corresponding condition of pressure and temperature; and the very high permeability of the former substance in the liquid state has been demonstrated by Prof. Dewar. But considerable discrepancies occur between the various determinations of the change of permeability of gaseous oxygen under changing conditions of pressure, temperature, and magnetic induction. An account of some recent researches on this subject by Hennig will be found in another column, together with an instructive pair of tables, the first of which gives the results of Hennig's own researches, and the second compares these with the standard figures obtained by other investigators. The probable causes of error, at least in so far as the method of Töpler which was used by Hennig, is concerned, would seem to consis in the difficulties of determining the thermodynamic conditions of the two gases in the two limbs of the V-tube, and in the irregularities of distribution of the magnetic induction. This last-named source of disturbance would to a certain extent be assisted, especially in strong fields, by the very difference between the permeabilities of the two gases in the two limbs; although it is possible that this cause of disturbance might be too small to affect the measured results. It does not appear that the method adopted by Hennig to determine irregularities in the induction distribution could eliminate the error of which we have just been speaking. It is noteworthy, however, that the results now obtained by Hennig are more nearly equal to the mean of all the determinations than the results obtained by the same investigator in conjunction with Töpler, in 1882.

Honours.—The Grand Cross of the Red Eagle has been conferred upon Dr. H. von Stephan, the German Imperial Minister of Posts and Telegraphs.

Steel Barrels and Electric Welding.—New machinery for the production of steel barrels is, says *Industries and Iron*, being put down at Barrow. The steel sheets which are used will be shaped by means of hydraulic presses when the metal is hot, and the half-barrels will be welded together by means of electricity.

The Theory of Heat.—Messrs. Macmillan and Co. will shortly publish "The Theory of Heat," by Prof. Thomas Preston of Dublin. The subject has been treated in a comprehensive manner, and in such a way as to interest the general reader as well as the student.

Aluminium.—The *Engineering and Mining Journal* of New York states that the Cowles Electric Smelting and Aluminium Company and the Pittsburg Reduction Company have not consolidated, as announced, nor does the Cowles Company expect to move its plant to Niagara Falls.

Personal.—Mr. W. B. Esson has severed his connection with the Gülcher Electric Light and Power Company, and has joined Messrs. Johnson and Phillips at their Charlton Works, where he will act as manager of the electric light, transmission of power, and electro-chemical departments.

Fatal Accident at Prescot.—According to the *Globe* a boy was killed by an electric shock at Prescot, near St. Helen's, last Wednesday night. The deceased, while assisting in repairing wires in a cellar of some business premises, accidentally got in contact with an exposed wire. He fell to the ground, being instantly killed. One of his hands was slightly burned.

Newport.—The sub-committee of the Town Council, who are entrusted with the conduct of the electric lighting of the borough, on Friday last visited Chelmsford for the purpose of inspecting the installation which Messrs. Crompton have provided in that borough. They also inspected another installation which the same firm have provided in the metropolitan area.

Cable Interruptions:

	Date of Interruption.
Cayenne-Paramaribo	October 15th, 1893
Bissao-Bolama	November 24th "
Cayenne-Vizeu	November 25th "
Garachico-Santa Cruz de Palma	December 27th "
Constantinople-Odessa	January 31st, 1894
Saigon-Thuan-An	February 1st "

The American Fire Losses of 1893.—During the year just ended the loss by fire in the United States in property value was almost $150,000,000, a greater loss than has been recorded in any one year, except that in which Chicago was burned, and that in which the best part of Boston was blotted out. Boston lost more last year than any other city, the estimate being $5,300,000.

Extension of Suburban Mains.—The Metropolitan Electric Supply Company have given notice to the London County Council of their intention to lay mains in Elgin-avenue and road, Carlton-road and hill, part of Edgware-road, Portsdown-road, Abercorn-place, Hamilton-terrace, Upper Hamilton-terrace, Abbey-road, place, and gardens, Violet-hill, Nugent-terrace, Alma-square, Hill-road, Garden-road, Grove End-road, Loudoun-road, Elm Tree-road, Circus-road, Hall-road, Melina-place, and Stranraer-place.

A Sidelight on Municipal Electrical Finance.—Some questions were put to the Chairman of the Huddersfield Gas Committee, at a recent meeting of the Council, as to the price charged for coke. From these it would seem that the Committee are disposing of coke to the Electric Lighting Committee for 6s. per ton, while other customers are charged 8s. 4d. Alderman Stocks explained that the Electric Lighting Department contracted for a supply of coke all the year round, while the other business was of a casual nature.

High-Pressure Alternate-Current Transmission at Chambéry.—A continuous current plant, which is at present at work at Chambéry (Savoy), is to be replaced by May next by a 5,000 volt alternate-current plant supplied by the Creusot Works. The generating plant will be some 12 miles from Chambéry and close to Chapareilan on the Cernou, where a 2,000ft. 2,000 H.P. fall is available. The plant will consist of 7-120 kilowatt turbine-driven alternators. The pressure will be reduced from 5,000 to 110 volts at one step, 10 kilowatt transformers being used.

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Brighton.—Mr. Arthur Wright, manager of the Corporation's Electric Lighting Works, has reported that the result of the past year's working of the sliding scale has been that the average price charged for electricity is 6·1d., against the old price of 7d., which exactly corresponds to the 13 per cent. reduction anticipated by Mr. Wright in January last. The revenue for the year is, in consequence, £1,007 less than it would have been if no reduction had taken place. 150 consumers out of the 320 that were connected on June 30, 1893, have benefited by the reduction.

Polyphase Currents in 1893.—The following list of polyphase current plants actually at work is from *L'Industrie Electrique*:—*France.*—(1) St. Victor-sur-Loir, near St. Étienne, 3 200 kilowatt machines; (2) Port Lignon, 1 200 kilowatt machine; (3) Florensac (Hérault), 1 200 kilowatt machine. All these machines are of the Lauffen-Heilbronn type, and were laid down by MM. Guitton et Bertolus, of St. Étienne. *Germany.*—Four three-phase plants: Lauffen, Bockenheim, Erding, Wangen. *Austria.*—(1) Pergine, three phase; (2) Budapest, two-phase. *United States.*—Reclands (Cal.) three-phase.

The Niagara Scheme.—The "real estate men" of Buffalo are, it is said, considering plans for celebrating on a "royal scale the inauguration of the use of the Niagara Falls electric power in Buffalo." The plan most favored is to issue letters of invitation to President Cleveland and his Cabinet, Senators and Congressmen, Governors of States, and other high officials, all the eminent electricians of the world, and representatives of the press from everywhere. The wire conveying the current is to be connected with one of the large manufacturing plants near the city line and the machinery set in motion by the touching of a button.

The Hermite Process.—The committee appointed by the Counseil Central d'Hygiene to visit Havre and inquire into the results obtained in the lengthy experiments with the Hermite process of purification by electricity, which have beer made in the St. François district, have recently published a report which, says *Industries and Iron*, is unfavourable to the process. The committee state that the result of their investigations into the process, as applied under the conditions prescribed by M. Hermite himself, gives them the right to say that the process does not bring about a sufficiently rapid sterilisation of sewage, and consequently does not constitute a sufficient guarantee for prompt disinfection, but as it shares with certain chemical products the property of deodorisation it may, from that special point of view, and that only, have some hygienic value.

The Late Capt. Halpin.—Mr. F. C. Webb sends us the following account of an episode in the life of the late Capt. Halpin, whose loss we had to deplore last week, which is characteristic both of his courage and great physical strength:—

"As every seaman knows, the mainstay of any full rigged ship lies at a very acute angle with the horizon; and, consequently, to attempt to slide down it, or climb up it, is dangerous, as if the legs are let go from the stay and the seaman has not strength to regain his legs round the rope, he can only hang (or come down hand over hand) until exhausted and then must drop. So well was this danger known in the old line of battle-ships (and I had this from Capt. Frederick Bullock, R.N.) that the moment a man was seen on the mainstay with his legs gone from the rope then every man rushed to the hammock nettings to snatch the hammocks out and pile them up on deck to break his fall. Well, once a man was in this dangerous position on board the "Great Eastern," only instead of being over the *deck* he was over one of the engine-room skylights. He was in extreme peril when Capt. Halpin (then chief officer) went up the stay and rescued the man."

Acoustic Synchronizer for Alternators.—An acoustic synchronizer was shown by the General Electric Company at the Chicago Exhibition, and attracted much attention. It consists merely of a cylindrical iron case with an aperture in the side, each end being closed by a flexible diaphragm, each of which has opposite its centre the pole of an electromagnet. In using this device one of the magnets is connected in circuit through a transformer with each of the machines to be run in synchronism. The current is then turned into the magnet coils, and the diaphragms emit a loud clear note. As the machines approach synchronism, the notes from the diaphragms approach closer in period and begin that loud, periodic sound, known in acoustics as beats. As the two machines more nearly approach synchronous speed, the beats grow slower and slower, until finally, the diaphragms fall into unison and each gives out the same low, clear note. At this moment, which is sharply marked, the switch connecting the two machines is thrown in. So sensitive and distinct is the indication of approach of synchronism, that it is possible to throw two machines together with hardly a quiver upon the ammeter.

The Provincial Central Stations of France.—Our esteemed contemporary *L'Industrie Electrique* published in its issue of January 25th a list of the provincial electric lighting central stations at present at work in progress and projected in France; the list has been corrected up to December 31, 1893, and is accompanied by a map showing the location and nature of the different stations. There are, it seems, 301 central stations actually in operation in France outside Paris, 248, or 83 per cent., being on the continuous-current system, 47 on the alternate-current system, and 6 having the two combined. The oldest provincial station in France is that at Bellegarde-sur-Valserine (Ain), which came into operation in February, 1884; the first alternate-current station was that established at Tours in January, 1886. As will be seen by the list below, the total horse-power of the French provincial stations in operation, in progress and projected is equivalent to a capacity of about 750,000 8-c.p. lamps, that of our own provincial stations *actually at work* being 425,000 8-c.p. lamps. It may be observed that our Paris contemporary's list includes central stations (?) of 3, 5 and 8 H.P. capacity, and the majority are less than 100 H.P.:—

Motive power.	Stations.	H.P.
Hydraulic	136	9,259
Hydraulic and steam......	36	6,000
Steam	113	21,820
Producer gas	3	140
Town gas	13	1,015
	301	38,234

Perfect and Imperfect Combustion of Carbon.—In a Paper on the "Combustion of Carbon in Air," by R. Ernst, the author states that the oomposition of the products of combustion depends almost exclusiveiy on the temperature. The formation of carbonic anhydride begins at about 400deg., and at this temperature there is already a small quantity of carbonic oxide produced. The maximum production of carbonic anhydride occurs at about 700deg., and amounts to some 20 per cent. of the products, including the nitrogen of the air used; up to this temperature the formation of carbonic oxide is but small, hardly exceeding 3 per cent.; the oxygen, however, is entirely used. At higher temperatures, the carbonic anhydride rapidly disappears, giving place to carbonic oxide, until at 995deg. this gas amounts to 34 per cent., the remainder being atmospheric nitrogen. There was no further change in the composition of the products up to the highest temperature—1,092deg.—at which the author experimented. The production of carbonic oxide could not be induced at a lower temperature by altering the other experimental conditions. It is concluded that carbonic oxide is the only oxidation product of carbon at 1,000deg., and that producer gas should be prepared at this temperature. By substituting carbonic anhydride for air it was proved that this gas is never entirely reduced to carbonic oxide by the hot fuel, so that, where the production of carbonic oxide is preceded by that of carbonic anhydride, some of the gas must appear among the products of combustion; it may be concluded, therefore, that the carbon burns directly to carbonic oxide. In the rational furnace, where a high temperature is required, the air supply directly to the fuel must be only sufficient to burn it to carbonic oxide, which must subsequently be burnt by admission of fresh air. The temperature must be maintained at 995deg. and upwards. The observation that coke burns without flame at moderate temperatures, but with flame at higher temperatures, is, the *Journal* of the Chemical Society remarks, now explicable.

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MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(*Continued from page 289.*)

THE STEAM ENGINE.

Fuels.

Definitions. — Steam engine plant is a combination of thermal and mechanical parts having for its purpose the production of mechanical motive power from the energy known as *heat*, through the agency of steam. It belongs, therefore, to the class known as *heat engines;* and comprises the following parts: (1) the apparatus for the generation of steam by the heat of the energy source, with its accessory parts; (2) the engine, in which the energy of the steam is converted into mechanical motion, with its accessory parts; and (3) the mechanical parts by which the motion is transferred and adapted to the work. In the majority of cases heat engines, and steam engines in particular, derive their heat from the combustion of fuel; though in rare instances the direct heat of the sun's rays is utilised. The term *fuel* is applied to an extensive class of substances which have the property of developing light and heat by their chemical combination with the oxygen of the air, the rate at which the heat is generated being sufficient to maintain the process of combination without external heating. It is generally necessary to raise a fuel to a high temperature before this process can be started. *Combustion* is the name given to the process by which any substance maintains itself in a continuous state of entering into combination with the oxygen of the air, by virtue of the heat which is generated during the process. The term *products of combustion* is given to the chemical compounds which result from the combustion of fuel. These usually comprise gaseous products, smoke and ash.

Classification of Fuels.—The character of a fuel depends upon: (1) the ultimate constituents of the fuel, *i.e.*, the chemical elements; (2) the proportion by weight of these elements; and (3) the character of the groups of compounds into which these elements are arranged. Fuels are, for the most part, the products of protoplasmic activity, either animal or vegetable, though in some instances they are purely inorganic. They generally consist of one or more of the following elements: namely, hydrogen, carbon, sulphur, oxygen, nitrogen and earthy matter. Of these, one or more of the first three are essential to the conditions of the compound being combustible, and the remaining constituents are prejudicial. The useful fuel-elements, hydrogen, carbon and sulphur, are not equally valuable even in the elementary state, so that the value of the fuel depends upon the proportion of these elements to one another and to the whole mass. The elements in a fuel do not as a rule occur in the elementary state in the fuel, but are combined in various groups. The hydrogen, for example, may be combined, wholly or in part, with oxygen, forming water, or with carbon, forming bituminous and gas-producing matter, or with nitrogen, forming volatile ammoniacal compounds. In the first instance it would be very prejudicial to the value of the fuel; in the second, it would be highly useful; in the third, it would be only slightly prejudicial. As with the hydrogen, so with the other constituents; the actual value of each and all is determined by the proportion of each, and by the associations with the remainder which it forms. Hence the importance of a knowledge of the quantitative analysis of the fuel, in estimating its thermal value. Fuels may be divided into three classes—solid, liquid and gaseous; and the principal fuels in each class are as follows:—

Solid fuels.

Coal.	Wood.	Peat.
Coke.	Charcoal.	Dried vegetable matter.
Town refuse.	Straw.	Dried animal matter.

Liquid fuels.

Crude petroleum.	Petroleum oils.	Shale oil.
Vegetable oils.	Animal oils.	Alcohols and ethers.

Gaseous fuels.

Coal gas.	Water gas.	Dowson water gas.
Oil gas.	Producer gas.	Spirit vapour.
Natural gas.		

The special features of liquid and gaseous fuels are discussed later, as these are not frequently used in raising steam. Solid fuels and general considerations only will be dealt with at present.

Combustion of Elementary Fuels.—The elementary fuels are hydrogen, carbon and sulphur. Hydrogen enters directly into combination with the oxygen of air, by combustion, in only one proportion, namely, in the proportion of one part by weight of hydrogen to eight parts by weight of oxygen. Nine parts by weight of water are produced. Carbon enters directly into combination with the oxygen of air, by combustion, in two proportions. In the first, or *incomplete* combustion, one part by weight of carbon combines with 1·33 parts by weight of oxygen, forming 2·33 parts by weight of carbon monoxide. In the second, or *complete* combustion, one part by weight of carbon combines with 2·67 parts by weight of oxygen, forming 3·67 parts by weight of carbon dioxide. The first stage is produced by combustion in a limited and insufficient supply of air; the second, when combustion occurs in an abundant stream of air. The product of the first combustion is a poisonous, colourless, faintly odorous and slightly combustible gas; the ignition of which with free oxygen results in the second stage. The product of the second combustion is a heavy, colourless, inodorous, incombustible gas. Sulphur enters directly into combination with the oxygen of air in one proportion, namely, in the proportion of one part by weight of sulphur to an equal weight of oxygen. An incombustible, poisonous, corrosive gas, known as sulphur dioxide, results. Owing to the injurious properties of this product of combustion, native sulphur is not used as a fuel, and all fuels which contain sulphur in large quantities are rejected. Owing, then, to the small amount of this element in commercial fuels, as well as to the very low heating value of the element in itself, it is usual to neglect it in calculations about any fuel in which it may occur.

Air, which supplies the oxygen, is composed of a mixture of numerous inactive gases, of which the principal one is *nitrogen*, together with the active oxygen. The inactive gases do not, of course, undergo any chemical change in the process of combustion of a fuel, but they absorb and waste a certain amount of the heat in becoming raised in temperature. They serve a useful purpose, however, in modifying and reducing the rapidity of the combustion, and thus keeping the temperature of the burning fuel below the impracticable limit which would be reached if the oxygen were undiluted. 1lb. of oxygen is contained in every 4·35lb. of air, or, by volume, one cubic foot of oxygen is contained in every 4·76 cubic feet of air. Each pound of air occupies a volume of 13·14 cubic feet at one atmosphere of pressure and 62° Fahr. temperature, whence we may obtain the following table of the weights and standard volumes of air required to burn 1lb. of elementary fuel:—

	Hydrogen.	Carbon (incomplete.)	Carbon (complete.)
Weight of oxygen (lb.)	8·00	1·33	2·67
Weight of products (lb. in oxygen)	9·00	2·33	3·67
Weight of air (lb.)	34·80	5·80	11·60
Volume of air (c. ft.)	457·00	76·00	152·00
Weight of products (lb. in air)	35·80	6·80	12·60
Standard volumes of products of combustion (c. ft. in air)	552·00	76·00	152·00

In the above table it has been assumed that only the quantity of air or oxygen actually required for the chemical process has been supplied. In actual practice a considerable excess of air is necessary, which would make the volumes and weights of the products of combustion considerably greater. It must not be forgotten, also, that in practice the products of combustion are at a high temperature, and that their volume, but not their weight, is correspondingly increased. In estimating

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upon the basis of the above table the quantity of air required merely for the chemical process of combustion without dilution in the case of compound fuel, it is customary to assume that the constituent elements will behave as if they were uncombined, with the single exception of the oxygen which is supposed to be combined already with its equivalent of hydrogen. Thus, if we have a fuel which is composed of C per cent. of carbon, H per cent. of hydrogen, and O per cent. of oxygen, we treat it as if it were a mixture of C parts of carbon and H_1 parts of free hydrogen, where H_1 is the hydrogen uncombined with oxygen. To obtain H_1 we must subtract from H the number of parts of hydrogen assumed to be combined with oxygen, which is equal to one-eighth of the weight of oxygen. Whence—

$$H_1 = H - \frac{O}{8}.$$

The air required for the hydrogen in one pound of this fuel will therefore be—

$$\text{Weight of air} = \frac{34 \cdot 8}{100}\left(H - \frac{O}{8}\right) \text{ lb.}$$

$$\text{Volume of air} = \frac{457}{100}\left(H - \frac{O}{8}\right) \text{ cu. ft.}$$

And for the carbon in the same amount of fuel, it will be—

$$\text{Weight of air} = \frac{11 \cdot 6\, C}{100} \text{ lb.}$$

$$\text{Volume of air} = \frac{152\, C}{100} \text{ cu. ft.}$$

Thus, the total amount of air required by the chemical process, per pound of the fuel, will be determined by the formulæ—

$$\text{Volume of air} = 4 \cdot 57\left(H - \frac{O}{8}\right) + 1 \cdot 52\, C$$

$$= 1 \cdot 52\left(C + 3\, H_1\right) \quad . \quad . \quad . \quad . \quad (34).$$

To obtain the weight of air we must divide the volume by 13·14. In a similar manner we may determine the quantity of the products of combustion, arriving at the formulæ—

Total weight of gaseous products of combustion of 1lb. of fuel in air. $= 0 \cdot 126\, C + 0 \cdot 358\, H_1$. (35).

Standard volume of gaseous products of combustion of 1lb. of fuel in air $= 1 \cdot 52\, C + 5 \cdot 52\, H_1$ . . (36).

The amount of excess of air required is determined by practical considerations of the character of the fuel and of the furnace in which it is burned. This is discussed in the chapters on the practical application of fuels. The methods of determining volumes of gaseous products of combustion and other gases at other than standard temperature and pressure will be discussed in a later section.

Heat of Combustion.—The heat which is developed by the combustion of a fuel is measured in terms of various units. One of the most common is the *British Thermal Unit* (B.T.U.), which is equal to the amount of heat required to raise one pound of pure water one degree Fahrenheit, the water being initially at its maximum density (39°·1 Fah.). The number of thermal units developed by the combustion of one pound of any fuel in air, all the heat generated being taken into account, is called the *total thermal value* of the fuel, or briefly, the thermal value. In calculating the thermal value of a compound fuel it is customary, though undoubtedly incorrect, to assume that the value for the fuel is the sum of the values for its elementary constituents, the net value of the hydrogen after the equivalent of oxygen has been subtracted being taken as the percentage of hydrogen. This has the merit of convenience, although there is necessarily an error, generally, however, of small value, introduced on account of the elements being more or less completely combined into chemical compounds. Thus, for example, a hydrocarbon gas has in actual fact a less thermal value than the separated hydrogen and carbon of which it is composed would have; less, indeed, by the amount of heat energy liberated by the combination of the elementary substances into the compound hydro-carbon which they form. As a rule, however, especially in the case of solid fuels, it is unimportant to notice this difference. The following are the approximate thermal values in British thermal units of one pound of various simple fuels:—

Hydrogen	62,000
Carbon	14,500 (to CO_2)
Carbon monoxide ...	4,325 (to CO_2)
Sulphur	4,032

Retaining the original meanings for the symbols H, H_1, C., and O, we may express the thermal value of any fuel in the following equation:—

$$(\text{B.T.U.}) = 62{,}000 \,.\, \frac{H - \frac{O}{8}}{100} + 14{,}500 \,.\, \frac{C}{100},$$

which may be simplified into

$$(\text{B.T.U.}) = 145\,(C + 4 \cdot 28\, H_1) \quad . \quad . \quad . \quad . \quad (37)$$

Evaporative Power.—It is often convenient to express the heat of combustion of a fuel in terms of the number of pounds of pure water which that heat would evaporate. It is usual to specify that the water shall be initially at the boiling point (212° Fah.), and that it shall all be evaporated from and at 212° Fah. The number of pounds which might thus be evaporated by one pound of fuel, assuming the whole of its heat could be used for the purpose, is called the total *evaporative power* of the fuel. Since it requires 966 B.T. units to evaporate one pound of water from and at 212° Fah., it follows that the evaporative power is equal to the themal value divided by 966, or roughly, divided by 1,000.

Dynamical Value.—In other cases, it is convenient to express the heat energy of one pound of fuel in terms of the mechanical work which it would do if the whole of it could be utilised. This is called the *dynamical value* of the fuel. It will be shown later that one B.T.U. is equivalent to 772·55 foot-pounds of energy. We may, therefore, obtain the dynamical value of a fuel by multiplying its thermal value by 772·55.

Coal.—The name *coal* is given to a widely-varying class of petrified organic compounds which are the remains of vegetable growth of ages long gone by. Coal usually consists of carbon, hydrogen, oxygen, traces of nitrogen and earthy matter, this last forming the *ash* after combustion. Coal also may be said to consist, in general, of volatile and non-volatile, or fixed, constituents. The volatile constituents include compounds of carbon and hydrogen — which are highly valuable — water and ammoniacal compounds — which are wasteful of the heat. The fixed constituents include uncombined carbon and earthy matter.

The destructive distillation of coal ultimately leaves a residue of solid matter, more or less porous, consisting of the fixed carbon and the ash. This is known as *coke*, and is largely used as a fuel. Coke is commercially a by-product in the manufacture of coal gas; coal being subjected to destructive distillation for the purpose of obtaining the volatile hydrocarbons in gaseous form. Being a by-product it often happens that the prepared article is cheaper than the raw material, which accounts for its common use in place of coal, especially in countries where coal is dear.

Analysis of Coal.—It will be convenient to divide the various kinds of coal into the following classes:—(1) anthracite; (2) dry bituminous coal; (3) caking bituminous coal; (4) long flaming coal, and (5) lignite. We may also consider two divisions: caking coal and non-caking or free-burning coal. The first two classes belong to the second division; the remainder are more or less caking. Free-burning or dryness in coal is generally caused by the absence or small proportion of bituminous hydrocarbons; or by the hydrocarbons which are present being of a light and highly volatile nature. Heavy, tarry hydrocarbons, and in some instances water, will cause the coal to soften and coalesce into a cake, which, however, often again becomes more or less free-burning on the

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vaporisation of the volatile matter. The anthracites are a class of heavy coal, composed almost entirely of carbon, and practically destitute of hydrocarbons. They require a very high temperature for their combustion; are liable to chip into small pieces if suddenly heated; and burn with a short, lambent blue flame, or without any flame at all, developing intense heat within a zone quite close to the fuel. The free-burning bituminous coals contain from 70 to 80 per cent. of carbon, of which from 50 to 60 per cent. of the weight of fuel is fixed; and there is from 15 to 20 per cent. of volatile matter. They are capable of very perfect combustion, owing to the freedom with which air can pervade the glowing mass of fuel. The caking bituminous coals contain from 20 to 67 per cent. of volatile matter, and may have as small a quantity of fixed carbon as 10 per cent. All the bituminous coals swell considerably during combustion, and emit yellow flames of burning hydrocarbon. Cannel coal is almost free-burning, and develops long hydrocarbon flames; it has an average of 84 per cent. of carbon, of which a greater proportion is fixed than in the bituminous coals. Lignite, or brown coal, is an inferior quality of fuel, being intermediate between coal and peat. Both cannel coal and lignite develop long flames, which are liable to produce smoke unless specially dealt with. The former, which is specially used for making coal gas, is an exceptionally rich quality of fuel when burned in suitable furnaces. British steam coals are anthracitic or moderately bituminous; they develop flames of short or moderate length, and are imperfectly liable to cake. The more bituminous and long-flaming British coals, such as Boghead cannel, are most commonly employed for gas manufacture and in open grates, their use for raising steam being limited owing to their sensitive nature and liability to inefficiency.

Electric-light engineers may find it convenient to classify coals under two heads: steam coals and gas coals. The distribution of these over the surface of the globe will very much affect the growth and distribution of electric lighting. The distribution of coal is not strictly natural; for, especially in the case of steam coals, the establishment of a Government coaling station at a place where no coal naturally exists will, of course, affect the supply and price of coal at that place. Where steam coal is cheap and abundant, either by natural occurrence or by importation, and gas coal is absent or very scarce and dear, the electric light is placed under favourable conditions as compared with gas. Where, however, steam coal is not abundant nor cheap, while gas coals are plentiful, the production of coal gas is remuneratively and cheaply carried out; and electric light can only compete with gas by the adoption of generating plant capable of dealing either with the local coal itself or with the coal gas which is supplied from it. These considerations are again very much modified where there is water-power cheaply and abundantly available.

Small Coal and Patent Fuel.—Breakage of coal during transit from the workings to the furnace is usually very considerable, and it becomes a matter of great importance to be able to economically consume the large amount of small coal, or *slack*, which is thereby produced. Caking slack can be burned in ordinary grates with little difficulty, even without mixing; but dry slack must either be mixed with fuel, which will prevent it from falling between the fire-bars, or special fire-bars must be used, or else the slack must be previously made into large blocks by admixture with some binding material. Slack is largely and very economically used in furnaces which are mechanically fed, but in ordinary cases block fuel is found to give satisfactory results. Patent block fuel, which possesses a high thermal value, is prepared by mixing the powdered slack with about 10 per cent. of its weight of tar or pitch. The mixture is softened by heating, is next moulded into blocks resembling large bricks, and finally is hardened at a high temperature. This fuel requires careful treatment in the furnace, owing to the large amount of heavy bituminous matter contained in it and the consequent liability to produce smoke if not properly burned.

(To be continued.)

FRENCH CABLE ENTERPRISE.

So much has been said of late about French cable enterprise that it may not be without interest to take stock of what the French have actually done in the immediate past, and what they are seriously proposing to do in the immediate future.

The first group of colonies to benefit by the newly-awakened desire of France to lay cables were the French possessions in South America and the West Indies. In 1887, M. Granet, the then Minister of Posts and Telegraphs, brought forward a *projet de loi*, the object of which was to "create less expensive and surer means of communication with Guadeloupe and Martinique, and to release French Guiana from the telegraphic isolation in which it has remained up to this date." The scheme then proposed was to connect together Cayenne, Martinique, Guadeloupe, and Puerto Plata (San Domingo), a line to

Fig. 1.

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be then extended northwards to New York, and another southwards from Cayenne to Vizeu (Brazil), and in that way the system was to be doubly connected with the general telegraph system of the world; branch lines were also to be run to the island of Curaçao, to Venezuela, and New Grenada. The French Government was to guarantee a net revenue of £40,000 for 25 years, the working expenses being estimated at £8,000, and the receipts at £86,000. Although the scheme was most favourably reported on by the Committee charged with the duty of examining it, the *projet de loi* was rejected by the Chamber of Deputies. A very similar cable network has, however, since been carried out by the Société Française des Télégraphes Sous-Marins, aided by a total annual subsidy of £8,800 from the colonies of Guadeloupe, Martinique, and Guiana, the system as at present existing being shown on the accompanying sketch map (Fig. 1). Instead of the proposed Puerto Plata-New York cable, a more modest extension has been made to Santiago de Cuba, with branch lines to Môle St. Nicolas and Port-au-Prince (Hayti). All these cables were laid in 1888-91 and have a total length of 3,754 nautical miles, their first cost aggregating close upon £720,000. The annual receipts for the first three years up to December 31, 1892, have averaged £29,450, and the working expenses £24,200, no money being set aside for renewals, and interruptions having been few during that period. During 1893 there have been numerous repairs and interruptions, and at present the Cayenne-Paramaribo, and the Cayenne-Vizeu cables are interrupted, the first since October 25, 1893. Under these circumstances it is not surprising that the *Bulletin de l'Electricité et de la Télégraphie* should remark that "it is not the results of the working of the Antilles cables by the Société Française des Télégraphes Sous-Marins that will overcome the prejudice of the French public against submarine telegraph company shares."

Detailed information with regard to the cable enterprises now in contemplation will be found in a series of articles published last December in the above-mentioned newspaper. The French possessions in the West Indies having been more or less satisfactorily connected, from a French point of view, to the general telegraph system of the world by private enterprise, it is now proposed to similarly join together the French possessions off the East Coast of Africa, the French Government this time bearing the brunt of the undertaking. The articles in question commence by detailing the various negotiations which finally resulted in the laying of the Zanzibar-Seychelles-Mauritius cable in the autumn of last year. The island of Mauritius appears to have been all along remarkably pertinacious in this matter, and when we consider the great commercial value to that colony of telegraphic communication with the rest of the world, its pertinacity is not surprising. Mauritius is situated 550 miles east of Madagascar; it has a busy population of nearly half a million; its total exports are valued at over two millions, and its total imports at a million and a-half. The one great crop of the island, however, is sugar, which is exported to the value of over £1,800,000 every year, and it was the disadvantage at which the island was placed in selling this commodity that has induced the Council of Government to make such efforts to secure a cable, previous to the laying of which three weeks at the very least elapsed before buyer and seller could complete a negotiation. So far back as 1873 a subsidy of £10,000 was voted by the colony; in 1888 negotiations took place between the English, French, and Mauritius Governments and Sir John Pender on behalf of the Eastern and South African Company. In 1890 M. de Coriolis, a member of the Council of Government, came to Europe to try and negotiate a loan of £3,000,000 for cable purposes, with England and France as guarantors. The idea was favourably received in Europe, but rejected by the colony as too grandiose. After prolonged negotiations, however, the common interests of England, India, and Mauritius resulted in a subsidised cable being laid, at the end of last year, by the English company named, between Zanzibar and Mahé (Seychelles), a distance of 1,172 nautical miles, and between Mahé and Port Louis (Mauritius), a distance of 1,115 nautical miles (*see* Fig. 2).

France, with its important possessions thus left out in the cold, is now eager to make up for lost opportunities. A short length of cable of 170 miles would indeed suffice to place Réunion in telegraphic connection with the rest of the world *viâ* Mauritius and the Seychelles, but a more ambitious scheme is on foot. The present intention of France is to make Mozambique, where landing rights have been conceded by Portugal to France, the point of junction between its colonial cable system and that of the English companies. From Mozambique the idea is to run a cable to Mayotta, thence to Nossi Bé, and thence to Diego Suarez and Tamatave. The total length of this cable would be 1,239 nautical miles, and the estimated cost is £182,000.

"Such," says the *Bulletin de l'Electricité*, "is the first cost of the Madagascar cable system, on which interest at the rate of $4\frac{3}{4}$ per cent. will have to be guaranteed, as well as a renewal fund to renew the cable within 25 years. If we add for maintenance and repairs a sum of 65fr. per kilometre, in accordance with the data upon which this item was based in connection with the Zanzibar Seychelles-Mauritius cable, we shall require a minimum annual revenue of 462,500fr., no allowance being made for the working expenses of the six stations, which cannot be estimated at less than 150,000fr., and which

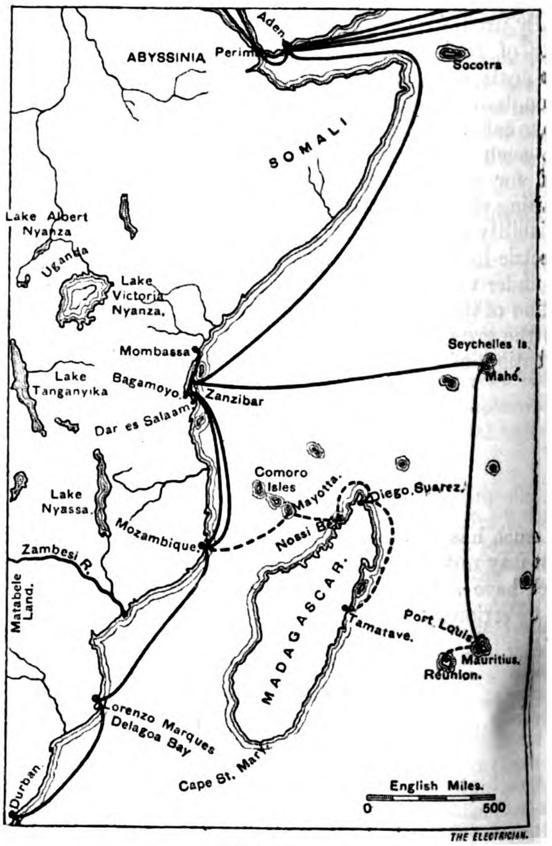

FIG. 2.

we cannot hope will be covered by the Madagascar message revenue, which it is difficult to estimate, and for which there are no data to go upon except the returns for 1891-92, which give an average of 4,700 words per annum. If Réunion is to be connected to Madagascar, the return, at the same rate as above, upon the capital outlay of 1,690,000fr. necessary for this 845-kilometre cable, will call for a revenue of 168,000fr. However, as the connection of Réunion with the general telegraph system of the world is almost entirely a matter of commercial interest, it would suffice to connect it up by way of Mauritius, which would involve a much smaller outlay. Whatever may be the decision as regards the size and nature of the system of cables which is to be laid down in Malagasian waters, it is impossible to attach too much weight to the imperious necessity of maintaining and repairing it in the most effective manner; if this be not done, all the expense of establishment will be thrown away."

The only remaining French cable to be mentioned is that just laid between Queensland and New Caledonia, of which the *raison d'être* is certainly not commercial.

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THE BLACKPOOL ELECTRIC TRAMWAY.

The following summaries of the Reports on the state of the Blackpool Electric Tramway, presented to the Town Council by Mr. J. Hesketh (borough electrical engineer), and Messrs. T. Parker and Holroyd Smith, will be read with interest:—

Mr. Hesketh states that the engines and boilers are in good average condition, only the governors requiring renewal, and in his opinion there are many years' work yet to be got out of them. With regard to the belting and shafting it is pointed out that the engines drive on to a countershafting by means of ropes, and from the countershafting to the dynamos by means of two link leather belts. The ropes on one engine have had to be replaced, the old ones being worn out. Before replacing them it was occasionally necessary to stop one engine and start the other when ropes broke. These stoppages were on an average three to five minutes in duration. On September 9, 1892 (the first day on which the Corporation controlled these tramways), the main belt of No. 1 dynamo broke. Since that date to about August, 1893, one or other of the belts have given trouble on an average every ten days. These did not, however, cause stoppage of the cars, one dynamo being able to do double duty until the necessary repairs were carried out. It was, however, in the early part of September last that the more serious trouble with the belts began, and on August 24th Mr. Hesketh reported to the Committee that the belts were rotten and "running under protest." However, had the load on the dynamos been regular, even though heavy, the belts and all the parts would have borne the strain safely. It was owing to the excessive and *irregular* strains that the trouble arose, and that the care of these belts became a dangerous occupation. The hole in the roof of the engine-room, Mr. Hesketh remarks, still stands as a testimony to one of the many breakages. The dynamos are in a condition equal to that in which they were handed over to the Corporation, with the exception of the commutator of one machine, which is worn out. No stoppage has been caused by this. Trouble, however, has been experienced owing to the breaking of armature connections. This is due almost entirely to the heavy strains arising from the "short circuits" and "cut outs." The motors have run well, with one or two exceptions, considering their condition when handed over to the Corporation. The field-magnet windings have had to be renewed in some cases, and repaired in almost all. In one or two cases wires had been ripped bodily off the framework of the motor by the steel end of the collector rising and catching the motor on a "break away" happening at a narrow part of the channel. The wiring in the cars has given considerable trouble, and in most cases has been renewed. The old joints had been made with salts as a flux, and even though the action was slow it was certain, and at the end of 7 to 7½ years *all* the joints so made became useless. This, remarks the Borough Electrical Engineer, is interesting, as giving the life of a badly made joint, but as an experience on taking over the old Company's system it is disheartening. In discussing the question of the centre channel and collector, it is stated that the cover rails being fixed, it becomes an impossibility to examine the connections and insulators frequently. Nor can the whole of the insulators be cleaned more than once a year, and even on this occasion they cannot be freely handled. The freedom with which dirt enters the channel is well known. In removing it, it is impossible to avoid leaving some amount round the insulators. In the course of a month or two this becomes a serious consideration, and at the end of twelve months the leakage of the first few hours of the day is sufficient to drive 10 to 20 cars. Then the cover rails expand and contract with varying temperatures, supporting-chairs in many instances break, and the slot which should be $\frac{1}{2}$in. diminishes to $\frac{3}{8}$in., or even less. It should be borne in mind that through this slot has to pass the current-carrying conductor to the motors, and that this *must* be well insulated. To make an efficient collector for this system to pass through a $\frac{3}{8}$in. slot is impossible. By an *efficient* collector is meant one that will run a week without causing any trouble in any kind of weather. During the past year there have been days on which as many as 24 to 30 collectors have been sent into the shed for repairs.

It is my firm conviction, says Mr. Hesketh, in conclusion, that if the channel construction had originally been such as to admit of a wider slot with more perfect insulators and collectors, the trouble we are at present experiencing would never have occurred. And if the Committee is desirous of making the present system run, the only manner by which, in my opinion, it can be done, is by attention to these points. It would not be justice to the staff, who have had to bear the brunt of these troubles, if I did not here record how well they have striven to meet the difficulties as they arose. I am convinced that had not they in my department, and the Traffic Manager with his staff in his, done their level utmost up to, and more especially since August last, the complaints would have been, if not more frequent, at least more justifiable.

Mr. T. Parker reports:—The channel and conductor are in better condition than I expected, and there are no difficulties other than have had to be encountered by the Company in working the line. At a number of the crossings the parts have worn and fallen out of form. These need a little planing or fitting, and the road at these points will require to be adjusted. The channel in many parts has closed in, due to the weight of the traffic. To remedy this the steel pieces will have to be taken up on the outmost convenient side, to give the slot a minimum width of $\frac{5}{8}$. At the same time the whole of the insulators and conductors could be examined and corrected. The wood pavement has closed the gauge of the line in some parts, and this will always be a trouble unless provision is made to permit of the expansion of the pavement towards the footway, and prevent the closing in of the guage. The electrical machinery at the generating station and the car motors have fallen into a sad condition of delapidation. Considering the whole problem in the interests of the Corporation, there seems but one line to follow—the overhauling of the road to bring it up to a working condition, and the overhauling of the motors and car gearing so that they will work out their duties until the larger problem can be reconsidered when the extensions are decided upon. I would, therefore, suggest that one machine should be put down, which shall be a suitable unit for driving the tramways when the larger scheme is adopted, and this machine be up to date, powerful enough to use the power of both present engines, and sufficient in itself, with a spare armature as a reserve, to work the tramway as it now is, until the extension and system shall have been determined, when the spare armature could be fitted to a pair of magnets making two machines which would be sufficient power to deal with the proposed extension, whilst for the temporary arrangement the spare armature would be a stand-by in case of anything happening to the other armature.

Mr. Holroyd Smith says: The tram rails and channel steel, considering the time the line has been in use, are in very fair condition, and may be considered good for many years to come. With few exceptions, all the rail points need attention; some of them are in a bad condition, and will require renewing. Where wood paving has been employed, the gauge of the rail was tight, whilst in other places the gauge was wide, the variation between the two being about three-quarters of an inch. This is distressing to the car wheels. Some hydrants of the salt water supply were leaking, the water finding its way into the electric channel mostly at the rail crossings, which are in a defective condition. Many channel chairs were broken, probably by the heavy load taken over the road for supplying materials for the tower and south pier. In some places the slot was its original and correct width, but considerable difficulty has been experienced in maintaining it in others; in many places the slot is too narrow for the safe passage of the collector. Nearly all the caps which cover the nuts holding the steel channel in places were broken. The drivers informed me that the contracted channel caused them much trouble; in many instances the collector jammed, tilted up, and the hook ripped open the field wires of the motors. This has evidently resulted from an attempt to force the collector through a tight place instead of correcting the slot; for the collectors are so designed and should be so attached to the car that when an obstruction occurs they will be automatically released and cause no damage. It has been a mistake to abandon this practice. The majority of the sump-holes were full of mud; in some the outlet was choked. Several were rusted fast, and, presumably, have not been opened for some time. A few sump-holes were fairly clear of mud, from which it may be reasonably inferred that with due attention the others might have been kept the same. A number of insulators were broken or defective; none were quite clean. All the copper tubes that have been in for any length of time are corroded where the wooden stud of the insulator supported them, due to electrolitic action, and the corrosive action of salt water. The present shape of insulator with the wooden studs was adopted notwithstanding my emphatic protest and prediction of the present result. Only those tubes that have recently been fixed are fit to remain; the rest are so corroded they should be removed. I was only able to find six U couplings; of these, three were in fair condition, the rest bad and in a condition to account for a large percentage of leakage.

The condition of things in the shed was deplorable—dirt and confusion where everything should be clean and in order. The tramcars are mostly in a poor condition; in many cases the "horn" plates are severely strained, I noticed broken wheels and a broken axle. Two open summer cars that have been little used, and apparently in good condition, are littered with old iron and rubbish. The motors have been removed from the cars; they were somewhat carelessly stored in the dynamo room; they were in a dirty condition; in every one the lids were missing from the oil cups, in some the commutators were worn out and the field windings damaged. Many parts of gearing were lying about the shed, but no set complete. I found that my original design of gunmetal invert wheels, held in a cast-iron casing by wooden blocks to deaden the sound, had been abandoned, and cast-iron inverts used instead; cheaper certainly, that is all. The dynamos were covered

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with moisture and dirt, to the risk of destroying their insulation; the commutators are worn out, and the connections to the armatures are defective in many places. Still, I consider them serviceable machines, and, if put and kept in order, fully able to supply electric energy sufficient for all the cars that can be run upon the existing line.

By sending a current into the line it was found that the insulation resistance was little more than one ohm. While recognising that owing to the saline moisture of the road, the frequent sea-flooding and sand-storms, Blackpool is, perhaps, the most difficult place that could be selected for the construction of an electric tramway with the conductors underground, and, further, that the line was the first of its kind, there being no precedent for guidance, and that the conditions imposed were difficult to fulfil (that requiring so narrow a slot being specially to be regretted), yet the line as originally designed and constructed has for many years been successfully worked, though it requires painstaking and skilful attention. To restore the line to its original state, all the existing insulators with wooden studs would have to be removed and another type used. The number of insulators would be 2,000 instead of 9,000, as now, and the insulation of the line would be proportionately increased, and the excessive loss through leakage which now occurs would be reduced to a minimum. Though the existing motors are in a bad condition I see no reason why they should not, at a small expense, be put into a thorough state of repair. The whole of the material at the shed requires overhauling. For the present the tramway working should not be combined with the Electric Lighting Station. The plant when put into proper order is amply sufficient for the existing line and the number of cars that can be run thereon.

THE PUBLIC SUPPLY OF ELECTRICAL ENERGY: ITS COST AND PRICE.*

BY A. BROMLEY HOLMES, M.INST.C.E.

Three years ago the author had the privilege of reading before this Society a Paper descriptive of the Liverpool Electric Supply Company's stations, in which the plant used was described and the subject dealt with solely from an engineering point of view. The object of the present Paper is to regard the distribution of electrical energy from what may be termed the commercial point of view; that is to say, to deal with the items forming the cost of production and the considerations which decide the price and method of charging for the supply. Before proceeding with his subject the writer would desire to place on the records of this Society a few figures with regard to the progress of the local company referred to above since the date of his previous paper. At the end of the year 1890 the number of lamps supplied was 12,000, the length of mains 20 miles, the maximum output 4,000 amperes. At the present time there are 25,000 lamps supplied, the length of mains is 30 miles and the maximum output over 9,000 amperes. A new central station has been constructed in Lark Lane for the residential district of Sefton and Princes Parks. The system of supply is the same as in 1890, such modifications in minor details having been made from time to time as experience has shown to be advantageous.

In dealing with the cost of production and selling price of electrical energy it is convenient to adopt as the basis of calculation the Board of Trade unit. This unit is equivalent to a current of 10 amperes at an electromotive force of 100 volts flowing for a period of one hour. It represents approximately the amount of electricity consumed per hour by two arc lamps, each of 1,000 c.p., or by eighteen 16-c.p. incandescent lamps. The items which form the cost of production and distribution may be divided broadly under three heads: (1) Coal, oil, water, wages and repairs; (2) Rent, taxes, office expenses and management; (3) Depreciation and interest on capital.

To obtain figures which represent practical work the author has analysed the working costs of eight of the largest supply companies, which distributed in the year 1892 a total of 7,259,000 units, and for which companies the various items of cost average as follows:

Coal	1·14	pence per unit.
Oil, water, stores	0·19	" "
Wages	0·87	" "
Repairs	0·45	" "
Total works costs	2·65	
Rents, taxes, &c.	0·18	pence per unit.
Management and office expenses	0·73	" "
Total expenses	0·91	" "

In dealing with the third item—viz., depreciation and interest on capital—the author finds that the expended capital of the eight companies referred to averages 57 pence per unit distributed. Assuming a charge of 5 per cent. for depreciation and 5 per cent. for interest, a total of 10 per cent. on the capital expended, or 5·7 pence per unit, may be taken for the purpose of the present calculation. The total costs would then stand as follows:—

Works costs	2·65	pence per unit.
Other expenses	0·91	" "
Depreciation and interest	5·70	" "
Total	9·26	" "

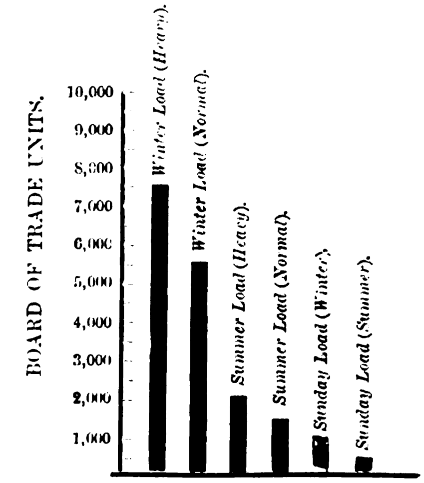
The average price obtained by the eight companies in 1892 was 6·45 pence per unit, and although this price afforded a good margin beyond the actual cost of works and management, it is obvious from the above figures that depreciation and interest were not sufficiently provided for. The figures for the year 1893 are not yet available, but no doubt they will be somewhat more favourable than the above, though the exceptionally fine autumn, the greater care exercised by consumers in the use of the light, and, lastly, the coal strike, are causes which have prejudicially affected the revenue of electric supply companies during 1893.

It may be of interest to examine the items of cost *seriatim*, with the view of considering the conditions which affect them and the possibilities of reduction.

First to take the coal bill. The greatest difficulty that supply station engineers have to deal with is the great variation of load—a variation that is often extremely rapid and not unfrequently takes place at quite unexpected periods, as, for example, in the case of a thunderstorm in summer or a sudden fog in winter. With a varying load it is practically impossible to run the engines under the most economical conditions. The efficiency of a modern combined engine and dynamo (that is to say, the ratio of electrical output to indicated horse-power) may be almost 90 per cent. at full load, whereas at one-third load it will only be about 60 per cent. The lesson to be drawn from this is that the smallest set of plant in a station should not have a greater output than (say) one-tenth of the maximum output of the station, and that generally the size of plant selected as a unit should be chosen with due regard to the load diagram of the station, so that the engines may always be run fairly well loaded. The following figures will give some idea of the variations of load of stations supplying electricity almost entirely for lighting purposes. During the past year the output of the Liverpool stations, with about 24,000 16-c.p. incandescent lamps (or their equivalent) connected to the mains, has been (*see* Diagram 1)*—

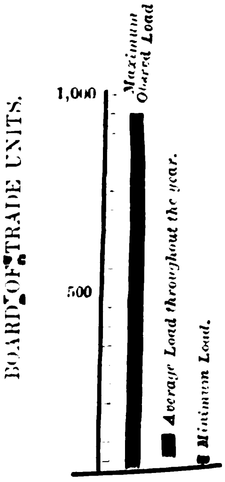
For a normal winter day	5,500	units.
" heavy " "	7,500	"
" normal summer day	1,400	"
" heavy " "	2,000	"
" Sunday in winter	1,100	"
" " " summer	520	"

DIAGRAM 1.



Output of Liverpool Central Stations during Summer and Winter.

DIAGRAM 2.



Maximum, Minimum, and Average Load of the Liverpool Central Stations.

The rate of output has varied as follows:—On a heavy winter day from 912 to 29 units per hour, with an average of 313 units throughout the 24 hours; and on a normal summer day from 143 to 11 units per hour, with an average of 59 units for the 24 hours. The maximum load during the year has been 929 units per hour and the minimum 6 units, the average load throughout the year being about 110 units per hour. (*See* Diagram 2.)

[* We have taken the liberty of giving our readers a graphic representation of Mr. Holmes' figures.—ED. *E.*]

* Abstract of a Paper read before the Liverpool Engineering Society.

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Mechanical stokers render it possible to burn a cheaper class of fuel than is possible with hand stoking, but fuel should be selected, not necessarily at the lowest price per ton, but of such a class as is found by experiment to evaporate the most water for a given expenditure. Sufficient consideration is often not given to the fact that in an electric light engine room cleanliness has a real money value. Wages are an important item of expenditure. The men employed must be fairly paid, and economy must be sought by making all the working conditions of the plant as simple as possible, so as to avoid any unnecessary labour.

In the earlier portion of the Paper 10 per cent. has been put down for depreciation and interest. Depreciation naturally varies very much with the various items of capital expenditure. A percentage that would be reasonable for boilers and moving machinery would be excessive for buildings and for street mains. The exact rates of depreciation on such articles as meters and accumulators have yet to be fixed from experience. As far as can be seen at present an all round rate of 5 per cent. for depreciation is a fair basis for the present calculation. With respect to the rate of interest a return of 5 per cent. will attract the necessary capital for electric light and kindred undertakings when carried on by companies. Municipal corporations can borrow at lower rates, but in compensation for cheap money they would appear to suffer from disadvantages which prevent them from carrying out their work more economically than other people.

A reduction in the cost per unit under this head must be sought in the smaller amount of locked up capital per unit generated that may be looked for as the demand for electrical energy increases, not only for lighting, but also for power purposes. As far as the writer is able with his present experience to form an opinion, there is reason to expect that the costs given above may gradually be reduced to the following rates :—

Works costs	1·5	pence per unit.
Management	0·5	" "
Depreciation and interest	3·0	" "
Total	5·0	

or little more than half the figure arrived at from the returns of the eight companies referred to above for the year 1892.

As regards the selling price of electrical energy in the earlier Provisional Orders granted by the Board of Trade, the maximum price to be charged was fixed at 1s. per unit. In the more recent orders the maximum rate has been reduced to 8d. The Electric Lighting Acts forbid any undue preference in favour of any particular consumer, and it is therefore necessary either to make a fixed charge to everybody or to adopt some system of sliding scale that will be equally just to all classes of consumers. It is obvious that a consumer who uses 1 H.P. for 1,000 hours per annum is a much more desirable customer than one who uses 10 H.P. for 100 hours per annum, for, although each of them uses the same total quantity of energy, the plant required at the station to supply the former customer is only one-tenth of that required to supply the latter. In the Liverpool Electric Lighting Licence issued by the Board of Trade in 1888 this fact was recognised, and a sliding scale clause was inserted. More recently the Manchester Corporation have offered their consumers either the statutory rate of 8d. per unit, or, as an alternative, a fixed charge of £3 per quarter for every unit per hour consumed when all the lamps or other consuming devices are in use, and 2d. per unit for each unit supplied as measured by meter. Both the Liverpool and Manchester methods recognise the value of the long-hour consumer and seek to encourage him by a differential rate of charge. What the result of the Manchester system may be remains to the seen; but in Liverpool, after four years' trial of the sliding scale, it was found desirable to abandon it and to adopt in its place a uniform rate of charge.

Some supply companies offer a discount to consumers who use more than a stated quantity of electricity, irrespective of the rate at which that quantity is consumed. Such a system would seem to press unfairly on small consumers, and to compare unfavourably with the Liverpool and Manchester sliding scales, which give equal advantages to all classes of users. Again, some companies offer a discount to consumers who pay their accounts without application within a specified time. This plan deals out a kind of rough-and-ready justice by making those consumers whose accounts have to be collected with more or less difficulty pay the cost of collection.

The simplicity of a fixed rate of charge has much to recommend it, and the interests of the greatest number of consumers are probably best secured by a system of uniform charge rather than by one which gives advantage to a limited number of consumers at the expense of the rest.

This Paper so far has only dwelt with the cost of producing and the price for selling a unit of electrical energy without any reference to the amount of light that can be produced by it. The price charged for electrical energy for lighting purposes is so constantly compared with that of gas, that a few figures of comparison may, in conclusion, perhaps, be of interest. A gas burner consuming 5ft. of gas per hour will, with Liverpool gas (which is of higher illuminating power than any other public supply of gas in the kingdom), produce a light of 20 candles. Experiments made in London and elsewhere have given much less favourable results, and probably even in Liverpool the average house gas burner in average condition does not afford more than 16 c.p. for the consumption of 5ft. of gas per hour. Assuming gas to cost 3s. 4d. per 1,000, the above 16-c.p. burner would cost two-tenths (·2) of a penny per hour. An ordinary incandescent lamp consumes energy at the rate of 3½ watts per candle, and consequently a 16-c.p. lamp consumes 54 watts, and with electricity at 7½d. per unit costs four-tenths (·4) of a penny per hour, or just twice the cost of gas. Incandescent lamps consuming 3½ watts per candle may be expected to have a life of about 1,000 hours, and when lamps cost 3s. 6d. each a reasonably long life was an important factor. Now, however, that the patents have expired and lamps can be obtained at about one-fourth the cost it may pay to run them at a much higher efficiency with a shorter life. Lamps can even now be made which consume only 2½ watts per candle-power, and when such lamps can be shown to be fairly durable they will no doubt be largely used. Assuming that in the not very remote future electrical energy can be supplied at 5d. per unit the cost of a 16-c.p. lamp would be two-tenths (·2) of a penny per hour, or just the same as the present cost of gas.

LONDON CHAMBER OF COMMERCE.

ELECTRICAL TRADE SECTION.

An adjourned meeting of this body was held at Botolph House, Eastcheap, on Monday last, Mr. Emile Garcke presiding.

The Secretary (Mr. Kenric B. Murray) intimated that a meeting was held at the Mansion House the preceding week, the Lord Mayor being in the chair, at which it was decided that this Chamber, in conjunction with half-a-dozen gentlemen, appointed then as a committee, should act as an English Commission over the English section of the forthcoming Exhibition at Antwerp. Fairly satisfactory arrangements had been made, inasmuch as the British Consul General had, with the sanction of the Foreign Office, consented to act as British Commissioner from motives which were purely disinterested, beyond endeavouring to develop British trade in Antwerp, other parts of Belgium, and the Continent generally. The Consul's action, apart altogether from the financial side of the question, would be under the joint supervision of the said Committee and the Chamber of Commerce. They regarded the Antwerp Exhibition to some extent as an experiment from which they might learn a good deal to guide them in the future, when larger Exhibitions might be held in London and elsewhere. They had printed documents in regard to applications for space, the charges to be made for exhibits, and other such information, which he would be glad to place at the disposal of all concerned; and they would transmit to Antwerp all such applications, and acquaint the applicants with the replies received therefrom. They would gladly receive the co-operation of any trades, and particularly of those connected with the Chamber.

The Chairman said that he had approached several large electrical firms on the subject, but as far as he could gather they did not seem to show any inclination to send exhibits to Antwerp, but he thought it was only right that the Chamber should issue a circular to the members bringing to their notice the opportunities which they have of being represented at the Exhibition. He did not know of anything else that could be done.

Mr. Henry Edmunds said that one of the great difficulties in connection with all such exhibitions was that unless exhibitors were unanimous and pulled together it was found that there were only one or two individuals who spent a great deal of money who really reaped any return for their outlay.

The Chairman said there was no doubt that we were not improving our trade by abstaining from putting in an appearance at these exhibitions, but it was very hard that the onus should be thrown upon individual firms who found it very difficult to make both ends meet.

It was then resolved to issue the circular as suggested by the Chairman.

The Chairman said that the next question on the agenda was the report of the action of the Traction Committee. It had been suggested by several members of the section that it would be interesting to them to know what was the result of the suggestion which was discussed at a former meeting to constitute a special committee for the purpose of representing interests which were, if he might use the term, antagonistic to some extent to those of another part of the section. That arrangement had been carried out very satisfactorily, and it was of interest from this point of view that it showed that the London Chamber of Commerce afforded opportunities for the interests of other sections being adequately and fairly represented. They had been able to bring about an organisation

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of interests which was necessarily very satisfactory to those who were concerned in the matter, and which, he took it, had not in any way prejudiced the interests of the other members of the section as such. They were able by this organisation to raise a sufficient amount of money to consult counsel and to attain generally the objects which they had in view. It would be gratifying, therefore, to the section to know that if the occasion should arise in future there would be no difficulty in arranging with Mr. Murray so that they would be able to raise money, and apply it to their own purposes, and to have their own executive officers.

Mr. BEAUMONT asked whether there was to be any report from the Traction Committee, and whether the work for which it was formed has been accomplished.

The CHAIRMAN replied that the work for which it was formed had not been accomplished, but the Board of Trade had now the matter in hand, and had been drafting regulations in pursuance with the recommendations of that Committee, and until those regulations were completed the work of the committee could not be carried out.

This was all the business, and the members separated.

THE MAGNETIC PERMEABILITY OF OXYGEN.*

BY R. HENNIG.

The author utilised in these researches the method of Toepler, who by one observation determines the difference in the pressure exerted by two gases under the influence of a magnetic field, his principle being as follows: A glass tube of small bore is taken and bent into a slight elbow, and a small quantity of a liquid is poured into it in such a manner as to form a short thread of liquid separating the arms of the tube, the bend being, of course, at the lowest point. If the tube be now placed in a magnetic field, in such a manner that the liquid is in the centre and the limbs project, then if one limb is filled with a gas of greater magnetic permeability than the other, the pressure on the liquid will be greater on that side, and the thread will move up the tube towards the opposite side, and the amount of displacement is a measure of the permeability of both gases which can be determined in absolute measure. For call these permeabilities μ_1, μ_2, that of the liquid μ_0, and let them be in a field of strength H, and let the pressure on each side be p_1 and p_2 along the tube, then

$$p_1 = \frac{\mu - \mu_0}{2} H^2 \qquad p_2 = \frac{\mu_2 - \mu_0}{2} H^2.$$

Whence we get the equation to the force,

$$p_1 - p_2 = \frac{\mu_1 - \mu_2}{2} H^2,$$

producing the force on the thread of liquid. This can be equated to the force produced by the displacement

$$P = l \, . \, a \, . \, s,$$

Where l is the horizontal displacement in centimetres and the angle at which the limits are inclined, in circular measure, and s the specific gravity of the liquid in degrees per c.c. Thus we get the formula—

$$\mu_1 - \mu_2 = 2 \, l \, a \, . \, s / H^2,$$

which, it will be noted, is only true for a uniform field. A difference of pressure due to want of uniformity in the field may be detected by observing the deflection, all other conditions being identical when the limits are filled with the same gas; first for one of the gases under examination, and then for the other. Calling these deflections l_1 and l_2 the formula becomes modified into—

$$\mu_1 - \mu_2 = 2\,(l - l_1)\, a\, s / {H_2}^2\,;$$

or

$$\mu_1 - \mu_2 = 2\,(l - l_2)\, a\, s / {H_1}^2\,;$$

in which case H_1 and H_2 are the strengths of field at the surfaces of gases 1 and 2 respectively.

The author's chief object in these researches has been to determine the permeability of oxygen under various pressures, and his chief difficulty appears to have been in the sufficiently accurate determination of the magnetic field. He therefore goes into detail on the subject, chiefly of three methods; first, the optical method, by determination of the amount of rotation of the plane of polarisation, which is accurate, but has the disadvantage of requiring a darkened room; secondly, the induction method by slipping a coil of known area quickly into the field. This is the most generally useful method, but the mechanical details of the apparatus prevented its being always used. Thirdly, the bifilar galvanometer method of Weber, used by Kohlrausch for determining the horizontal intensity of the earth's field, the principle of which is as follows: a coil of area F is hung by a bifilar suspension (of controlling force D), which conveys a current, C, to the coil whose axis is horizontal, and whose plane is parallel to the lines of force of the field. The horizontal deflecting moment is H F C cos a, where H is the field and a the angle of deflection, and the controlling torque is D sin a; so that

$$H = D \tan a / F\,C.$$

This method has many advantages, chiefly the great range owing to the various values which can be given to C, the possibility of measuring the current and the deflection a very accurately by scale and mirror. The coil may have a copper damper, and so come to rest at once; and the whole thing may be made excessively small. By careful measurements the field was determined to well within 1 per cent.

The results of the observations, which up to date are confined to a comparison of oxygen and air, are summed up in a table, of which the following is an abstract. The author considers that, broadly speaking, they show that the pressure varies with the density of the gas and the square of the field, and that the ratio of the permeabilities should be a constant, the differences in the last column he puts down to errors of observation. The mean error is 3½ per cent., and the probable error of the result may be taken at 1 per cent.

Table II. contains a summary of the values obtained by other observers, and by the author. Note that for every degree (at about 20deg.) rise of temperature, the permeability falls by 0·7 per cent.

Table I.

No.	Gas-pressure.	Temperature.	Field.	Difference of permeability. $(\mu_1 - \mu_2) \times 10^{-6}$
	Mm. Hg.	C°.	C.G.S.	
1	75	26	5,700	0·0991
2	75	24	8.450	0·0993
3	75	23	10.340	0·0944
4	170	27	5.690	0·0975
5	153	24	8,360	0·0932
6	211	27	5.700	0·0983
7	297	26	5,430	0·0997
8	328	24	3,630	0·0908

Mean $(\mu_1 - \mu_2)$.................. $= 0{\cdot}0961 \times 10^{-6}$

Table II.

Observer.	Temp.	Pressure.	$(\mu_1 - \mu_2) \times 10^{-6}$ reduced to 1 atm.
Quincke........................	16°	1-8 atm.	0·097
		40 atm.	0·125
Du Bois........................	15°	1 atm.	0·093
Curie..........................	20°	5-20 atm.	0·121
Töpler and Hennig, 1888..	20°	1 atm.	0·131
Hennig, 1892	25°	1-4 atm.	0·096

THE EFFECTS OF LIGHT ON THE ELECTRICAL DISCHARGE.*

While engaged on his classical experiments, Hertz noticed that the appearance of the discharge between the two terminals of the oscillator was greatly changed upon the spark gap being illuminated by the light coming from another spark. This change was not due to an electrical action of the sparks, for it was equally well produced by other sources of light, such as the electric arc and burning magnesium, while all effect immediately ceased on interposing a plate of glass. Since the time when the above observations were made, many experimentalists have investigated this subject, and have obtained rather divergent results. In most cases the source of light employed has been the electric arc formed between carbon rods, though, with a view to increase the proportion of ultra-violet rays emitted, Bichat and Blondlot used carbon rods with aluminium cores, while Righi used a zinc rod for one terminal. Other observers have used the spark of an induction coil passing between terminals of copper, zinc, or aluminium. While Hertz had only noticed that the illumination of the discharging knobs increased the facility with which sparks passed, Wiedemann, Ebert and Hallwachs found that it was only when the negative terminal was illuminated that this effect took place. More recent observations by Branly have led to this view being modified, for he finds that on illuminating a piece of zinc by the sparks of a large induction coil produced between aluminium terminals, if the source of light is sufficiently near to the plate, the loss of charge is nearly as rapid for a positive as for a negative charge. On increasing the distance between the spark and the charged plate the decrease in the rate of

* Abstract from *Wied. Ann.*, Vol. L., No. 11, p. 485.

* From *Nature*.

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loss of charge is much more rapid for positive than for negative charges, and thus at some distance from the source of light the negative charge is the only one which is appreciably affected. Hence radiation of certain kinds increases the rate at which a positively charged body loses its charge, just as in the case of a negative charge, but the rays which are active in the case of positive electricity are absorbed by even a small thickness of air, while those rays which are unabsorbed are still able to accelerate the discharge of a negatively charged body.

After having made a series of experiments in air at ordinary pressures, Stoletow, on the one hand, and Righi, on the other, have investigated the influence of pressure on the phenomenon, and have both found that the effect increases with a decrease of pressure, while Stoletow has shown that if the rarefaction is carried to the extreme limit there exists a pressure, after which the effect decreases as the pressure is further diminished.

An experiment of Bichat's seems to show that the loss of electricity is due to convection currents, and this view has been further strengthened by Righi, who placed a plate of ebonite covered with tin foil on its upper side above a brass plate on which some figure, such as a cross, had been traced with varnish so that the plate was protected at these points from the effect of the illumination, the active rays being absorbed by the varnish. The negative pole of an electric machine was connected to this plate, the positive pole being connected to the tin foil, and the light of an electric arc allowed to fall on the under plate for a few seconds. The plate of ebonite being removed and powdered over with a mixture of sulphur and red lead a yellow cross on a red background was obtained of the same size as the one traced on the brass plate. As the sulphur attaches itself to those parts of the plate which are positively, and the red lead to those which are negatively charged, it follows that the parts of the lower plate which were not protected by the varnish have lost some of their negative charge, which has been carried on to the ebonite plate, and that this displacement has followed the lines of force of the electric field between the plates, which are in this case perpendicular to the two plates. This conclusion is further strengthened by observing that, if the electrified particles which escape from the lower plate are prevented, by means of a screen, from reaching the ebonite, a shadow of the screen is obtained.

The explanation that this convection is caused by the molecules of gas which, after being in contact with the body, become charged and are repelled, is hardly satisfactory, and the experiments of MM. Lénard and Wolf seem to show that it is particles of dust which carry the charge, for they suspended an insulated plate of metal in a box filled with air which had been carefully freed from dust. A plate of quartz fixed in one side of this box allowed the light from an electric arc to fall on the metal plate, while a stream of some vapour could be introduced through a side tube. Under these circumstances the vapour was condensed on allowing the light to fall on the plate if it was uncharged or negatively charged, while if the plate was positively charged no condensation took place. As it is known that a given space can become supersaturated with vapour when no dust is present, but that the introduction of the least trace of dust causes an immediate condensation, it appears that when a body either uncharged or negatively charged is illuminated it gives off some dust, and that the loss of charge is due to this dust. Further particulars of the work which has been done in this subject are given in a Paper by M. Blondin in *Electricité*, p. 313, 1893.

EXPERIMENTS ON A NEW RESISTANCE MATERIAL, "KRUPPIN."*

Messrs. Krupp and Co., of Essen, have recently brought out a new material for resistances which they call "Kruppin," the chief peculiarity of which is its high specific resistance. Herr Dettmar, of Frankfurt, has sent the results of some experiments on it to the *Elektrotechnische Zeitschrift*, from which it appears that the resistance varies with the hardness of the material, but becomes practically constant after the wire has been once annealed by heating to redness by means of a suitable current. The specific resistance is about $82 \cdot 9 \times 10^{-6}$ ohms per cc., which is about 50 time that of copper.

The temperature coefficient, measured between 75° and 15° centigrade, had an average value of 0·13 per cent. per degree. The author gives the results of a series of experiments on the amount of spacing in spiral coils of given diameter for which the rise of temperature is a minimum, or rather for which the current required to produce a certain temperature is a maximum, and his results in these cases are capable of general application. They are as follows: the coil heats least (when 12mm. in diameter) 2·2mm. wire, 15 turns per decimetre; 1·0mm. wire, 35 turns per decimetre; with a coil (of 2·2mm. wire) 18mm. in diameter, 18 turns per decimetre; with a coil of 6·0mm., and the same size wire, the turns had almost to touch one another. In the 13mm. coil the best result is attained by having the spaces equal to twice the diameter of the wire.

Finally, the results as to carrying power for various wires are given by the accompanying table; the limit of temperature allowed being that at which the wire "spits" when touched with the damp finger.

Diameter of wire.	Resistance.	Current carried by spirals.			
		In air.		On insulating cylinder.	
		Cnstnt.load	1 min. load.	Cnstnt.load	1 min. load
mm.	Ohms pr mtre	amps.	amps.	amps.	amps.
0·5	4·23	1·0	2·0	3·0	6·0
1·0	1·058	3·0	6·5	9·0	20·0
1·6	0·413	5·5	15·5	14·5	31·5
2·0	0·264	7·5	23·0	18·0	37·5
2·5	0·1690	10·5	34·0	21·2	43·5
3·0	0·1175	14·0	45·0	23·5	48·5
4·0	0·0661	21·5	75·0	—	—

All the above results apply to the best spacing for each spiral. "Kruppin" is also manufactured in sheets, but the author's experiments on this subject are not yet completed.

* Abstract from the *Elektrotechnische Zeitschrift*, December 15, 1893.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, February 2nd.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. Annual Meeting at 25, Great George-street.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting at 28, Victoria-street, S.W. Experiments illustrative of the Paper on "Multiphase Currents and their Applications," read at the last meeting, by C. V. Drysdale.

ROYAL INSTITUTION.

9 p.m Evening Discourse: "Bookbinding: its Processes and Ideal," by T. J. Cobden Sanderson.

MONDAY, February 5th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture. "The Detection and Measurement of Inflammable Gas and Vapour in the Air," by Frank Clowes, D.Sc.

TUESDAY, February 6th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Monthly ballot for members. The following Paper to be read: "The Transport of Petroleum in Bulk," by Boverton Redwood.

WEDNESDAY, February 7th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read: "Automatic Balance of Reciprocating Machinery, and Prevention of Vibration," by W. Worby Beaumont.

THURSDAY, February 8th.

SOCIETY OF ARTS.

4:30 p.m. Meeting of the Indian Section at the Imperial Institute. The following Paper will be read: "Telegraphic Communication between England and India: its Present Condition and Future Development," by E. O. Walker.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper will be read: "Some Notes on the Electric Lighting of the City of London," by Maj.-Gen. C. E. Webber, C.B., M.Inst.C.E.

FRIDAY, February 9th.

PHYSICAL SOCIETY.

5 p.m. Annual General Meeting. The following Paper will be read: "The Viscosity of Liquids," by O. G. Jones.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting at the Palatine Hotel, Manchester. The following Paper will be read: "Blackpool Electricity Works," by J. Hesketh.

JUNIOR ENGINEERING SOCIETY.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read and discussed: "The Construction and Working of Electro-motors," by A. H. Dykes.

ROYAL INSTITUTION.

9 p.m. Evening discourse on "Fortuitous Variation in Animals," by Prof. W. F. R. Weldon, F.R.S.

SATURDAY, February 10th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture on "Light," with special reference to the Optical Discoveries of Newton, by the Rt. Hon. Lord Rayleigh, F.R.S.

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The Electrician.

(The Oldest Electrical Journal, 1861—1878.)

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STEEL-PLATE PORTRAITS

Of Willoughby Smith; W. H. Preece, C.B., F.R.S. (President of the Institution of Electrical Engineers); Michael Faraday; Sir John Pender, G.C.M.G., M.P.; Sir William Thomson, F.R.S. (Lord Kelvin); C. H. B. Patey, C.B.; Dr. John Hopkinson, F.R.S.; Dr. Oliver J. Lodge, F.R.S.; Prof. William Crookes, F.R.S.; Prof. von Helmholtz; Prof. W. E. Ayrton; Lord Rayleigh, F.R.S.; Cyrus W. Field; Werner von Siemens; Sir James Anderson; Joseph Wilson Swan; and Mr. Alexander Siemens have been issued as Supplements to "THE ELECTRICIAN."

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BELT-DRIVING *v.* DIRECT-DRIVING, AND OTHER CONTROVERSIES.

The rivalry between alternate currents and continuous will not cease for many a year; and it is commonly supposed that it will only be diminished when experience has proved that, other things being equal, districts exceeding a certain size should take advantage of the economies of the former, while smaller areas may enjoy the conveniences of the latter. But what irony and paradox is there in this use of the words "equal" and "certain"! As long as the glowing filament or arc carbon are used as sources of light, the battle will continue, and is likely to be settled as far as electric lighting is concerned, only after these sources of light have been superseded. For transmission of power no such distant end as this seems possible. American engineers of a mathematical turn of mind are at present engaged in hot discussion of the saving of copper in di-phase-three-wire and in tri-phase-Y or tri-phase-Δ systems, while the representative of electrical engineering in this country has recently suggested that continuous currents are better than all, even on a Niagara scale. The fight here is between an old, simple, and well understood, but fully developed system, and a new complicated, rather obscure principle which has hardly emerged from the experimental stage. Little or nothing remains to be calculated in

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direct-current work; dynamos and motors are well-nigh perfect; insulation that has already been proved has only to be extended. But the fascination of multiphase systems, to say nothing of wide room for reduction of cost as well as of losses in ordinary transformers and alternators, will for many years attract enthusiasts and inspire engineers.

There seems to be no *à priori* reasons why electrical engineers should be of a combative disposition, but it is evident that they have many a tilting ground, and are generally ready to enter the lists on "direct *v.* alternating," "tube boiler *v.* shell," "rope or belt-driving *v.* direct-driving," and there are probably enough electrical engineers for a joust on "electromagnetic *v.* electrostatic voltmeters." Civil engineers on "concrete *v.* masonry" behave quite mildly in comparison, and such is the amiability of mechanical engineers that no topic for furious controversies suggests itself. Curiously enough, it is left for electrical engineers to dispute about two of the matters which we have instanced, matters on which only those electrical engineers who are at the same time mechanical engineers have any real arguments to offer. One of these, "rope or belt-driving *v.* direct-driving," is a subject admitting of no compromise. It is all very well to fix on a mile radius or a mile diameter as the limits of a continuous-current district of supply, and 500 volts as the point beyond which electrostatic voltmeters should be used; no such line divides dynamo driving into two portions. Belt-driving, for we will not discuss ropes *v.* belts, would be out of the question with steam turbines, but by no other means could such enormous speeds be approached, unless by belts. Nothing but positive inability to run without knocking at high speeds can be the unacknowledged excuse for such slow running as to make the cost of the dynamo a serious question. Nor does the actual scale impose any restriction on one system or the other; neither for a very large nor for a very small plant is there any special advantage in either mode. The disadvantage of direct-driving, due to the increased cost of a slow-speed dynamo, practically disappears in the large machines used in supply stations.

The adoption of direct-driven dynamos by the Admiralty has given a great impetus to fast-running engines, though it has not exercised, perhaps, so wide-spread and beneficial an influence as it has on dynamos. Had there been as many first-rate high-speed engines as there are first-rate contiuous-current dynamos, prejudice against direct driving might have been less. Direct-driving in Germany and elsewhere has led to the building of dynamos which are a standing wonder to English makers. The cost, the expanse of commutator, and the size and weight of these machines remain to us a marvel. It is probable that engines will be built to run faster, and that the output of these huge machines will be proportionately increased. The question of belt-driving *v.* direct-driving seems to resolve itself into cost of floor-space, wear and tear (including breakdowns), and cost of fuel. Experiences such as those recorded by Mr. Hesketh at Blackpool are, fortunately, rare, and the skill which they seem to engender, as is evinced by the short duration of the stoppages, is simply a waste of dexterity. Many engineers are almost unaware of the evils of belt-driving until they meet with a rope-driving enthusiast, and none know the troubles of rope-driving until they have had a few years' experience with it. Direct-driving men, many of whom know neither how to take care of a belt nor to splice a rope, are unaware of any evils at all. But this by no means settles the point. Belts and ropes admittedly enjoy shorter lives than the engines, and the increased wear and tear of the engines, if any, cannot be estimated for years. Where floor-space is a consideration it is to be observed that rope-driving requires from four to five times greater space than direct-driving; and even when jockey pulleys are used, as at Manchester, twice the floor-space is needed.

The coal bill is, as we have before observed, a smaller item in the cost of production than at one time seemed probable; but none the less, the coal bill measures the size of the plant, of the station, and of the staff, and its ratio to the output generally seems to measure the success of the system. For the present purpose we may consider steam consumption alone, and here, unfortunately, we have figures on one side only. Unrivalled as are the arrangements for measuring steam consumption at Thames Ditton, other engine-builders need not hesitate to provide a less perfect equipment only because there might be some doubt about the accuracy of the third figures in their results. We should be content with a ± 1 in the second figure rather than have, as at present, practically no figures at all. Rather because it is nobody's business to conduct steam trials than for want of time or opportunity, engineers of belt or rope-driven electric supply stations seem to have made no attempt to make test runs, and few engine-builders, beyond the mere giving of a so-called guarantee, ever say a word about steam consumption. It is true that the coal consumption at the generating station of the City and South London Railway, as given in their last accounts, works out at about 0·7d. per unit generated; but the load, though maintained all day, is so unsteady that this figure cannot carry much weight. The steam consumption per indicated horse-power has been carefully measured on many different kinds of engine, but the driving of dynamos affords such unparalleled opportunity for measuring the actual power delivered with the greatest exactness, that it is by such tests that the efficiency of slow-speed belt-driving can alone be compared with direct driving. In the absence of figures relating to the former system, we cannot attempt to come to any conclusion. Such figures are among the many might-have-beens of great exhibitions, and we can only wait until some non-direct-driving engine maker has some well-authenticated tests to publish. Meanwhile, we give in our correspondence columns, not only the latest but, we believe, the best figures that have ever been announced, namely, a combined efficiency of 88·04 per cent. for a Siemens-Willans 300-H.P. plant.

ELECTROSTATIC VOLTMETERS.

After much trouble and money had been spent by instrument makers on the perfecting of the Cardew voltmeter, magnetic voltmeters were made, rivalling the Cardew in accuracy, and, like that instrument, could be left on the circuit for any length of time. When alternating currents became fashionable, the Cardew voltmeter came to the front again, but high pressures could not be measured without the use of resistances, or of small transformers. The former expedient was wasteful, and the latter for several reasons untrustworthy. Demand, however, was soon followed by the supply of excellent magnetic voltmeters, slight modifications of the direct-current instruments, and thoroughly suitable for their work. There was but little difficulty in making voltmeters which would read correctly at any given frequency, and although this could always be specified at the time of ordering, it prevented the stocking of such instruments by dealers. For high pressures external resistances are still necessary, but much less current is required than for a Cardew voltmeter.

Electrostatic voltmeters consume no current, and are independent of frequency, but the directive force is small, and where large bare metallic surfaces are employed precautions must be taken against short-circuiting by sparking. The

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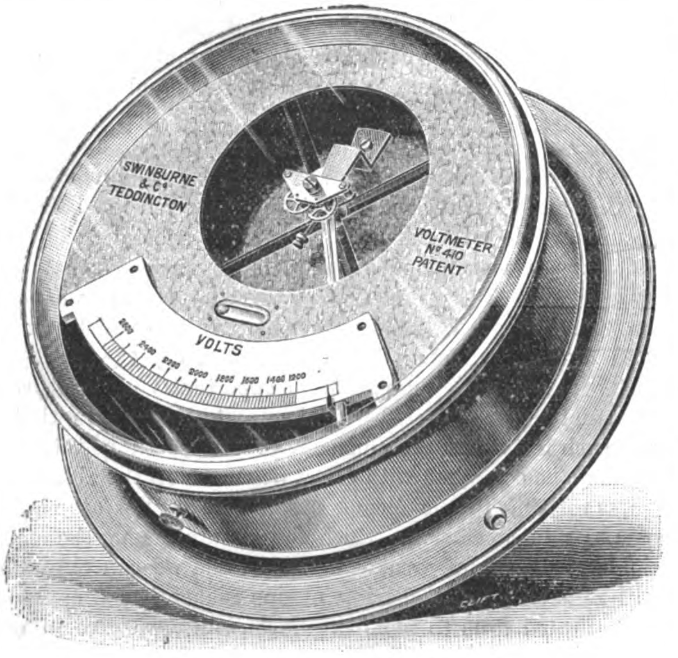
Kelvin, the Ayrton-Mather, and the Swinburne electrostatic voltmeters stand foremost among the various instruments of this class, and the first two kinds employ the multicellular principle for measuring comparatively low pressures, and the last is intended only for use on primary circuits of over one thousand volts, although one-third of this can be measured if required. We have recently received a few particulars of the Ayrton-Mather and of the Swinburne instruments. The former of these has been fully described in these columns,* and, as we stated in a Trade Note last week, has been made by Mr. R. W. Paul. We understand that they are now being also made by Messrs. Elliott Bros., who are introducing a reflecting instrument for use either with a lamp and scale or with a telescope.

The Swinburne electrostatic voltmeter was described in *The Electrician* in connection with the experiments by Dr. Fleming on various transformers. An early form of this instrument was used in this investigation. It consists essentially of a quadrant electrometer with quadrant boxes, as shown in the illustration, and flat aluminium vanes. A long series of



The Swinburne Electrostatic Voltmeter.

experiments have been carried out with the object of converting a delicate laboratory instrument into a substantial voltmeter, fit for use on switchboards. The vanes had to be made without solder, as it was necessary to avoid softening the aluminium, and the surface has been punched with many holes to decrease its mass, thus allowing the instrument to be handled without fear of bending the vanes. The vanes are shaped so as to give a scale evenly divided near the standard pressure, for which the voltmeter is intended. The contour of the vanes determine this, and although, of course, all the middle part could not be removed, the vane punched with holes acts practically as a grating or continuous sheet. The directive force being small, great care has been taken in the mounting. Jewelled bearings have been avoided, owing to the delicacy and weakness of the fine pivots which must be used with them. Friction wheels, as shown in the illustration, are employed, and the spindle and other parts of the movement are strongly made. The coaxial, or cylindrical system, has been tried by Messrs. Swinburne and Co., but was abandoned by them in favour of the present design. The instrument is fitted with double-pole fuses, suitable for high pressures, the insulation resistance is very high, and the experience of the makers with the experimental use of more than 100,000 volts, and of voltmeters for measuring such pressures, has been employed in preventing sparking between the different parts of this voltmeter.

* *The Electrician*, Vol. XXXI., p. 151.

NOTES OF A TRIP TO THE UNITED STATES AND TO CHICAGO, 1893.*

BY W. H. PREECE, C.B., F.R.S., PAST-PRESIDENT.

In 1877, together with Mr. H. C. Fischer, I made an official and thorough inspection of the telegraphic system of the United States and Canada, and the lessons of that journey were reported to this Institution on February 13, 1878. The results of that trip were the introduction of the telephone, the practical application of quadruplex working, the adoption of sound reading in our telegraph offices, the disappearance of the Morse recorder, and the more general assimilation of the methods of working in the two countries. In 1884, as a member of the British Association, I again visited Canada, and made another tour through the States, reporting my observations to the Institution on December 11, 1884. The chief result of this second trip was the introduction of the multiplex system of working of Mr. Delany, now so much in use amongst us, and doing splendid service with many of our chief towns; hexode working, six messages in any direction, are simultaneously transmitted between London, Brighton, Bristol, Birmingham, and other commercial centres. The telephone was found fully developed, and firmly rooted as an invaluable aid in domestic and business requirements. The electric light was making great advances, especially as the illuminant of public streets and ways, to the great advantage and safety of the public, but electric railways and the transmission of power were only just looming in the air in an extremely tentative and experimental stage. Now I am able to report another tale of a ten weeks' trip taken in August and September last over much the same ground, but with two *pièces de résistance* thrown in—a visit to the great "World's Fair," and the holding of an Electrical Congress at Chicago.

I.—Telegraphs.

The telegraphic system in the United States is in the hands of two great private telegraph companies, the Western Union Telegraph Company and the Postal Telegraph Company.

The Western Union Telegraph Company, which is by far the larger of the two, is a gigantic undertaking. It is a congerie of at least 500 other companies which have been purchased, absorbed, or amalgamated from time to time; and it is also closely connected with virtually all the railways in the States. This connection with the railway companies gives it a very prominent and commanding position over its rival. In order to show the progress made since 1884, and the present condition of the business, I give the following table:—

Particulars.	1884.	1893.	Great Britain, 1892.
Miles of poles and cables	145,037	189,936	33,689
Miles of wire	450,571	769,201	207,231
Offices	13,761	21,078	8,537
Messages	42,076,226	66,591,858	72,302,556
Capital	$80,000,000	$123,000,000	£10,130,820
Receipts	$19,632,940	$24,978,442	£2,486,791
Expenses	$13,022,504	$17,482,405	£2,470,839

The Postal Telegraph Company is a very much smaller concern. It has virtually come into existence since my previous visit, for when I was last in the States it had just commenced its operations, and it only possessed 1,500 miles of line and 4,260 miles of wires. It is a Company which has been promoted, not so much to attack the Western Union Company, as was the case with all previous competing lines, but to establish a collecting company for the cable business which is in the hands of the Commercial Cable Company. The present position of the Postal Telegraph Company is as follows:—

Miles of line	15,997
Miles of wire..	99,664
Offices..	2,664*
Messages..	9,335,291

* Of this number, 860, or nearly one-third, are situated out of the States, in Canada and elsewhere.

The enterprise in telegraph work is evident at once on landing in New York. Every passenger on landing at the dock stage is approached by a messenger from one or both Companies, soliciting messages; and on all stages, except that of the Cunard Company, one or other of the telegraph companies has succeeded in establishing an office. The business done at these offices is very great, as, when facilities are thus given to passengers to send messages, nearly everyone wires home his or her safe arrival. This enterprise is evident everywhere. The blue and white sign of the Western Union Company, which is extremely prominent, is found in every hotel, at all railway stations, and in large cities, and is as abundant as the Post Office sign is in England. At Long Branch,

* Paper read before the Institution of Electrical Engineers, January 25th.

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the Brighton of New York, where I spent two or three very pleasant days, there were no less than 19 offices belonging to the Western Union Company, and all paying. There were 20 offices in the World's Fair alone, and 70 hotels in Chicago have Western Union offices in them.

Competition is intense, but there is no war of rates. A general tariff has been agreed upon, and the only rivalry that exists is in the collection and transaction of business. Dividend-earning being the chief end aimed at, only paying commercial stations are properly served. Social and domestic telegraphy is practically ignored, and sparsely populated districts are very inadequately provided for. Hence in the United States telegraph business is neither so general nor so cheap as it is with us. The average price received per message is 15¾d., as against 7·7d. earned by us. On the other hand, however, it must be remembered that their mean distance is far in excess of ours.

Construction of Lines.

I inspected considerable lengths of the line work constructed by each company, and drove over many miles of a new road line passing through Connecticut. In this direction American electrical engineers have been very much behind us. They have not built their lines so solidly, nor have they followed true engineering principles in the same way that we have. As a rule, their lines are extremely irregular, being badly constructed with poles that we in England would not look at. But recently, owing to the difficulty in finding fresh routes, the growth of the number of the wires, and to the absolute necessity for accuracy of workmanship for securing silence on telephone lines, great improvemenes have been made, and some of the trunk lines put up by the telephone companies, and the new trunk line put up by the Postal Telegraph Company, will compare very favourably with our best modes of construction.

The telephone line to which I have alluded above consists of 16 arms, each carrying 10 wires, or 160 wires in all ; the poles are 60ft. high, and are placed 100ft. apart. The arms are of pine, and their scantling is 3¼in. by 4¼in., and they are 10ft. long. Owing to the use of wooden pins they are bored with holes 1¼in. in diameter. This weakens the arm, and I observed two instances where arms were broken. A 6ft. arm bored for four insulators costs 15 cents, which is cheap compared with the price we pay. But they are undoubtedly weak, and not to be compared with the oak arms that we use. As a rule the poles number 40 to the mile. They are generally of cedar, but sometimes of chestnut. The cedar poles come from Canada and Michigan. Each 25ft. cedar pole costs $2.25, and is said to last 15 years without preparation. The chestnut pole is a little cheaper, and it lasts only 10 years. It is extremely irregular in shape.

American engineers do not adopt the same plan that we adopt in the erection of arms. They are fixed any way, but generally on the modern lines they alternate on each side of the pole. This is done under the impression that it adds strength to the line. I do not know why it should. (We invariably fix the arms on that side of the pole facing London.) Every fifth pole is earthed as a protection against lightning. (We earth-wire every pole.) Stays are very little used indeed, but on new lines they have longitudinal stays in the direction of the wires, one end being fixed at the foot of one pole, and the other end at the top of the next pole. These are called "head guys," and are frequent. Iron poles are used only for electric railways. These are very substantial, and look very well. They are made in three sections of simple iron tubes, either 6in., 5in. and 4in., or 5in., 4in., and 3in. in diameter respectively. Pole roofs are not used as with us, but the poles are tapered off to throw off the rain.

Neither the Western Union nor the Postal Telegraph Company adopt any system for preparing their timber to resist decay. My attention had been called to a system of artificial seasoning called "wood vulcanising," and it was reported that this system had been adopted by the Western Union Company. I found this was not true. The Western Union Company had experimentally tried the system on some wooden troughing, employed for the protection of their pneumatic tubes underground ; but the process was so expensive, and the advantages so doubtful, that they do not apply it to their poles or their arms.

Copper wire is very much used on telegraph and telephone lines. I saw in the Exhibition at Chicago a form of wire called "tempered copper." This is said to be extremely strong and hard, but it is evidently an alloy of copper, for its resistance is high. I was surprised to find that a compound wire 1·7 ohms resistance per mile, put up by the Postal Telegraph Company in 1883, is still in use, and working well. Our experience of the durability of this wire was disastrous.

Underground Work.

Underground work was scarcely started in the States in 1884, but now, owing to peremptory legislation on the part of the municipalities, it has made very rapid progress. Underground work in the cities of the States has become general, with great advantage to the public and also, as they have come to acknowledge, to the companies themselves. The only exception to this rule that I heard of was at Boston, where complaint was made that their underground system had been much disturbed by "wash-outs." These "wash-outs" are freshets, or great floods, tearing up the line and carrying away the pipes and wires. The system of underground work adopted by the telegraph companies in America does not differ much from that adopted by us, excepting that they do not use gutta-percha, owing to its high price. They are using very largely a cable similar to the Fowler-Waring cables, and also kerite-covered wire. Kerite is a form of vulcanised india-rubber.

Offices.

Not much change has been effected in the mode of fitting up offices. Glass of the best quality is used very much indeed: doors, partitions, boxes for the collection of messages, are all made of thick glass. This looks very clean and nice, and is certainly effective. There is an extremely efficient mode of collecting and distributing messages in the Western Union offices at New York and Chicago. Endless cords are kept in motion by means of small electric motors, and these cords transport small metal carriers somewhat similar to those we use in our pneumatic tubes. Before leaving New York I saw an improvement on this by which messages can be picked up as by the finger and thumb from the desk in front of each operater. They also have in use a system by which messages, envelopes, slips, &c,, are conveyed by broad continuous leather belts, 8in. wide, kept in rapid motion by motors, and upon which the messages, &c., are laid, and carried to the point desired.

Each company has adopted a uniform and pretty-looking box for its office in the hotels. American hotels differ from ours in this: The hall of an hotel is usually open to the public, and no hotel that I entered was unfurnished with a telegraph office. I have mentioned that there were 70 hotel offices in Chicago. In fact, hotel proprietors court the presence of a telegraph office. Space is usually accorded free, and board is also provided for the operator. In some places, like the "Palmer House" Hotel at Chicago, which is a great business centre, a very high rent is demanded ; but, generally speaking, no rent at all is paid. At the hotel I stayed at in Chicago—"The Lexington"—each company had an office in the hall ; the rivalry that exists between the two companies taking the form of each striving to work with the louder sounder. The louder was that of the Postal Telegraph Company, and when I asked the operator why he allowed his instrument to make such a row, he replied, "We must beat the Western Union Company anyhow."

At Fort Sheridan, a military station about 20 miles away from Chicago, the Western Union Company opened an office, although the place contained only 1,000 soldiers. The office was worked by the soldiers, and I was assured by the Company that they found it pay well.

The common system in the States is to tile the floors of their telegraph galleries, and not to board them. Fireproof channels, or conduits fitted with slate tops, are arranged about the office for the distributions of the wires. Lockers for coats and hats are roomy and well made, and ample in the supply. At Chicago they are of open ironwork, very neatly made, 6ft. 6in. high, and 28in. by 8in. in sectional area. Four men, each of whom is supplied with a key, use such a locker. Great advantage is said to arise from the use of these open lockers in wet weather, and they are worth our own consideration. The use of bicycles for messengers is very prevalent in the States.

Batteries at all the principal offices in the United States are gradually disappearing. The current for working the circuits is being supplied from dynamos, or from the electric lighting mains. In New York from 30,000 to 40,000 cells have been replaced by dynamos. At Boston 10,000 cells, which cost probably £4,000 per annum to maintain, have been replaced by current derived from the electric light mains at a cost of £600 a year. It must be remembered that the American telegraph circuits are worked entirely on the closed-circuit system. They use immense cells, and their cost of maintenance is excessive. We cannot compare their system with ours in this respect, for we use open circuits ; and the maintenance of our batteries is certainly, cell for cell, not more than one-fourth or one-fifth that of the United States form of battery. In New York the Western Union Company have a special plant of 51 small dynamos. In Chicago they have 46. The Postal Telegraph Company in New York are also using dynamos, and in their new station which is being built they are supplying what they believe to be an improvement on the system adopted by the Western Union Company.

We have shown in England that the use of dynamos, owing to the variation current, is not suitable for high-speed working, and I much prefer the plan that we have adopted with so much success in working our Continental circuits—namely, the use of accumulators. Accumulators have an immense advantage over dynamos ; they store up energy, so that in the event of any accident or breakdown of machinery the accumulator maintains

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the circuits working. The accumulator is not in motion. There is no machinery to fail or to break. There is nothing to stop, and little to get out of order. But the chief advantage of the accumulator is the absolute steadiness of its voltage There is also economy in capital expenditure, and I am quite convinced that the Western Union Company in New York would have effected considerable economy if they had used accumulators charged by the electric lighting plant, instead of supplying the elaborate series of engines and dynamos now working their circuits direct.

At Boston and other stations a very well-made and well-designed motor-dynamo is supplied by Messrs. Crocker-Wheeler. They are primarily motors worked on the 110-volt electric lighting service, driving a small dynamo, and they transform this down to a voltage which will charge any number of cells required. This system is in use by all the telephone companies, and, as I will point out when speaking of telephones, the service is much improved by the use of accumulators thus charged.

Apparatus.

I observed little or no progress in the form of apparatus used. In neither company has there been any advance made on the systems in use in 1884. Duplex and quadruplex working are principally relied upon, while on the long-distance lines Wheatstone working is gaining ground, and being much more used. The only novel mode of working that was brought to my attention was a system of working cables automatically. This system has been threshed out by Mr. Wilmot at Waterville, and adopted by the Commercial Cable Company, but it has been very much improved upon by Mr. Delany, the inventor of our multiplex system.

Typewriters have become quite common. The rule is for an operator to have his own machine. The Postal Telegraph Company use this system more largely than the Western Union Company. The latter company employ it invariably for their Wheatstone and other news circuits, but the Postal Telegraph Company use it very largely on all circuits, and I watched many operators taking off messages by ear and typewriting them at the same time, and in all cases the typewriting machine held the sounder well in hand as regards speed.

The working of the Wheatstone system between New York and Chicago is admirable. The grand total of messages handled in one day on this circuit is certainly astonishing. 4,211 messages have been passed between these two places on one circuit in a day —a number that we can scarcely hope to rival. The reason for this is not the greater speed at which the apparatus is worked— for the speed is less than ours—but to the fact that the business day in the United States extends over a much greater number of hours than with us. The business day in New York commences three hours before that in San Francisco, and the business day in San Francisco extends for three hours beyond the business day in New York. Hence the business day, which in England scarcely extends telegraphically to four hours, in the United States extends probably to twelve hours. Thus the number of messages handled is much greater per day than with us.

The advantage of Wheatstone working to the Company was illustrated while I was there. On August 29th a cyclone in the eastern part of the States prostrated the poles and wires for miles throughout half-a-dozen States. Three Wheatstone circuits were maintained working—and working badly—between Chicago and New York by means of repeaters at Buffalo and Pittsburg, but on these three circuits 8,693 messages were handled. This was the only means of telegraphic communication between the Eastern and Western States. Curiously enough, the new and strong long-distance telephone line was not broken down. On August 18th, while I was there, I took down as having been sent between 8 a.m. and 5:30 p.m.—forwarded, 1,272 ; received, 1,889. This work was handled on two circuits, with an average speed of 190 words per minute.

The Wheatstone system in the States is much more extensive in the West than in the East. It is giving such good service that it will probably receive considerable additions this year. It must be remembered that between Chicago and San Francisco we are dealing with a distance of 2,500 miles, and on this circuit they were working when I was there at the rate of 110 words per minute.

I observed a very high rate of working on some of the quadruplex circuits. I took down these figures at Boston :—

Forwarded	686
Received	521

This was an ordinary day's work. On another circuit, between 8:30 a.m. and 11:30 a.m., in Buffalo, the numbers were :—

Forwarded	126
Received	140

on one side of the quadruplex only.

I noticed at the Chicago Exhibition, in the French exhibit, a new adaptation of multiplex working by M. Mercadier, who showed in operation twelve working sides. But the working, although interesting, was poor. The reading was done by telephone, and each branch was selected by the sounding of a particular note. The apparatus is not yet in anything approaching a practical stage, but for short lines something may some day come out of it.

Pneumatic Tubes.

The Western Union Company have not extended their system of pneumatic tubes greatly since may last visit. The Postal Telegraph Company are about to use pneumatic tubes for the distribution of their internal work in their new building on a plan somewhat similar to that which we use at our central station.

The only novelty in pneumatic tubes that I saw was that on trial between the Post Office at Philadelphia and a sub-office in Chestnut-street. This is a line of two pipes 6¼in. diameter and 5,792ft. in total length—that is, a distance between the two offices of 2,896ft. The carriers are metal cylinders whose inside dimensions are 16in. long and 5¼in. in diameter. They weigh 6lb. each, and carry 120 letters. The carrying capacity of the line is said to be 180,000 letters per hour, but I think this is exaggerrated ; the time taken by a carrier in transit is 55 seconds, and the air pressure is maintained at 7lb. per sq. in. The line has been working since February 17th, and it has been used for the transmission of letters, the whole service to this particular sub-office being done through the pipe. The pipe is continuous, and a current of air is constantly flowing through it. Twenty-five horse-power is absorbed in maintaining this current at the pressure required, and the carriers are said to move at the rate of 40 miles an hour. Twenty-five carriers are in use. Unfortunately, while I was there the tube was out of use, for the boilers had broken down. These boilers belong to the Post Office Administration, and were not under the control of the contractors who are carrying out the experiment. It is merely an experiment, but it is an experiment that has been carried out in a very practical manner, and they are threshing out a question that may be of importance. They find that the tube used is too small for their purposes, and they are going to use in future an 8-inch tube.

Distribution of Time.

A feature of considerable interest and novelty is the distribution of time by the Western Union Company. Correct time is received every day at noon from Washington. The time current lasts one second. Time balls are dropped at Boston, Newport, Woods' Holl, New York, Philadelphia, Baltimore, Washington, Fortress Monroe, Savannah, New Orleans, and Havanna. This current is also distributed by the Western Union Company to subscribers in the principal centres. In New York there are 1,100 subscribers, in Chicago there are 1,837, while in the whole of the Western District of the Company there are 7,963 subscribers. Each of these subscribers has a special wire upon which the time currents are sent from a master or a controlling clock. The Western Union Company also furnish synchronous self-winding clocks to the subscribers, which are controlled and regulated daily by these time-signal currents. They are wound automatically every hour. The rates for this service are not excessive. Each subscriber is charged $2¼ per month, while large buildings using five or more clocks get the time signal supplied at $1¼ per clock per month. The standard time adopted in 1883 is virtually Greenwich time. It is divided into four sections. The following table will show how far these differ from Greenwich meantime and from each other :—

W. Long.	Centre.	Actual time.	Name adopted.
0°	Navigators' time (Greenwich)	Noon.	Greenwich time.
75°	Washington Meridian	7 a.m.	Eastern time.
90°	Chicago Meridian	6 a.m.	Central time.
105	Denver Meridian	5 a.m.	Mountain time.
120°	San Francisco	4 a.m.	Pacific time.

Thus the minutes and the seconds are the same as with us. There is no necessity to alter one's watch.

Hefner von Alteneck proposes to place clocks in the circuit of an ordinary glow lamp, and to wind and control them by a slight change in the current made at the central station once a day. It is surprising what can be done by electricity when it is laid on in a house and served from a central station. Von Alteneck's system was exhibited at the World's Fair.

Conclusions.

It is quite impossible to inspect the telegraph system of the United States and compare it with our own system without drawing comparisons between the way in which the work is done in the two countries. The result of my previous visit was to confirm my view that we do our work better in England than they do in the States. Our apparatus is better, our speed is higher. Messages are handled with greater reliability. A message can be sent and its reply received with certainty in an hour in England. I fancy such rapidity would astonish the users of the telegraph in the States, except those in such busy centres as New York and Chicago, and

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generally the speculative branches of the community. The domestic telegram scarcely seems to have reached the United States, and this is owing, probably, to the fact that the districts of private residences, the small towns, and the villages do not possess telegraph offices, unless they are supplied by the railway company at the railway station, or by the Western Union Company, who do the work for the railway company.

I fail to see any superiority in the manipulation skill of American operators. They certainly have not made the same advance in technical education that we have, and altogether it may be said that the management of the telegraphs in the States in the hands of the private enterprise does not compare favourably with the management of the telegraphs by the State at home. At the same time, it must not be assumed, because the Government have advantageously taken the telegraphs in hand at home, that such a process would be possible in the States. In my opinion it would be absolutely impossible. The Civil Service of the States is in a very chaotic condition. The principal appointments are four-years appointments only, and are filled politically. The principal postmasters come in and go out with each new President. We in England scarcely consider that a postmaster is fit to be a postmaster until he has had many years' experience of the working of the Post Office system. In the States a man is made a postmaster because he has been a political supporter. At one or two offices I found the new Post Office officials absolutely ignorant of simple facts they ought to have had at their fingers' ends. A business like that of telephones or telegraphs can only be conducted properly by those who possess a considerable amount of enterprise, and who look primarily to the necessities of the community. The reason why our post offices and our telegraph offices at home work so well is becsuse the public exercises such a useful and such a determined supervision over the work. The free opening of the Press to complaints; the readiness with which members of the House of Commons ask questions—though at times, perhaps, irritating and vexatious—are undoubtedly good for the service, for they keep us all alive. Such a state of affairs is impossible in the States.

The Govenmment of the United States must first reform its Civil Service, and when it gets officials into the service whose tenure of office is secure, and whose zeal is as unquestioned as it is in England, then there will be some chance of their Government acquiring the telegraphs; but under existing circumstances the acquisition of the telegraphs by the Government of the United States would amount virtually to the deterioration of the service. The commercial management is at present, as I have pointed out, characterised by great energy. I do not, however, acknowledge that they show greater energy than we do in England. Competition may make it more conspicuous, but it is not more reaching. Our speculative business, stocks and racing, is done as well as theirs. The management at home is characterised in all particulars with similar energy to that which I observed in the States; and I come back without any views or wrinkles which I think could be impressed with advantage on the commercial or technical management of our system at home, unless it be the encouragement of offices in hotels, for it is found everywhere that a telegraph office at one's door prompts the desire or want to telegraph.

The capital of the Western Union Telegraph Company was in 1877 $22,000,000; that of the British Post Office was £10,000,000. The capital of the former is now $123,000,000, while that of the latter remains virtually the same. Scarcely a single vestige of the old telegraph companies' systems purchased by the State in this country now remains. Whence, therefore, this splendid system of cables, underground lines, and new pole lines in this country, spreading everywhere, and transacting an annual business of £2,500,000, instead of the £600,000 handed over to us? It has all been paid for out of revenue! The Government keeps no capital account.

How do we do our work? The proof of the pudding is in the eating thereof. The criterion of telegraph working is rapid despatch. "Time is our only competitor," said Dr. Norvin Green. The time occupied in its transit from the hands of the sender to those of the receiver is the pudding. The whole of the messages arriving in Newcastle on the morning of January 20th were examined and analysed. The mean time of transit from all parts of the United Kingdom averaged 7·8min. A similar examination at Glasgow on January 15th gave a mean result of 8·7min. This cannot be beaten, and it certainly will not be believed. The late Mr. Patey was once asked why express telegraph service at higher rates was not introduced in England. His answer was, "All our messages are express already."

II.—Telephones.

The business of telephony in the United States has made gigantic strides since I visited that country in 1884. The following table will show the position of the industry then and now.

It will be seen that there is a very small increase in the number of exchanges opened. This is owing to the fact that hitherto there has been a tendency to centralise the exchange work; and while many exchanges have been abandoned, the small increase is due to the fact that many new exchanges have been opened.

It will also be noticed that in the States they have gone in very largely for underground work. This has been forced upon them by municipal action. In addition to this, the companies themselves have been compelled by the indifferent working of their systems to fall back upon the metallic circuit, and now there are 23,053 metallic circuits in use. In New York 62 per cent. of the circuits are metallic, in Buffalo 77·84 per cent., in Boston over 50 per cent., in Chicago 20 per cent., and in Brooklyn 60 per cent.

——	1884.	1893 (January 1st).
Miles of wire	115.255	440.793
Miles of underground wire	Nil	91.463
Telephones in use	325.574	552.720*
Telephone subscribers	123,625	232.140
Number of connections between subscribers and exchange	215 millions	600 millions (est.)
Telephone exchanges	1.325	1.351
Staff employed	4,762	9,970

* This is the total number of transmitters and receivers. According to our system of reckoning, where the two together are considered as one instrument, the number given should be divided by two. Thus, for comparative purposes, it may be said that the United States has 276.360 telephones in use.

The business of telephony in the United States is a gigantic monopoly in the hands of the American Bell Telephone Company, whose headquarters are at Boston. This company owns more than one-half the stock in every telephone company in the States. It holds itself the whole of the stock of what is commonly known as the Long-Distance Telephone Company, but which is really entitled the American Telephone and Telegraph Company, and thus by having control of the stock in every company it maintains the power and monopoly. The advantage of this monopoly is the establishment of a uniformity of working and practice that is highly and extremely beneficial. The form of apparatus used, the mode of working, the details of construction, and all the methods in use are dictated from Boston. The result is little or no friction; and while each independent company is self-managed and self-contained, nevertheless it is subservient to the direction and control of headquarters at Boston. There is no divided responsibility in the United States. Every town has but one system. The result is that the service is thoroughly and perfectly performed. In those parts of the country where metallic circuits have not yet been adopted there may be defects in working, but these are rapidly being removed, for the benefit derived from metallic-circuit working is being felt everywhere in the United States.

Exchanges.

The modes of working may be divided into three classes—(*a*) That dealing with local subscribers alone working upon a single exchange; (*b*) That dealing with trunk working between exchanges in one town or district: and (*c*) That dealing with long-distance speaking, such as that between New York and Boston, New York and Philadelphia, New York and Chicago.

I visited three exchanges at Chicago, one at Buffalo, one at Boston, and three in New York, and I looked very thoroughly into the working of each system. While I did not think that any of their local working is done any better than, if as well as, the local working on our own exchange at Newcastle-on-Tyne, there is no doubt that in their trunk working, both for inter-exchange communication and for long-distance working, they are far ahead of us in England.

The prevailing switch in the United States is the multiple board, made by the Western Electric Manufacturing Company. The largest board in the world is one which I carefully examined at the Cortlandt-street Central Exchange in New York. It has a capacity for 6,000 subscribers; it is 263ft. long, and is divided into 40 sections. One operator handles 60 subscribers. There are 260,000 holes, or "jacks," as they are called in the States; while in fitting up this switch 780,000 soldered joints were made.

It is found in the States that multiple boards can become too large, too unwieldy, and they introduce troubles of their own that have to be remedied. These defects are aggravated when there are several exchanges in the same city. In Chicago Main Exchange 25 per cent. of the business, in Harrison-street Exchange 94 per cent., is trunked out. The average trunking is 50 per cent. A multiple board is, therefore, useful for only 50 per cent. of the work done. It should be explained here that the term "trunk" is adopted in America to indicate connections effected between one exchange and another within the same area. Connections between town and town are designated "long-distance" connections. The tendency is to depart from the principle of the multiple switch; and an extremely interesting

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experiment is being carried out simultaneously in Chicago, Buffalo, and New York to determine the merits of a new system of working called the "divided" board. The divided board means this:—There are two boards, the one called the *answering* board, and the other the *connecting* board. The answering board contains the indicators and trunks, including those to the connecting board, and all local connections are treated as trunks through the connecting board. Thus, while each operator at the answering board attends to and answers only her 60 subscribers, and is able still to control all the trunk wires, the local spring jacks are duplicated on the connecting board, which may contain one, two, or three complete sections, as the case may be, and are attended to by separate operators. All the business is thus trunked. The result is that the service performed for the subscribers for local connections is slightly retarded. On the other hand, the work done on the trunks is equally expedited. If 50 per cent. of the work done in the Central Exchange is trunk work, it is argued that, if subscribers find that one-half of their work is expedited and the other retarded, the expediting of the more important part will compensate for the retardation of the less important, and the general result will be beneficial. The chief merit of the divided board is that it reduces the "jacks," as the switch-holes are called. Seven sections of board with 42,000 jacks would replace 40 sections with 240,000 jacks in an exchange of 6,000 subscribers. I find opinion, however, divided upon this question; but the view is very general that when the multiple switchboard exceeds a capacity of 2,500 subscribers it certainly introduces disadvantages and defects which must in some way or other be remedied.

Trunk Working.

The trunk working is wonderfully well done. In the first place, the connections between the different exchanges are very numerous. In the Central Exchange at Chicago there are 344 outgoing and 325 incoming trunks. There are 11 exchanges, and these exchanges are located as nearly as possible in the centres of the districts which they are designed to serve. The business of these offices, however, is by no means self-contained, and a very great amount of their work is in handling calls from subscribers in one exchange to subscribers in another. These are now handled by means of 954 trunk circuits extending between the various offices, the total number outgoing from each office being as follows:—

Main	344	Oakland	68
North	34	Lake View	26
South	77	Harrison	59
West	74	Wentworth	19
Canal	63	World's Fair	80
Yards	61		

In Boston, between their Central Station and Tremont Exchange—an exchange of 833 subscribers—there are 27 outgoing and 33 incoming trunks. The service between two exchanges is virtually a silent one. No question is asked, but instructions are given simply—"301 on North 273." This is spoken on a call circuit. The trunk operator—always a male—wears a headgear telephone, receives this instruction, and carries it out without a word being said, or a second lost. In some places the subscriber, if he wants a subscriber on another exchange, calls his own exchange as usual, and, on getting attention, says "Tremont." He is then placed in connection with the Tremont Exchange, and he himself asks for the number he wants. The former plan is, however, the more general one, and that which is preferred. There are always so many trunk wires available that the operator has rarely to say "Wires engaged," or "Busy," which is the common expression. I never saw one case of the kind myself. The hourly maximum number of trunk calls between Boston (Main) and Tremont Exchanges was—From Boston, 557; to Boston, 475. The former averaged 20½ per circuit. The latter averaged 14½ per circuit. The result is that in places like Chicago, where there are 11 exchanges, and New York, where there are 9 exchanges, the trunk working is done between them virtually as though the whole of the exchanges were centred in one big hall.

The long-distance work is done in the same way. Only metallic circuits are switched on to the long-distance lines. The incoming trunk wires end in plugs, the outgoing trunk wires end in "jacks," so that when an operator hears "351 on Chicago 3," he simply takes up 351 plug and puts in a Chicago jack without hesitation. If, however, all the Chicago jacks are busy—which he sees at once by the visual signal—he says, "Busy," and the caller has to wait his turn. In my experience this occurred but rarely. When the calls were heard, the connections were made as rapidly as possible for it to be done, or as rapidly as one could wish that it should be done. In New York the Long-Distance Company and the New York Telephone Company are in the same building. A complete section of the New York multiple board is in the long-distance switch-room, so that connections are made *direct* between the long-distance lines and the subscribers. Usually a section of the multiple board in the local exchange is allotted for long-distance trunk work to the long-distance office, which may be elsewhere. It is so arranged that when a subscriber talks on a long-distance line his own circuit is entirely cut out from the local operating switchboard. There are a great many public call offices open in every city. There are 535 in New York. They call them "public pay stations." People pay tolls, and they come in and speak to the exchanges and get their connections through.

Long-Distance Working.

The long-distance speaking in the States is very popular and very successful. The opening of the circuit between New York and Chicago—a distance of nearly 1,000 miles—was so successful that they immediately found it necessary to erect two more circuits. There are now, therefore, three circuits between these two places. I tested these circuits, and found the working remarkably good. It was difficult to say that it was better or worse than the working of our London-Paris line. The tariff for the long-distance work is based upon 1 cent per mile for five minutes' talk. The greatest distance that I found upon which speech was conducted was between Milwaukee and Portland, and between these places talking costs $11 (44s.) per five minutes.

Rate of Working.

I found that the customers dealt with by each operator varied very much in different towns. The following table will show this:

Town.	Customers for operator.	
	Local.	Long-distance trunk.
Theoretical	100	6
Chicago	66	6
Buffalo	100	—*
Boston	70	3
New York 18th-street	50	6
Brooklyn	66	10
New York, Cortlandt-street	60	—*

* I did not record the number in these two exchanges.

The daily calls per circuit also vary very much. The average per day over the whole country is 8·03. At Chicago on one exchange it reaches to as many as 24·3; the mean for the whole town in January was 13·6, while in July it was 12·3. At Buffalo the mean is 6. It is interesting to note that the number at Buffalo is just the same as it was when I visited that place in 1884. At Boston the average number then was 5; it is now 12·6. While this average of 12 or 13 calls per day is not an extraordinary one, it represents great extremes in the use of telephones, which bring about complications which are at times difficult to meet. There are in the main exchange at Chicago at the present time several hundred telephones which are used more than 100 times each day. Nearly all this business is handled between the hours of 9 a.m. and 5 p.m. During the busiest hours of the day these instruments are in use almost continually. When calls are made for them, therefore, the only reply is that they are busy. As an example of this excessive use, my attention was called to the case of the Waukesha Hygeia Mineral Springs Company, telephone No. 929 South. A complaint was made by one of their branch offices that they could not reach the main office, the line always being reported to be busy. A record was made of the calls handled on this telephone, and in one day it was found to be used a total of 449 times, there having been 18 originating calls and 431 calls received. In one hour the telephone was used 51 times. This is, perhaps, the busiest line of which there is a record. Telephones used by railway offices, wholesale houses of all kinds, hotels, and many other places, are apparently in use almost continuously in the busy hours of the day. Many such establishments have more than one telephone, some of them having as many as six.

The subscribers per exchange in the exchanges that I visited are as follows:—

Chicago .... 10,312, divided thus:—

Main	4,912	Oakland	655
South	1,037	Lake View	244
North	996	Wentworth	46
West	903	World's Fair	269
Canal	434	Harrison	424
Yards	392		

New York, Cortlandt-street	4,500
Boston, Central	3,545

The total subscribers in New York are 9,574, at Brooklyn 4,800, and at New Jersey 4,900, making a total for New York and district of 19,274.

Underground Work.

The statistics that I have given show how rapidly underground cables have come into use in the States. At the Chicago Central Exchange, 76 cables, each containing 100 wires, enter the building

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and ascend up a shoot to the exchange room. The conductor used is smaller than that adopted by us. It is only No. 19 Brown and Sharpe gauge. It gives 47 ohms resistance per mile, and it has a capacity of 0·68 microfarads per mile. The insulation must be 500 megohms per mile at 60°F. All cables before being used are very carefully tested, not only to see that they comply with the specification as to conductivity, capacity, and insulation, but also for what is called "cross talk," by means of buzzers.

There are no less than 14,034 miles of underground wire in New York; 160 cables, each containing 100 wires, enter Cortland-street building—that is, 16,000 wires enters this exchange. In Boston 91 lead-covered cables enter—that is, 10,920 wires in all, for each cable carries 120 wires. The cables are made for 50, 60, or 100 pairs of wires. The 50-pair cables have a diameter of 1¾in., the 60 and 100-pair cables being 2in. and 2¼in. in diameter respectively. These cables are in all cases brought straight to distributing boards in a room alongside the switchboard room, and here they are brought to terminals in a way similar to that adopted by us, so that changes can rapidly be made. Subscribers' lines are so distributed among the sections of the switchboards that the work is distributed as uniformly as possible amongst the different operators.

The dry-core or paper insulated cable has proved to be a very great success, and is now universally adopted for telephone purposes.

Chicago.

I have gived the number of exchanges and subscribers in Chicago. To provide for this service there are—

Miles of conduit	48·02
Miles of duct, or channel	433·24
Miles of cable, underground	106·96
Miles of wire, underground	17,995·53
Number of manholes	888·0
Miles of cable, aerial	65·97
Miles of wire in aerial cables	5,184·70
Total miles of wire in cables	23,180·23
Total miles of wire on poles	7,958·0

Switch-Boards and Indicators.

Great improvements in working have been made in consequence of the introduction of metallic circuits. Visual signals, like those employed by the Post Office Department, are coming in. Dirt in the gear was a great source of trouble. False busy signals were frequently received. Now a third wire and an automatic restoring indicator has made the busy test reliable. The visual signals on trunk wires are assimilating the American working to our Post Office system.

Disturbances.

The disturbances in telephone circuits created by the extension of electric railways have been severely felt in many parts of the United States. We have experienced the same in London, Liverpool, Leeds, and Blackpool. But owing to the prompt action taken by the telephone companies, especially in Boston, the area of disturbance has been much reduced, and the influence of electric railways on telephones has ceased to be a trouble. Of course this result is very much favoured by the rapid introduction of metallic circuits into cities; but it has also been favoured by the prompt action of the railway companies themselves. They did all that they were asked to do, and that at once. In all cases the negative pole of the dynamo at the generating station is put to earth, and the return conductors have been enlarged. Extra copper wires have been buried between the rails, and heavier conductors have been put upon the poles. The return conductor is the largest size copper wire made, viz., No. 0. The rails have been bonded together and to this return conductor; and in Boston the rails are welded electrically, which is very effective. I was, unfortunately, unable to see this electric welding in operation, for the transformer had broken down, and was in the shops under repair. I saw the whole apparatus, however. A special car is used for the plant, and the system adopted is extremely satisfactory. The electrolytic action of these disturbing currents has been noticed, not only as affecting gas and water pipes, but also the lead coating of the telephone companies' cables. I have seen several specimens of lead pipes much pitted. I have reason to believe that the remedies adopted to cure disturbance will also put a stop to what might have become an element of great danger to underground cables.

Lightning Protection.

A very efficient system of lightning protection has been introduced upon the telephone system, not so much to protect the system from the effects of lightning, as from the effects of those powerful stray currents that enter a telephone circuit when accidental contacts occur between it and electric light and electric railway conductors. Such contacts have been frequent, owing to the prevalence of overhead systems, but they are diminishing now that conductors are placed underground. They have resulted in numerous accidents, and several telegraph and telephone offices have been set on fire and the apparatus destroyed. Every telephone circuit is now protected by a fuse, or cut-out—a fine wire of great resistance, which melts if traversed by a powerful current; also by an air space protector on the same principle as the lightning arresters we use, but having carbon plates instead of brass plates; and, finally, by a small heat coil, which puts the current to earth in a very ingenious way when the stray currents exceed a certain strength. These three guards have been found quite effective. No accident has occurred where they have been used.

(To be concluded.)

THE FERRANTI EFFECT.

The following abstract of an article by Dr. Sahulka in a Viennese journal is published in the *Elektrotechnische Zeitschrift* of December 29th last.

If the secondary circuit of a transformer, whose primary is on an alternator, be coupled to a condenser of suitable capacity, the ratio of transformation rises under certain circumstances above the ratio of the primary and secondary turns, while the primary volts rise and the current falls; and this is one of the most remarkable of the "Ferranti Effects." Dr. Sahulka begins by showing theoretically that this phenomenon has for sole cause the leakage of induction in the transformer, and describes some experiments which tend to support this theoretical conclusion. Supposing L_1 and L_2 to be the coefficients of self induction of the two circuits and M their mutual induction, and if N_1 and N_2 be the respective numbers of turns, then in a perfect transformer (that is, one in which there is no magnetic leakage)

$$M^2 = L_1 L_2,$$

and, therefore, with high resistance in the secondary circuit the ratio of transformation

$$U = N_2/N_1.$$

But, on the other hand, if the transformer be not perfect, a magnetic leakage takes place, then M^2 is less than L L_1 L_2 and U is less than N_2/N_1; that is to say, that in this case the ratio of transformation may be considerably less than the ratio of the numbers of primary and secondary turns.

If the secondary circuit, on the other hand, be closed through a circuit of capacity, C, then L_2 becomes $L_2 - 1/(2\pi n)^2 C$, where n is the frequency. The perfect transformer gives also in this case a ratio of transformation, $U = N_2/N_1$; but if leakage of induction takes place, the U is greater than N_2/N_1. In this case, therefore, the ratio of transformation is raised, and depends on the capacity of the condenser. The apparent resistance of the primary circuit also rises, and also the primary electromotive force of the transformer, and the primary current goes down.

In the experiments a transformer with straight cylindrical core of iron wire was used and wound on a quarter of its length with four layers of copper wire of 73 turns each, and on the remainder with four layers of 219 turns each. If the former was used as primary and the latter as secondary of the transformer, then the leakage was naturally very great, and the ratio of transformation, therefore, much less than the ratio of the numbers of turns. On open circuit the ratio of transformation was only 1·38. Under these circumstances, if a condenser of 5·15 microfarads was switched into the secondary circuit the ratio rose to 1·63, the increase being 18 per cent. If the primary and secondary were superposed, the primary being 292 turns outside and the secondary 876 turns inside, the leakage was naturally much diminished, and the ratio of transformation became 2·70 on open circuit and 2·74 with condenser, the rise being only 1·5 per cent.

There is, therefore, says the author, no doubt that the Ferranti effect is due entirely to magnetic leakage or "drop" in the transformer, and that, therefore, where there is no such leakage the rise cannot take place.

The Preservation of Belts.—The following empirical formula for a machine belt preservative is due to *L'Industrie*:—Warm in a covered vessel to a temperature of 50°C., 1 kilogramme of india-rubber broken up into pieces and mixed with 1 kilogramme of essence of turpentine. After the rubber has melted add 800 grammes of colophone; stir until this too is dissolved, then add 800 grammes of yellow wax. In another vessel put 3 kilogrammes of cod liver oil, and 1 kilogramme of tallow; heat this mixture until the tallow melts, and then pour it into the first vessel, stirring continually until the mass cools and solidifies. Belts, the working faces of which are occasionally treated with this compound, are said "to acquire greater solidity, and slipping at the pulleys is avoided."

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HISTORY OF THE TELEPHONE IN CANADA.*

BY L. B. M'FARLANE.

As the object of this Association is not only to foster the science of electricity, but to conserve its records, I have ventured to deviate from the usual plan adopted by members in their Papers, of dealing wholly with the scientific aspects of the subject, and offer instead a brief historical sketch of the telephone in Canada—the country that can with truth be called the birthplace of the telephone. Prof. Alexander Graham Bell's home was, for several years prior to the invention of the telephone, at Tutello Heights on the outskirts of Brantford, Ontario, and it was there that many of his experiments in multiple telegraphy, and some of the earliest in telephony, were made. The first experimental telephone line erected in Canada and used in this connection extended from the residence of the inventor's father across his garden. This line being found workable, it was afterwards continued on to the residence of the Rev. Thomas Henderson, in Brantford. Its successful working soon became noised abroad, and the novelty of the invention attracted many visitors from various parts of Ontario, to listen to the then wonderful performance of the electric telephone, and presently Brantford became known as the "Telephone City." At this time the much-condemned "Hello" had not come into use as a signal for conversation to begin; the words, "Hoy, Hoy," were considered most satisfactory. We must give a discriminating public the credit of choosing the less objectionable word, and be thankful that "Hoy, Hoy," did not survive. When the Canadian patent was issued to Prof. Bell he presented it as a gift to his father, Prof. Melville Bell, and the latter, believing a company or partnership unnecessary, appointed a general agent to exploit the Bell telephone. The latter visited the principal cities and towns, and exhibited the old-fashioned box telephone, with but little commercial success, however, as the difficulty of hearing the voice clearly rendered problematic its future value as a means of communication.

The first commercial telephone line was established at Hamilton, Ontario, in October, 1877, by the District Telegraph Company, who were quick to appreciate its value, and they, therefore, secured control of the invention for that district. This line connected together the residences of Messrs. Baker and Cory.

Mr. Edison at this time was not neglecting Canada as far as telephony was concerned. He had opened up correspondence early in 1877 with the City Electrician of Montreal, and forwarded two sets of his telephones for trial. These were placed on the telegraph line between Montreal and Quebec, a distance of two hundred miles, and worked with remarkable distinctness, notwithstanding the presence of several relays in the circuit.

On September 15, 1877, a contract was entered into between these gentlemen, whereby the latter secured the sole and exclusive right to the telephonic inventions in Canada of Mr. Edison for a nominal sum, with the option of purchasing outright the patents for the sum of $10,000.

The element of competition was thus introduced at the outset of the business. Both parties claimed priority of patents, and threatened suit against all and sundry users; but while this rivalry continued until 1880, it was not known that Edison as early as 1877 had admitted Bell's claim to priority. This he did in a letter to his Canadian representative, under date of October 13, 1877, wherein Mr. Edison stated that:—"Bell has done absolutely nothing new over Reiss, except to turn Reiss's from a contact breaking into a non-contact breaking telephone with permanent magnet, and worked the thing up to a success. The records of the patent office will show that myself (Edison), Bell and Gray started nearly together on acoustic telegraphy for Morse working, that Bell and myself dropped this for speaking acoustic, and that I dropped it first and was working on it before Bell. However, Bell got ahead of me by striking a principle of easy application, whereas I have been plodding along on the correct principle, but harder of application."

The cry of infringement failed to deter lessees from using the telephones, and numbers of private lines were erected in Montreal and Toronto. These lines formed the nucleus of exchanges in these cities, which were first put into operation in 1878. Montreal was equipped with the Edison apparatus, while the local company operating at Toronto adopted the Bell instruments. The Blake and Edison transmitters having been introduced, the business began to show some development. The Western Union Telegraph Company, through its ally, the Gold and Stock Telegraph Company, secured in 1878 control of the Edison patents for Canada, and the Montreal Telegraph Company were appointed agents for Ontario and Quebec, and the agents of the Western Union Telegraph Company in the Maritime Provinces were ordered to look after the telephone in the lower Provinces. In telegraphic circles it was thought that whoever could control the telephone could command the bulk of the telegraph business, and the telephone was used principally as a lever to this end. The Dominion Telegraph Company, then in fierce competition with the Montreal Telegraph Company, became alarmed at the apparently shrewd move on the part of its rivals, and immediately set about securing exclusive rights of the Bell telephone as a weapon of defence. Negotiations resulted in a contract between the patentee and the Dominion Telegraph Company, and the three telegraph companies started in a race to secure subscribers to their exchanges in the cities and towns from Windsor to Halifax, where exchanges inaugurated by local companies did not already exist. Some cities were, however, slow to appreciate the use of the telephone, notably Ottawa and St. John, N.B. At Ottawa an active canvass was commenced, but in order to save time a complete telephone exchange outfit was shipped there; the canvass was unsuccessful, no subscribers were forthcoming, and the plant had to be stored until the public could be educated into the use of the telephone. At St. John only one subscriber could be secured after two weeks' canvassing. A brilliant idea then occurred to the manager of the opposing company at this point, and was carried to a successful issue. It was to open a free telephone exchange, on trial. This at once demonstrated the necessity for an exchange, and soon two competing exchanges were working, and unable to keep pace with the paying orders offered.

This struggle between the telegraph companies, which signally failed in its main object of diverting telegrams to any one company, resulted not alone in cutting telephone rates to absurdly low figures, but in doing business absolutely without charge. To such competition there could be but one end, and it was soon reached. There had been a large capital outlay, and the revenue did not by any means meet the expenses. A proposition at this time to form a separate telephone company, independent of all telegraph companies, was made. The suggestion was gladly accepted by the interested companies and patentees, and by the public at large, who were suffering in most cities from the annoyance of two telephone exchanges. The Bell Telephone Company was thereupon organised and incorporated in 1880, when it took over all the existing plants and patents, reorganised and consolidated the exchanges, and began the manufacture of all kinds of telephonic apparatus.

The work of constructing lines connecting adjoining places was begun on the single-wire plan, and towns and villages within a radius of one hundred miles were given direct means of telephonic communication. This added to the value of the exchanges, and as the business prospered a question was raised by interested parties, anxious to embark in the business, as to the validity of the Bell patent. Two telephone companies were formed by these parties, and local competition at a few points ensued. The patent dispute was brought before the Minister of Agriculture at Ottawa, and the patent was lost to the Bell Telephone Company in 1885. A similar fate befell the Blake Transmitter Patent, and as the Minister's decision was final and irrevocable, the telephone field was opened to all comers. Notwithstanding this blow, the Bell Telephone Company continued to rapidly increase its list of subscribers and revenue, and their competitors were left to the tender mercies of their creditors, who found the venture, while it succeeded in breaking the patents, had proved an unprofitable financial undertaking. Later on competition appeared in several localities, but as the connections of these opposing concerns were necessarily limited, they again demonstrated the inutility of working a duplicate telephone system in a city or town, by disappearing from the scene without ever having paid a dividend.

A local company was formed in Nova Scotia and New Brunswick, and after a short struggle with the Bell Telephone Company an agreement was arrived at, whereby each of these provinces would have a separate telephone company, the Bell Telephone Company withdrawing from the field, but retaining an interest in each company. These companies have covered their territories with trunk lines and exchanges. The local company of Prince Edward Island, which had previously been formed by the Bell Telephone Company, has, however, reached the highest stage of expansion, it having a network of wires which reaches every town and village on the island. The Bell Telephone Company were early in the field in Manitoba and the North-West, and have kept pace with the development of this territory, by opening stations at all points where business would warrant. British Columbia is served by local companies, using the same type of instrument as Eastern Canada. These companies have been most energetic and progressive in their policy. As an indication of this we can note the fact that Vancouver, B.C., was the first exchange in Canada to alter its entire system at great cost, and give each subscriber a separate metallic circuit line.

Canada has kept pace with all the advances in the art of telephony. Metallic trunk lines between towns in Ontario and Quebec were erected and put in operation when the system was first introduced into the United States, and all the best and most modern switching and signalling appliances have been furnished, thus ensuring to the public a most reliable service. On some points it may be said that Canada is in advance of other countries;

* Paper read before the Canadian Electrical Association, September 12, 1893.

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notably in the use of the system of duplexing telephone trunk lines, which is now in operation in Toronto. The vast number of country trunk lines, both metallic and single in the older provinces, show that the service is appreciated and used by all classes of the community.

LEGAL INTELLIGENCE.

The Medical Battery Company (Limited).

C. B. Harness, the managing director of the Medical Battery Company, J. M. M'Cully, and C. B. Hollier surrendered to their bail before Mr. Hannay at Marlborough-street Police-court on Wednesday to answer the charges of having conspired together to defraud divers persons.

Mrs. CRAWSHAW, of Victoria-street, S.W., re-examined, said she attended the Court because she was interested in the case and grateful for the benefits she received from the treatment at Oxford-street. She offered to give evidence for the defence. She was quite satisfied with the treatment she received, and her feeling of gratitude still continued.

Mr. RICHARD ELLIOTT, a theatrical agent, of Greyhound-lane, Streatham Common, said that in June, 1891, he was suffering from laryngitis and nervous exhaustion, brought on by overwork. He consulted various medical men to get relief. Among them was Sir Morell Mackenzie. He derived no benefit from their advice. He therefore went, on June 29, 1891, to the Medical Battery Company, Oxford-street, when he saw Hollier. He told him what he was suffering from, and was recommended to undergo a course of electrical treatment. Hollier recommended him to wear a belt, and told him he would have to be under treatment for some time. It was arranged that he should pay a fee of 100 guineas, and that he should continue to visit the establishment until he was cured. He paid the money by cheque, and was than introduced by Hollier to Dr. Brabant. He visited the place three times a week, and was under Dr. Brabant's care. He was "massaged" and inhaled ozone. The result of the treatment was that he soon began to improve, and eventually he was restored to health. Altogether he went to Oxford-street between 70 and 80 times. Each time he visited the place he was under treatment for about three-quarters of an hour. He was perfectly satisfied with the treatment he received.

Cross-examined: He was not recommended to go to Oxford-street by anyone. He went there after reading the advertisements, and because he believed in that kind of treatment. Hollier told him that the 100 guineas must be paid in advance, and when he informed him that he had not his cheque-book with him, he believed Hollier said, "That does not matter; we can supply you with a form."

EDWARD CHURCHILL, of Manor-place, Walworth, manager to a firm of builders, deposed that since he was 18 years of age he had suffered from lumbago and piles. On the recommendation of a friend he purchased, in October, 1889, a Harness belt, paying three guineas for it. He wore it next his skin. He had worn one ever since. Since wearing the belt his ailments had disappeared, and his general health had improved. Before he wore the Harness belt he used a flannel belt, which did him no good. In December, 1892, he wrote a letter to the Medical Battery Company recounting the benefits he had received from wearing one of their belts.

WILLIAM HARKET, ex-police sergeant: While in the force he received an injury. About six months ago he suffered badly from cramp and congestion of the liver. He went to Oxford-street, and he purchased a belt for £4. 10s. During the last 16 years he had suffered from serious complaints, and had consulted medical men as to his condition. He wore the belt he purchased next his skin. After wearing it for two or three days it caused irritation, and he then put a handkerchief over the irritation, which disappeared. The result of wearing the belt was marvellous. Five hours after he first put it on he felt a warmth come all over his body. The next day he felt better and more cheerful. The cramp disappeared altogether, and he continued to improve in health. About two months after he had the belt he left off wearing the belt next to his skin, and then he became unwell again. He, therefore, put it next to his skin again, and almost immediately got well. He continued to wear the belt, and had not the slightest doubt that it cured him.

JOHN MARCHANT, 72 years of age, gave similar evidence.

Mr. HANNAY: Have you many more witness to call, Mr. Avory?

Mr. AVORY: Yes, Sir.

Mr. HANNAY: Then I do not think that I need trouble you to call them. I should like, however, to give Mr. Terrell an opportunity of saying how he thinks the evidence called for the defence affects his case.

Mr. TERRELL said he held that there was a *primâ facie* case for a jury.

Mr. HANNAY, in announcing his decision, said that after giving much time and thought to the case he had come to the conclusion that if it were sent for trial, no jury would convict. He was anxious that the full facts should be put before him, because he thought such a case might have been a test case, which would have had a very wide application. He should not have allowed the case to go on for such a long period had it not been that there was a great deal in the conduct of the business of which no honest man could approve. The practice of extracting large sums of money from persons who went to consult Mr. Harness was most reprehensible, for, although the management at Oxford-street had some reason to believe in the value of their appliances, they must have known that they could not be successful in every case. The two main circumstances upon which a jury might have been asked to draw an inference of guilt were the manner of conducting the business by exacting large sums of money down; and, secondly, the fact that the actions against *Science Siftings* and the *Electrical Review* were settled without being taken into Court. He could well believe that there were points in the conduct of the business which the mangement were most unwilling to have exposed to the full light of day. In defence of the practice of exacting large sums of money from patients it was said that it was done to make the patients give the system a fair trial. He must remark that several of the witnesses called by the prosecution were indifferent witnesses, as their memory appeared to have failed them. For the defence a number of witnesses of education and good sense were called, who stated that the treatment they received cured them. It was said by the prosecution that they could not have been cured. It seemed to him to say very little for the electricians, who declared that these things could not cure, while these witnesses swore that they did cure them. To make a case indictable there must not only be knowledge, but a guilty knowledge. These people at Oxford-street received numerous testimonials from persons who said they were benefited by the treatment they received. How was it possible to ask a jury to say that they knew all the time that these things were valueless when they were receiving constant testimonials as to their value? That was the real issue in the case. A regular record of the payments received appeared to be kept; there was no sort of concealment about the amount of the money received; and they invited medical men, the Royal College of Physicians, and the Royal College of Surgeons to visit the establishment and to inspect the appliances. He would just like to say one word regarding the chances of conviction. It was remarkable that, although they daily saw advertisements of quack medicines supposed to cure all sorts of diseases, no action had been taken by the Director of Public Prosecutions against the persons who issued such advertisements. He thought that if he had seen his way clear to get a conviction the Public Prosecutor would have undoubtedly intervened in such cases. What was still more remarkable was that in Scotland, where there was an effective Public Prosecutor in every district, no prosecution of the kind had ever been instituted. The only case like the present one was the recent prosecution of Indian oculists, which did not result in a conviction. The learned magistrate then discharged the defendants.

Mr. TERRELL asked that he should be given 24 hours to consider whether his clients should be bound over to prosecute under the Vexatious Indictments Act.

Mr. AVORY asked that the recognizances should be fixed at a sum of not less than £1,000. He should like to know who the real prosecutor was.

It was eventually arranged that Mr. Terrell should be allowed a week to consider whether proceedings would be taken under the Vexatious Indictments Act.

Edison-Bell Phonograph Corporation (Limited) v. Smith and Another.

This was an action before Mr. Justice Wright, in the Queen's Bench Division, and was brought in respect of the alleged infringement of a patent taken out by Mr. Edison in 1889, relating to phonographs. The defendants were Mr. G. A. Smith, of Hove, Brighton, and Mr. J. L. Young, of Fore-street, London, E.C., who pleaded that the plaintiff Company's patent had been anticipated by a previous patent taken out by Mr. Edison, and which had lapsed by the effluxion of time. It is claimed by the plaintiff Corporation that Mr. Edison in the patent which is the subject of this action claimed that it substituted one diaphragm for two, and that this alteration, together with other improvements, had made the phonograph a commercially useful machine, because of its easier adjustment.

Sir R. Webster, Q.C.; Mr. H. Fletcher Moulton, Q.C.; Mr. Bremner, and Mr. J. C. Graham appeared for the plaintiffs; and Mr. R. B. Finlay, Q.C.; Mr. Bousfield, Q.C.; and Mr. L. Edmunds for the defendants.

Sir R. WEBSTER, in opening the case, stated that Mr. Edison, with a colleague, had, about 1878, worked out the idea of the phonograph, but that their investigations were interrupted by other business, chiefly in connection with the telephone, and that the experiments with the phonograph were not resumed until about six years ago. The question of adjustment was the very essence of success so far as the phonograph was concerned, the instrument being one of extreme delicacy. A practical obstacle to a commercial phonograph was the difficulty to be overcome in very minute points, as any irregularity of pressure, or irregularity of cut, would render the instrument of small commercial value. The principal claim in Mr. Edison's invention was the replacing of the double diaphragm by a single diaphragm, this doing away with the necessity for using frames separate from one another, each governing its own tool, one the recording tool, the other the reproducing tool. From a commercial point of view the question of failure or success depended upon the adoption of the single diaphragm. This, however, was not effected without creating minor difficulties, which Mr. Edison had successfully combated by an invention which, although subordinate, was of considerable merit. Several other ingenious contrivances adopted by Mr. Edison were included in the patent which the plaintiff Corporation claimed had been unduly infringed by the defendants.

Several witnesses were called in support of Sir Richard Webster's case, amongst these being Dr. John Hopkinson, and, after hearing witnesses in support of the defendant's case, Mr. Bousfield summed up on behalf of his side, and the further hearing was adjourned till to-morrow (Saturday).

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—Notice is given that the transfer books and registers of members will be closed from the 10th to the 24th inst. inclusive. Subject to the completion of the audit, and after making the necessary provision for repairs, maintenance, renewals and reserve funds, the Directors, out of the profits for the year ended 31st December last, will recommend the payment of the full dividend at the rate of 6 per cent. per annum on both issues of the preference shares of the Company, payable on and after the 23rd inst., carrying forward a substantial balance to next account.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *January* 20, 1894.

Prof. Rowland and the Cataract Construction Company.—As we write, the case of Prof. Rowland against the Cataract Construction Company, claiming $30,000 for professional services rendered in connection with the Niagara plant, is being tried in a Federal Court in New York. Prof. Rowland submitted a bill of $10,000 for his services, but was only allowed $3,500, which he refused, and began suit for the sum named. Prof. Rowland was in the witness-box for parts of two days, and claimed that his recommendations in regard to low-frequency, step-up transformers, heavy moving parts in dynamos, and awarding the contract to the Westinghouse Company, were followed, as well as other points relating to design and distribution. On cross-examination it was developed that the Professor had recommended 33 periods per second, and the counsel for the defence claimed in his opening address to the jury that not a single point had been specified in the completed plans that could be claimed as distinctively originating with the plaintiff. Prof. Rowland was severe in the condemnation of Prof. Forbes, whose plans he described as foolish and puerile, and whom he characterised as ignorant and partisan. Mr. Joseph H. Choate, who is generally accounted the leading American barrister, was unsparing in his examination of Prof. Rowland and his witnesses. The adroit lawyer took advantage of a phrase in a letter from Prof. Rowland to the Presisident of the Cataract Construction Company, in which the Professor stated that he was the "first physicist and electrician in America," and ironically used the expression on every occasion. In reply to a question, Prof. Rowland stated that Lord Kelvin was a greater physicist and electrician than he, but appealed to the Court when asked if he was a greater physicist and electrician than Mascart, who, in reply to a question, he stated was exceeded in reputation by many others. The defence claims that the amount tendered Prof. Rowland is greater in proportion than he ever earned before, and larger in amount than paid for the services of Profs. Forbes and Sellers for the same length of time, and Mr. Choate added that a deduction should be made for the time spent in writing letters to the officers of the Construction Company vilifying Prof. Forbes. The witnesses for the plaintiff, Dr. Duncan, Dr. Jacques, Prof. Baker, and Mr. F. J. Sprague, testified that the amount demanded, $30,000, was not excessive in view of the eminent standing of Prof. Rowland and the time spent by him (six months) on the work. As we write this the examination of the witnesses for the defence has commenced.

The American Institute of Electrical Engineers.—At the eighty-third meeting of the American Institute of Electrical Engineers, Dr. Bell read an important Paper on "Practical Properties of Polyphase Apparatus," which was followed by a most interesting discussion, in which Mr. C. P. Steinmetz is generally conceded to have carried off the laurels. Among the points considered in the Paper are the relative merits of two and three-phase motors with reference to their torque, both starting and normal, and mechanical features. The subject of frequencies was also discussed with relation to lighting and power. Messrs. Wm. Stanley, jun., O. T. Crosby, C. P. Steinmetz, Pupin, C. O. Mailloux, and others took part in the discussion. Mr. Steinmetz traced the history of the rotary field from Arago, and in disputing Mr. Stanley's remarks against synchronous motors and in favour of condensers, said that motors of the synchronous type, if properly designed, have sufficient condenser action of their own. In regard to frequency, he said that his experiments showed that with high voltage incandescent lamps burned with usual brilliancy, the flickering was exceedingly disagreeable at 20 periods, and was still manifest at 30 periods.

BOOK RECEIVED.

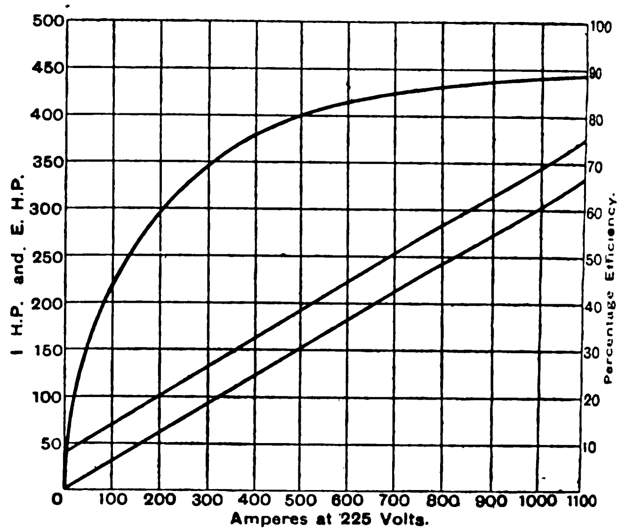
"The Inventions, Researches, and Writings of Nikola Tesla." By Thomas Commerford Martin. (Published by the *Electrical Engineer*, New York.)

CORRESPONDENCE.

A SIEMENS-WILLANS SET.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We venture to think that the figures in the enclosed table are of some interest, as, to the best of our knowledge, so high an efficiency as 88 per cent. has not been previously



obtained. The tests were made at the works of Messrs. Willans and Robinson, under the superintendence of Prof. Kennedy, the consulting engineer. The curve which we enclose is also remarkable.

Test of Siemens-Willans Set for Glasgow Corporation.

Siemens dynamo H.B. 27/40, shunt wound, No. 3,053.
Willans engine III., central valve compound, No. 1,533.

Load.	Pressure in steam chest.	Revolutions per minute.	Amperes.	Volts.	I.H.P.	E.H.P.	Water lbs. per E.H.P.	Efficiency per cent.
Full	139	346	1,001·0	225	343·0	302·0	23·08	88·04
¾	112	347	740·0	225	262·2	223·2	27·01	85·11
½	88	344	515·0	225	197·2	155·3	31·63	78·76
¼	56	345	236·6	225	112·2	71·2	47·09	63·44

SIEMENS BROS. AND CO. (LIMITED).
(AL. SIEMENS, Director.)

12, Queen Anne's-gate, London, S.W.

SAFETY FUSES IN HOUSES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I wish to endorse your remarks in a paragraph of this week's *Electrician* on the carelessness shown by wiremen in fitting fuses in private-house installations. Apparently the fuses are put in without the slightest regard to the number of lamps they are to carry; or, if any thought is expended on the matter, it is rather in the direction of trying to limit the consumer in the number of his lamps that he may light at one time, the fuse being adapted to the average load instead of the full load. In a house at which I was spending the evening a few days ago, the light was suddenly extinguished, and investigation showed that the main fuse had melted. There were about 70 lights in the house, while the fuses were for 35 lights, with the natural result that, on the first occasion on which the house was extensively lighted up (the lady of the house was giving a ball), the whole place was put into darkness. It seems, of course, a small matter to an electric light engineer that a fuse should go, but to the average householder the failure is as serious, so far as he is concerned, as a complete breakdown of the central station, for the mysteries of cut-outs are at present beyond his range of knowledge. In this particular case I was able to put the matter to rights in a

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few minutes, but if I had not chanced to be present the entertainment must have forthwith come to a conclusion.

As mistakes like this go far to discredit the electric light, and in an absolutely unnecessary way, I should think it would be to the interest of the electric supply companies to inspect the fuses occasionally at the time when the meters are inspected. The wireman does not care about the matter, as he has finished his job, and he probably puts in any fuse he happens to have with him. The same carelessness I have also noticed on branch circuits. In one case a set of six lamps were run on a No. 22 tin fuse wire, or single-light fuse, which must have been in a semi-molten condition every time the lamps were lighted, and which eventually broke with a slight increase of pressure on the circuit. Instances such as these give the enemy opportunity to blaspheme, and exert a powerful moral effect in deterring people from unreservedly adopting electric light. They are but two examples out of many, and in both cases the firms which had carried out the wiring were experienced and capable.—Yours, &c,, FRANCIS G. BAILY.

University College, Liverpool, January 26, 1894.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1894 Edition of "'THE ELECTRICIAN' ELECTRICAL TRADES' DIRECTORY AND HANDBOOK" will be published on Friday next. Printed particulars and List of Contents can be obtained, post free, from "The Publisher," *Electrician* Office.

"ELECTROMAGNETIC THEORY," by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application to the Publisher.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.) A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

TENDERS INVITED.—The Scarborough Corporation invite tenders for lighting, by electricity, the council chamber, court house, offices, &c., in the Town Hall. Tenders have to be in by 12 o'clock on Monday next.

VACANT APPOINTMENT.—The School Board for London require a stoker competent to take charge of dynamos and steam-engines in the absence of the engineer. See advertisement columns for further particulars.

LIQUIDATIONS.—At meetings held on January 5th and 23rd the shareholders of the Electric Arms and Ammunition Syndicate (Limited) resolved that the company be voluntarily wound up. Mr. E. F. Hunt, 17, Throgmorton-avenue, E.C., was appointed liquidator.

———— We have received the following from the Secretary of:—

"LATIMER CLARK, MUIRHEAD AND CO., (LIMITED).

"I regret to inform you that the Debenture-holders of the Company having taken action and obtained the appointment by Mr. Justice North of Mr. James Worley as Receiver and Manager of this Company's property and business, it is impossible for the Company to pay the debts as they fall due, and the shareholders have therefore passed a resolution for the liquidation of the Company, and Mr. Worley has been appointed liquidator. I have therefore to request that you will send to that gentleman, here or to his office, 27, Leadenhall-street, particulars of your claim. Meantime, with the authority of the Court, Mr. Worley is making arrangements for the completion of pending contracts, and the Directors hope the realisation under the circumstances may be favourable. If you desire any further information, the Receiver will no doubt supply the same, or you can apply to Messrs. Bircham and Co., Winchester House, Old Broad-street, E.C., the solicitors for the plaintiff in the Debenture action, or to Messrs. Trinder and Capron, 47, Cornhill, E.C., the Solicitors for the Liquidator."

———— Mr. Justice Wright, on Wednesday, sanctioned a scheme of arrangement which had been agreed to in respect of a petition for the compulsory winding up of Elmore's French Patent Copper Depositing Company (Limited).

———— Mr. Justice Wright, on Wednesday, made an order for the compulsory winding up of R. Bolton and Co. (Limited).

———— A petition for the compulsory winding up of the Platinum Plating Company (Limited) was, on Wednesday, ordered to stand over for three weeks.

BANKRUPTCY.—Creditors of Messrs. Austin and Myers, lately carrying on business as manufacturing electricians, at 7, Florence-terrace, Armley, near Leeds, must send in proofs of their claims by the 20th inst. to Mr. J. Bowling, Leeds, the Official Receiver.

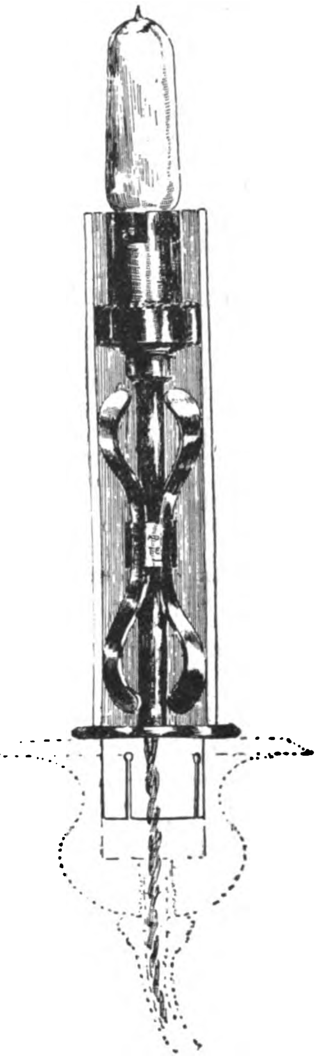
———— At the Liverpool Bankruptcy Court, on Friday, the discharge of Charles Walter Cox and Frederick George Robinson, formerly carrying on business as electrical engineers in Liverpool, was suspended for a period of two years.

DISSOLUTION OF PARTNERSHIP.—Messrs. Roberts and Mundy, trading as the North London Battery Company, electricians, 41, Hawley-crescent, Kentish Town-road, N.W., have dissolved partnership.

CHANGE OF NAME.—The Executive Committee of the City and Guilds of London Institute have changed the name of the Guilds "Central Institution" in the Exhibition-road, London, S.W., to the Guilds "Central Technical College."

MESSRS. C. A. PARSONS AND CO.—We are requested to state that by mutual arrangement, Mr. A. A. Campbell Swinton has ceased to represent Messrs. C. A. Parsons and Co., and in his place Mr. C. P. Martin has been appointed their London agent. Messrs. Parsons and Co.'s London office will continue to be at 66, Victoria-street, Westminster, as previously.

MESSRS. FARADAY AND SON.—A "Crystal Star Pendant" has been designed by this firm for ceiling lights in high rooms. It is suited to hang to the finials or hammer beams of large halls and dining-rooms, or in high conservatories. To obtain the best effect



Faraday's Candle Fitting.

with this arrangement the point of light should be as small as possible, hence it is generally used with the clear bulb lamp of 1in. or $1\frac{1}{4}$in. diameter. At a height of 12ft. or more the light is so refracted and transmitted by the cut-glass facets that it becomes a complete star in appearance, and, since it is placed so far above the line of horizontal vision, the full power of an unscreened electric light is made available without injury to the eye or annoyance to the senses. It is especially light and airy in appearance, when seen at a distance. A simple mechanical device has been arranged to afford support for the imitation candles, now so largely used in adapting the electric light to sconces and candelabra. The unsightly effect

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of candles standing at various angles is thus overcome ; at the same time they may be easily removed for the needful cleaning without in any way interfering with the electrical connections. These latter are readily made at the outset, and are so protected that they cannot be put out of order. Reports having been spread that the patent of the adjustable, or "Perfect," pendant (Sir David Salomons' patent, No. 6,358, of 1886) had expired, Messrs. Faraday and Son desire to make it known that the renewal conditions have been periodically complied with, and that the patent remains in force. The advantages of this well-known fitting are obvious, and in its decorative forms it is now fit for service in any dining-room or library.

CHICAGO AWARDS.—There has been an unprecedented delay in announcing the awards made at the Chicago Exhibition. No list of awards has yet been issued, and it seems quite uncertain when one will be. Many awards have been announced, but none have as as yet been officially confirmed. Sir Henry Wood has, however, at different times, received information, from which it appears that about 1,400 awards have been made in the British Section. Of these 836 were in the industrial departments of the Exhibition, and were divided among 449 exhibitors. The total number of industrial exhibitors was 597.

"DUROL."—Under this name, a hardening liquid for steel is being introduced by Messrs. W. Holtz and Co. It is claimed that an unusual degree of hardness may be obtained by its use. The steel is to be brought to a dark red, dipped in "Durol" for 10 to 20 seconds, then heated slowly to cherry-red and quenched in "tepid" water. The temperature is given on the circular which we have received as 35°F. to 40°F., but on making inquiries, we have been informed that 15° to 20°Reaumur or 66°F. to 77°F. is intended. The composition is said to restore steel after it has been "burned," and is therefore probably of a case-hardening or carbonising nature. A sample which has been sent us by Messrs. W. Holtz and Co., has the appearance of a mixture of lamp black and a vegetable oil, but it seems to have a greater case-hardening effect on soft iron than such a mixture. For hardening steel it appears satisfactory. The inventor, we understand, defies analysis, and he is, therefore, perhaps well advised in declining to patent the composition.

THE ELECTRIC LIGHT ON RAILWAYS.—Speaking at the meeting on Tuesday of the Great Eastern Railway Company, Lord Claud Hamilton (the Chairman) stated, referring to the extensive new works at Liverpool-street station, that it had been decided to light the whole of that station, the hotel, the Bishopsgate low level station, the Bishopsgate goods station, and the the Bethnal Green Junction with the electric light, served and distributed by themselves. They had incurred for this purpose an expense of £35,000, which he did not think was large under the circumstances. In a very short time the whole of these stations would be lighted by the electric light, not only to the comfort of the public, but to the great benefit of those who served the Company. Messrs. Crompton and Co. are, we understand, supplying the plant for this contract.

ACME AND IMMISCH WORKS (LIMITED).—This Company, which is an amalgamation of the General Electric Power and Traction Company (Limited) and the Acme Electric Works, notifies the trade that in the amalgamated businesses the *employés* of the old firms have been retained, and the factory at Ferdinand-street, Chalk Farm-road, London, N.W., is to be equipped with suitable machinery for the manufacture of all kinds of electrical plant and apparatus, of which Immisch motors for lighting and other purposes, and mains and distributing switchboards, switches, cut-outs, &c., will be made a special feature. The new Company acquires valuable patent rights, machinery, and apparatus for the manufacture of all plant necessary for electric light and power contracts. Among the specialities which the new Company will continue to manufacture are the Cockburn switches, cut-outs, &c. Price lists are being prepared.

MESSRS. W. H. ALLEN AND CO.—This well-known engineering firm purpose transferring their factory from the York-street Works, Lambeth, where they have been established for many years, to the neighbourhood of Bedford, where they are building new works, owing to their present premises having been acquired by the London and South-Western Railway Company for the extension of their line. The new works at Bedford will probably not be completed until next year.

MESSRS. EASTON, ANDERSON AND GOOLDEN (LIMITED).—As announced elsewhere, the above Company was registered on the 26th ult., and is an amalgamation of Easton and Anderson—the old-established engineering firm of London and Erith—with Messrs. W. T. Goolden and Co., electrical engineers, of Woodfield Works, Harrow-road, London. The former firm, who for so many years have had an extended connection in hydraulic and general engineering work, have more recently been paying attention to the development of the electrical transmission of power. In their Erith works, for some four years, travelling cranes of 15 and 20 tons have been in work, driven electrically. A special department has also been established for the execution of various descriptions of electrical work. The firm of W. T. Goolden and Co. has been prominently before the public in connection with the application of electrical transmission in mines. The nature of the electrical work of each firm being so similar, the combination of the two should lead to an increase of business on both sides, as the new Company will be in a position to carry out all work in connection with large electrical installations, either for transmission of power or for lighting.

NEW BOOKS.—We are asked to state that Messrs. Crosby, Lockwood and Son will shortly publish the "Engineer's Year-Book," by H. R. Kempe. The book is to consist of about 600 pages, with nearly 700 illustrations.

CALENDARS.—Mr. Charles Rettie, of 18, Geraint-street, Liverpool, sends us a neatly-printed hanging calendar, with tear-off sheets. Mr. Rettie is sanguine enough to anticipate the early use of aluminium in ship building, a prominent feature of the calendar being a sketch of a ship built of aluminium and driven entirely by electricity.

ABERDEEN.—It is anticipated that the electric light will be inaugurated on the 19th or 20th inst., and Mrs. Stewart, of Banchory House, Aberdeen, has been asked to perform the ceremony, at which the Lord Provost, the magistrates, and Town Council will be present. The Public Library Committee have instructed Mr. Murray, the inspector of electric lighting, to report as to the cost of lighting the whole of the library premises by electricity.

BRISTOL.—A special meeting of the St. George Urban Sanitary Authority was held on Monday last to further consider the clauses of the Bill now being promoted in Parliament by the Bristol Tramways Company to put down additional tramways in the district. The Chairman proposed that the Board give their sanction to the Company's proposal to work the tramway on the overhead system. The motion was carried unanimously. A discussion followed as to the terms upon which the Tramway Company were to be permitted to lay the tramways, and it was pointed out that the success of the Company in its endeavour to obtain the necessary powers would hasten the adoption of the electric light in the district—at any rate, for the areas served by the Tramways Company.

——— The electric light has now entirely taken the place of gas in those thoroughfares where the electric light has been installed. Now that the Exhibition is closed there is more power available for private lighting, the demand for which has considerably exceeded the Electric Light Committee's anticipations.

CLERKENWELL.—The Vestry have received a communication from Mr. Sydney Morse, on behalf of clients, asking for certified copies of resolutions recently passed by the Vestry, with regard to an extension of time asked for in regard to the electric lighting scheme. Mr. Morse's clients are anxious to carry out the electric lighting of the district, and he therefore hopes that the extension of time asked for will be granted by the Vestry.

FINCHLEY.—The School Board is discussing the advisability of adopting the electric light in the schools in this distrtct, and Mr. Hardy, who has been asked to prepare a report as to cost, is to present this at the next meeting of the Board.

FOLKESTONE.—In reference to the electric lighting of Folkestone, Mr. C. O. Grimshaw, M.I.E.E., complains in a letter to the Town Council that only high-tension systems have as yet been considered. He asks that low tension may have a chance.

GLASGOW.—In reference to our Trade Note last week o c rriage lighting, we are asked to state that the batteries used are those made by the Bristol Electric Safety Lamp Works, of 63, Queen Victoria-street, London, E.C., and for which Messrs. Anderson and Munro, of 136, Bothwell-street, Glasgow, are the sole agents in Scotland.

HULL.—The Electric Lighting Committee of the Corporation at their last meeting had under consideration the draft resolutions submitted by the Board of Trade for the security of those using electricity from those who use the same power in connection with the working of tramways. Dr. W. Holder, chairman of the committee, said the matter was of the greatest importance to them in connection with their tramway scheme. Plans and estimates had been received from different firms for supplying a condensing service suitable for their station and its work, and after inspecting the tenders the matter was deferred until the next meeting.

KEIGHLEY.—A meeting of the Tradesmen's Association has been held, at which the question of electric lighting was discussed. It was complained that, some years ago, a private company was prevented introducing the light, owing to the action taken by the Corporation ; but that, notwithstanding five years had passed, the citizens were no nearer the attainment of an electric light supply, although much smaller places were being supplied. The newly-appointed President of the Association intimated that steps would be taken to bring the matter to a satisfactory conclusion shortly.

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King's Norton.—The advisability of installing the electric light throughout the infectious diseases hospital and the whole of the rural sanitary authority's municipal buildings has been under discussion, and its further consideration has been adjourned for a month.

Lambeth.—The Vestry have decided to postpone, till after the elections in November next, the re-appointment of an Electric Lighting Committee.

Lancaster.—At the last meeting of the Local Board, the report of the surveyor upon the cost of lighting the streets by electricity was further considered, and it was resolved to place arc lamps of 1,000 and 2,000 c.p. in various main thoroughfares. Five 2,000 c.p. and eight 1,000 c.p. lamps were ordered to be fixed.

London County Council.—At their meeting on Tuesday last the Finance Committee of the London County Council presented a report on an application of the St. Pancras Vestry to borrow £30,000 for 42 years on the annuity principle, for electric lighting purposes. The Council had already sanctioned loans for £10,000 for the purchase of a site, repayable in 50 years, and £60,000 for works, repayable in 42 years. The £10,000 was advanced by the Council and the £60,000 borrowed elsewhere. On July 25th last they reported on the Vestry's application for a further loan of £30,000, when they recommended that the loan should be limited to £15,400. The Council concurred in their recommendation that the repayment of that sum should be spread over 42 years. The Vestry had not taken up this loan, and now renewed their application for the £30,000. The life of the different portions of the work having to be considered, the only satisfactory way of dealing with the present application appeared to be to consider it as part of an application for £90,000, on account of which £60,000 had been sanctioned. It must be borne in mind that an electric light undertaking differed from many other undertakings, in that a very large proportion of the total cost was in respect of works of a short-lived character. The Vestry contended that they should be allowed a longer period than one based upon the life of the work, in order that they might have equal advantages with an electric light company, which did not have to pay off its capital; but even if this be admitted, it must be remembered that a company could not borrow money at 3½ per cent., as the Vestry could, and that a company had to establish a reserve fund to meet depreciation and other contingencies. These considerations led to the conclusion that practically the only safe course for the Council to adopt was to sanction the loan for a term approximating to the life of the work. And there would be this advantage in the course suggested, that the Vestry would be justified in borrowing again for renewals. If the Council accepted this view, the present application might be granted as follows:—£2,500 for five years, £4,200 for eight years, and £23,000 for fifteen years, and in this event the resolutions of July 25th last, agreeing to sanction and lend the Vestry the sum of £15,400, should not be further proceeded with. They recommended accordingly.—Mr. J. Williams Benn, M.P., moved, as an amendment, "That the recommendation be referred back to the Finance Committee, with an expression of opinion that the total initial cost should be extended over a reasonable period, and without regard to the life of any particular portion of that which forms initial cost, and that the Finance Committee should be at liberty to take such professional advice, in addition to that of the officers of the Council, as the Committee may think fit."—Mr. McCall seconded this amendment, and, several other members having condemned the recommendation as being prohibitory to electric lighting being taken up by local authorities, the amendment moved by Mr. Benn was agreed to.

Madras.—Operations have been commenced for the laying of the Madras tram lines along the Esplanade-road. The central-power station at Madras is fast approaching completion, and one section of the tramway is to be pushed forward, and to be opened for traffic at the earliest possible moment.

Maidstone. —The Electric Lighting Committee of the Local Board, in response to inquiries from various quarters as to the terms upon which private firms or companies are prepared to carry out the installation of the electric light in the district, received five offers. These were considered at the last meeting, but no decision was arrived at, as further information on certain points was deemed necessary. The Committee anticipate reporting to the Board in a week or two.

Sutton (Surrey).—The Local Board contemplates transferring its Electric Lighting Order to a local company; but the Board of Trade decline to approve of the proposal until the transferee has been nominated, when the Department will require evidence of the latter's capacity to carry out the terms of the Provisional Order.

Wigan.—A meeting of the principal tradesmen in this town has been held to discuss the question of the adoption of the electric light, and it was pointed out that, unless the Corporation moved actively in the matter, there were amongst the citizens many who felt disposed to take the matter into their own hands, and to form a local company for the purpose. It was decided to prolong the time for tradesmen to reply to the circular issued by the Corporation on the subject.

Westmoreland.—Mr. George J. McKay, a prominent resident of Kendal, recently made a statement that he had saved £500 in five years by using the electric light. Several correspondents of the *Westmoreland Gazette* have called in question Mr. McKay's veracity; but in a letter to that journal he says he will be glad to demonstrate to any doubter how he saved £500 in five years, and he adds that his plant has not cost him £5 to maintain during the whole period, or less than £1 per annum.

————A proposal is to be placed before the next meeting of the Kendal Town Council from Messrs. R. H. Fell and Son (Limited) asking for the approval and consent of the Corporation to their application to the Board of Trade for a Provisional Order to supply electric current to the district.

Annual Dinner.—The fifth annual dinner of the *employés* of the Liverpool Electric Supply Company (Limited) took place on Saturday last, to which nearly 100 sat down, the chair being occupied by Mr. Clough, the works manager.

COMPANIES' MEETINGS AND REPORTS.

Liverpool Overhead Railway Company.

The following is the report of the Directors to be presented to the eleventh ordinary half-yearly general meeting of the shareholders, to be held at the Law Association Rooms, 14, Cook-street, Liverpool, on Tuesday, 13th inst., at 3 p.m.:—

In presenting the half-yearly statement of the capital and revenue accounts to December 31, 1893, your Directors have to report that the gross revenue receipts for the half-year amount to £18,518. 4s. 7d. The number of passengers carried were: First class, 260,221; second class, 1,295,840; workmen (special return tickets), 921,578—total, 2,475,639; making the total number of passengers carried since the opening of the railway, on March 6th last, 3,846,381. The electrical equipment continues to work very satisfactorily. During the past half-year 46,429 trains have been run, and 95.35 per cent. have been punctual. Your Directors have taken over from the Electric Construction Company the electrical working of the railway, from December 31, 1893, by which they hope to effect a considerable saving in the expenses. Progress with the northern extension was somewhat delayed by the coal strike, but the work is now well in hand, and it is expected to be completed about the middle of March. Under the powers sanctioned by the shareholders on August 8th last, £25,000 of the remaining Preference capital has been issued and fully subscribed.

The gross receipts from traffic ammount to £18,002. 16s. 11d.; miscellaneous receipts, £515. 7s. 8d.—£18,518. 4s. 7d.; less working expenses, £13,732 11s. 5d.—£4,785 13s. 2d. From which deduct interest on debentures and on calls paid in advance £2,627. 1s. 10d., and add balance brought forward from last half-year, £3,293. 9s.; leaving available for dividend the sum of £5,452. 0s. 4d. Out of this balance your Directors recommend the declaration of dividends at the following rates (less income tax), payable on and after February, 16th viz.: 5 per cent. per annum on Preference shares, £978. 13s. 3d.; 1 per cent. per annum on Ordinary shares £1,875—£2,853. 13s. 3d.; leaving a balance of £2,598 7s. 1d. to be carried forward to next half-year.

The Directors retiring by rotation at this meeting are Mr. James Barrow and Mr. Richardson Hobson, who, being eligible, offer themselves for re-election. The auditor retiring by rotation is Mr. George Nicholson, who is also eligible for re-election.

City and South London Railway Company.

The nineteenth ordinary general meeting of this Company was held yesterday (Thursday) at Winchester House, Old Broad-street, under the presidency of Mr. Charles Grey Mott.

The SECRETARY (Mr. W. F. Knight) read the notice calling the meeting, and the register of shareholders having been sealed, the report of the Directors was taken as read.

The CHAIRMAN: It now becomes my duty to move the adoption of the report and accounts. I am glad to be able to say that during the past half-year we have again carried the whole of our large number of passengers with absolute safety, and with almost absolute punctuality. As regards the number of passengers carried, there has been a slight check in the regular increase we have had every half-year, and you will notice, from the statement appended to the report, that as compared with the corresponding period of 1892, the decrease in the numbers carried has been 24,251, exclusive, however, of season ticket holders. There is an increase in the number of season ticket holders of 59, so that practically there has really been no decrease, but an actual increase in the numbers we have carried. The consequence is that the receipts have shown an increase of £65 in the half-year. We should undoubtedly have done very much better if it had not been for several special causes. I have always told you that fine weather morning and evening is always against the traffic of this line, and, as you know, during the greater part of the half year we had exceedingly fine weather both morning and evening in fact, there was hardly a wet morning or evening during

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the whole of that time. Then, Kennington Oval has been closed for three months, and the football matches there are a considerable source of revenue to this Company. They are the best attended of any matches during the year, and we have, of course, lost that traffic, and I regret to say that we shall continue to lose it for another month or two. They are relaying the turf on the Oval, but when that is finished I hope that we shall get a better traffic on the railway. We have also undoubtedly suffered, in common with all the other railways of the kingdom, from the general depression throughout the whole of trade in the past year. Of course, we have not suffered in the same way as if ours were a goods line, because we have had no coal or goods to lose traffic on, but still that kind of depression of trade is always felt, even on solely passenger lines, and that is shown by the large decrease in passenger traffic all over the kingdom. We have not been idle during the half-year. The new sidings at Stockwell have been brought into use, so we have been able to give a better service and to decrease the overcrowding which was taking place in the morning and evening trains. The result has been, of course, that we have had to run an increased mileage, and we have run about 10,000 miles more than in the corresponding period of 1892. We have also introduced additional intermediate signals, and this has enabled us to run an increased service of trains, and thus we have been enabled gradually to relieve the overcrowding which was previously complained of. We have also been at work on the upper part of the King William-street station. That is now nearly completed, and in the course of the present month it will be opened for use. It will quite transform the appearance of that station, and make it much more attractive than it has been heretofore, and I hope in that way it will tend to increase the attractiveness of the line. We trust that the expenditure there, with the interest on it, will be recouped by the receipts we shall get from the left-luggage and parcels offices, &c. The conversion of the debentures into debenture stock has gone on, and we have paid off a large amount of the terminable debentures which became due just before the end of the year—to the amount, in fact, of £32,200, part of which has already been replaced by the Four per Cent. Debenture stock. We borrowed part of the money to pay these debentures off, but as they are replaced in the market by debenture stock, this loan will very soon be got rid of. The conversion is a permanent gain of interest to us. The bill for the extension to Islington, after a long delay, owing to the dissolution of Parliament, has been passed. A number of Bills, our own among the number, were carried over on the dissolution of Parliament to the next Session, on the suppersition that this would reduce their cost, but unfortunately it was found in practice that so far from reducing the cost it was increased considerable. Our Bill, however, passed this Session, and in one respect the delay was advantageous, for although we lost money by it, we gained a good deal—probably more than we lost—from the fact that during the delay we paid dividends on the ordinary stock and we are no longer paying interest on the deposit. We have also been able to relieve ourselves from the deposit. This will effect a future decrease of capital expenditure, which will compensate us for the extra cost caused by the delay. Turning to the accounts, and taking the capital account first, you will see that we have received on Preference shares for the half-year £400, and on Debenture stock issued £20,000; we have a loan of £22,000; and we have received a premium on Debenture stock of £616. These make a total of £43,016 received on capital account. During the half-year we have paid off £32,200 of the old terminable debentures; we have spent in connection with the Act of Parliament £4,400; the purchase of the adjoining house in King William-street—which you approved of last year—cost £2,827, and sundry other works (sidings, &c.) involved an expenditure on capital account of £3,144. These items make together a total of £42,571, leaving over expended the amount of £445. That disposes of the capital account, and now we come to the revenue account. The receipts from passengers show an increase of £61, compared with those of the corresponding period of 1892; parcels are £11 more: there has been a decrease in transfer fees of £4, rents show an increase of £39, and in sundry receipts an increase of £58 is shown, making a total net increase for the half-year of £168. On the other side, the expenditure shows an increase of £173 in maintenance; in locomotive and generating power there is a decrease of £535; carriage repairs show an increase of £13, traffic charges a decrease of £295, general expenses an increase of £14, law charges are £41 less, and there is a decrease in compensations of £66. That is not an actual decrease, because we insure against accidents, and this appears under the item of general expenses. Rates and taxes, as you know, are increasing half-year by half-year, and they show an increase this half-year of £101. The passenger duty is £5 extra. These items make a net decrease in the expenses of £629, and there being an increase in the receipts of £168, a net increase of £797 is shown in our revenue for the half-year, to which is to be added the £65 less that we have paid for debenture interest, thus making us £862 better off on the half-year. Last half-year the full dividend on the Preference shares did not come in, but it did this half-year, and there is an increase of £506 on that account, which would leave us £357 to the good for our Ordinary Stock. This time last year we paid a dividend on this stock of ⅝ per cent., taking £116 from the balance brought forward. This half-year we have increased the balance brought forward by £241, which makes up the £357 of the comparative increase. The working expenses are 64·6 per cent., against 67·9 per cent. in the corresponding period of the previous year. Deducting the cost of working the lifts, as we have done before, you reduce the actual working to about 55 per cent., which I think will be found to be less than most of the railways of the country. The receipts per train mile are exactly the same as they were at this time last year—namely, 2s. 0½d.—and the expenses are 1s. 4d., against 1s. 5¼d. last year. The locomotive expenses are 6·22d., against 7·1d. in the corresponding period of 1892. As I have explained before, we have to pay for the carriage of our coal, whereas the large railways do not charge for this item; and if you deduct this charge in our case, it brings the locomotive expenses to about 5d. per train mile, or very little more than what it costs in steam in the big lines; but our trains are much lighter than theirs. The receipt per passenger was 1·65d., against 1·60d. last half-year, showing a slight increase. The question has been raised whether we should not have taken something further out of our balance brought forward, and have paid another ⅛ per cent. dividend. We, however, thought, on the whole, that it would add to the general value of the property of the Company if we showed the greatest prudence in all these matters, and that rather than take from the balance brought forward we should add to it. That, however, is a matter of opinion. I may say now, in conclusion, as far as the working of the line is concerned, that we have now been open for three years, and I think we have shown that the electrical system is specially adapted to this class of traffic. I think it is pretty clear now that electricity, certainly for metropolitan railways, is going to be and is a cheaper mode than that of steam. Of course, in the early stages of the Company, there were many doubts expressed as to whether this system would be successful, but all those points are now beyond dispute. We have proved beyond all doubt that the electrical system of working is, as far as can be known, for an undertaking of this kind, the cheapest and the best. The position of the Company is a very solid one; it wants only an increase to our dividend on the Ordinary shares to make us take rank as one of the first in the kingdom. Our Debenture stock and our Preference shares, I am satisfied, are as solid investments as any one can get in these days, and they ought to command as high a price as those of any railway in the country. The question of carrying out the extension to Islington is one which we are carefully considering, but we are not disposed to move in that matter until we can do it in such a way as to make us feel sure that any diminution in our dividend will be avoided during the time these works are being carried out. The moment they are open, as soon as we can get properly into the City, as we propose to do, you will, I have no doubt, see our dividend go up rapidly. The cost of working the extension will be a very small addition. I am satisfied that the receipts from this source will be very large, and that they will be earned at a very small additional cost; but at the same time we must proceed with this matter with t e greatest possible caution. We have therefore not brought any proposal before you to-day in regard to this matter, and we shall not do so until we can present a case which you will feel is unanswerable. I think these are all the remarks I have to make, but I shall be glad to hear any observations from the shareholders. I will now conclude by moving—

'*That the report and statement of accounts for the half-year ended December 31, 1893, now submitted to the meeting, be approved and adopted.*"

Mr. EDWIN TATE briefly expressed his pleasure at seconding the motion.

Mr. DRAKE said that he had been travelling on the line that morning and got into conversation with a passenger, who remarked that the line was a great success, although perhaps this gentleman was not a shareholder. He (the speaker) had freely criticised their undertaking in its early stages; but he had obtained further information on the subject, which had tended to modify the severity of his criticisms. The management had not yet made the concern a commercial success; but the practicability of this mode of conveyance had been clearly demonstrated. He felt very strongly that they had now turned the corner, so far as making the concern pay, and any further judicious extensions would unquestionably add to the convenience of the public, and would increase the Company's profit out of all proportion to the cost of such extensions. He felt very strongly that they would act wisely in further catering for the teeming population of South London, either by loop lines or small extensions.

Mr. BLACKWOOD referred to the prospectus regarding the prospects held out originally. He congratulated Mr. Drake on that gentleman's thankfulness for small mercies, but for his own part he thought that ⅝ per cent. compared very unfavourably with the 12 per cent. per annum which was the prospect held out to them in the prospectus. He thought that an effort should be made to increase the fares, so that they might get something like what they were entitled to charge. The Chairman had anticipated a question which he had been going to ask regarding their locomotive expenses, which, they had been informed, were 6·22d. per mile last year, whereas they were originally assured that the charge would be only 3d., or at the outside 3½d.

The CHAIRMAN: If no one else has anything to say I will reply to Mr Blackwood's observations. I myself, as he has done, have referred from time to time to the original prospectus, because I have been quite as much disappointed as he has been with the result; but so far from misleading the shareholders at these meetings I have always, I think, been complained of for not making my remarks a little more *couleur de rose*. The prospectus was issued in the dark entirely as to what the circumstances of a line like this would be. Existing facts were given, and deductions were simply drawn from them tentatively—deductions which any one could have drawn as well as the Directors. I do not, however, despair of even the 12 per cent. being yet realised on this line if the policy we are adopting, and intend to adopt, is followed; but it is a difficult operation to carry out a line of this kind. In the first place we had to get the working power—a new working power hitherto unknown—into thorough order; but having succeeded in that, our intention is now to try and steadily develop the traffic of this line. That we have done so is manifest from the fact that, although our dividends have been small, they have steadily and regularly increased every half-year until the present occasion. We have this half-year earned more than we did in the corresponding period of 1892, but we have thought it prudent not to pay any more, because we wished in many respects to strengthen the position of this line and to give the public confidence—and our shareholders also—that we were acting as prudently as possible, and we are also advised by our auditor as to the wisdom of this course. Mr. Blackwood says that

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we stated that we could work this line at 3d. or 3½d. per train mile. That is perfectly true, but that charge was purely for the electrical power He forgets what was stated at the time, that that was the arrangement with the contractor, and so far from that price being exceeded, we are now working at less than that. We have not misled the shareholders in any way in that respect. The amount is less than 3d. or 3½d., but Mr. Blackwood quotes that sum as if it was intended to cover the whole of the locomotive expenses, whereas it did not cover the cost, for instance, of engine-drivers, besides many other things. He has also referred to the figures given in the prospectus in regard to the number of people who pass over London Bridge, but that includes a very large traffic from the London Bridge stations, and we are unable to take advantage of that traffic by making a station in connection with those railways, as they would not let us have such connection. They did not believe in us then, but they have since altered their opinion, and they are now willing to let us join them. We have gone for a Bill, therefore, to enable us to secure that traffic, which forms a very large portion of the immense traffic which goes over London Bridge. I have no doubt, in fact, that when we get that station we shall have a difficulty in dealing with the traffic, although we shall deal with it, because we shall apply for additional siding accommodation, and get rid of the heavy inclines that we now have. As I have said before, too, the calculations in the prospectus were all based on a much more rapid service than we have at present. We had no idea that circumstances at King William street would confine our traffic as they are doing. We are endeavouring to get rid of these difficulties, however, and we are doing our best really to carry out the very objects which Mr. Blackwood has in view. With respect to his remark about the rate per passenger, Mr. Blackwood has raised a question of the greatest importance. If we could increase our rate we should increase our net revenue very considerably. We have tried all kinds of experiments for the purpose of doing this; we have altered our fares from time to time, and they are now somewhat complex in consequence. We have carefully felt our way as regards the different classes of passengers we carry, and for different times of the day. We are always trying to raise our fares, and we have succeeded in doing so to some extent; but it is not quite so easy a matter to increase the fare per passenger as Mr. Blackwood supposes. Our rate per passenger is exactly the same—or as nearly as possible the same -that the Metropolitan and the District Companies, as well as the omnibuses, re eive; and therefore it seems as if metropolitan passengers can only be got at about the rate that is charged. Every attempt has been made by these railways and omnibuses to increase their fares, but they have had to reduce them. Mr. Blackwood says that we should look at the competition of the omnibuses with the District Railway. It is true that there is that competition, but we have competition also, and what is the result? The District Company are unable to pay a dividend on their Ordinary stock after 25 years' working, whereas, we, after the first year paid a dividend and have gone on doing so, and I trust that we shall continue to increase our dividend. I really think that you cannot say that the comparison is against us. I quite admit all that Mr. Blackwood has said about the original prospectus, but excepting the 12 per cent., I do not think there is anything in the prospectus which has not been verified. It is true that we have not been able to get the traffic to the extent then expected, because that calculation was made on the supposition that the mid-day traffic would be the same as the morning and evening traffic, and that has not been the case. Until we can get the line extended we must have our trains half empty during part of the day. I do not think any Board of Directors could have been more anxious or have given more earnest attention to this concern than we have done; and we shall continue to do our best for you, and to get as large a dividend as we can.

The resolution was then carried.

The CHAIRMAN subsequently proposed, and Mr. S. BARCLAY HEWARD seconded the payment of the Preference dividend, which was agreed to, as was also the dividend on the Ordinary stock, on the motion of the Chairman, seconded by Mr. Tate.

The retiring Directors, Mr. Sampson Hanbury and Mr. Heward, were afterwards re-elected to their seats at the Board, and Mr. James L. Oliver, the retiring auditor, was re-appointed.

On the motion of Mr. DRAKE, seconded by Mr. BLACKWOOD, a cordial vote of thanks was passed to the Chairman and Directors.

The CHAIRMAN acknowledged the compliment, remarking that the Directors might have made mistakes, but their earnest desire had been to carry on the undertaking honestly and remuneratively. Such votes of thanks went far to encourage the Directors to increase their exertions, if possible.

The proceedings then terminated.

Eastern Telegraph Company (Limited).

The forty-third half-yearly ordinary general meeting of the Eastern Telegraph Company (Limited) was held on Thursday, January 25, 1894, at Winchester House, 50, Old Broad-street, London, "to receive the Directors' report and accounts, elect Directors and Auditors, and transact the ordinary business of the Company." The chair was taken by Sir John Pender, G.C.M.G., M.P., Chairman of the Company.

The SECRETARY (Mr. George Draper) read the notice convening the meeting; and the minutes of the last general meeting, held on Thursday, July 13, 1893, having been read and confirmed,

The CHAIRMAN said: Gentlemen, the report having been taken as read, before I ask you to adopt it, I shall, as usual, go over the working of the last six months, and give you such information as we ourselves possess, and which we think it desirable to be communicated to the body of the shareholders.

The gross revenue for the half-year under review amounts to £369,967, as against £352,391, or an increase of £17,576. Analysing the receipts from various sources we find an increase of £28,123 in the message receipts. There is an increase in the traffic with most of the different places, the principal being in the traffic with the Cape, India, and beyond. The total ordinary expenses for the half-year to September 30, 1893, amounted to £98,106, as against £98.797, or a decrease of £691. The details are as follows: general expenses in London £9,255, as against £9.120, or an increase of £135. The working expenses at stations were £75,707, as against £74.486, or an increase of £1,221. Several of the items under this head show substantial decreases, more particularly in travelling expenses, £509, expenses of land lines, and maintenance and renewals of electrical apparatus, &c., £298, repairs and renewals of furniture and fittings, £640. The principal increase is in the salaries and wages of our staff at stations, £2,439, there being an increase of thirty-two clerks compared with the corresponding period of last year. This, together with the operation of the scheme to provide regular promotion to deserving *employés*, which had been fully explained at previous meetings, accounts for the increase under this head. Comparing the other items in the revenue account, we find a reduction of £989 for special repairs to buildings at Alexandria, &c. The repairs being completed, this account is now closed.

I think I explained to you at a previous meeting that we have at Alexandria an important station, but the climate admits of a good deal of rapid destruction sometimes in the wood-work, so that we have had to make a regular overhaul, and introduce iron in many cases in the buildings; but we have now made them thoroughly complete and efficient, and I hope that we shall not be troubled again for a very long time. There is also a decrease of nearly £1,000 in the amount carried to maintenance ships' reserve fund. We carried as much to this account as in the previous half-year, but the difference has been subscribed by other companies hiring our ships from time to time.

The expense attending repairs and renewals of cables amounted to £31,906, as against £37,636, or a decrease of £5,730. It will be seen from Abstract C, page 6, that we have received during the half-year over £20,000 for the hire of our ships from cable companies associated with us to a considerable degree. We have also been fortunate in not having to expend so much cable in effecting repairs, so that although we have had five ships more or less busily employed during the half-year, the cost of maintaining communication has been less than for some years past.

After providing the usual amount for interest on debentures and debenture stock we are able to pay the usual interim dividend for the half-year at the rate of 5 per cent. per annum, and to carry forward the substantial sum of £86,252. I may inform you that this is, I believe, the largest amount we have ever carried forward. I think that is encouraging, and from what I have told you, I believe, you will feel satisfied that economies have been effected by us, and that the whole concern has been very closely and carefully watched. We have applied a further sum of £35.505 from the reserve fund in reduction of the cost of the Aden-Bombay No. 3 cable and other expenditure, so that our capital expenditure on account of cables, land lines, &c., practically remains at the same figure as it did eight years ago. The total sum applied from the reserve fund from time to time now amounts to £1,292,000. This is a very large sum, gentlemen, and it would otherwise have been in the reserve fund, but it is practically working for the benefit of the Company. We have duplicated and triplicated our cables, we have not increased our capital, and as you will very well understand, we have, owing to these duplications, &c., and the large reserve fund which we still possess, placed the Company probably in as strong a position as it is possible for us to enjoy.

I have now put before you a statement which I think must satisfy you all. It is a very encouraging one, but it is one which has not been arrived at without great attention and care on the part of your staff and on the part of those who manage the staff. While the Directors do their work in this way—doing it well, I hope - we have at the same time been very modest in our demands for any increase of remuneration. On the death of our late Managing Director, a colleague of whom I spoke very warmly on the last occasion, we reconstructed to some extent the work of the management of the Company, and by the arrangements then made, we have, I think, given great efficiency and strengthened our position in every way. Nevertheless, what we have done only entails on the Company something like £300 extra. This is a very small sum, as you see, particularly as, I think, the efficiency of the Company has been maintained and strengthened by what we have done. I may also state that if we had claimed what we were entitled to when we became Directors of this Company we might have asked you to approve of a very much larger sum being paid to us. For many years we have been discharging our duties for an amount at least £1,000 less per annum than the Directors are entitled to by the Articles of Association, but the time may come when those who are guiding this great undertaking and who are devoting the greater part of their time and their life to the work may ask you to approve of their receiving a larger amount of remuneration. At the same time I shall, I hope, be in a position to justify any request of this nature, because we shall never ask you for anything further unless we improved the position of the shareholders at the same time.

You will find on reference to paragraph 5 of the report that the cable connecting Lisbon and this Company's general system with the Islands of the Azores was laid and opened for traffic in August last. This Company has taken a large interest in that cable, but, as I told you before, the *quid pro quo* we have received is an extension of the exclusive rights which we have possessed for many years at Lisbon, that extension being for a period of ten years. I need not tell you that this is worth a very large sum to us, and by-and-by, in all probability, we may be able to add to the revenue of our Company through this extension.

The Company which is associated with us, the Eastern and South African Company, has laid the cable from Zanzibar to Seychelles and Mauritius. That matter was for a long time under negotiation, but the work has now been carried out, and the cable has been opened for traffic. The Eastern and

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South African Company receive for that a subsidy of £28,000 a year, but we are practically the holders of all the stock in that Company, and this cable, therefore, benefits us to some extent. I can scarcely tell you much of the result of its working yet, but so far as it has gone it has not disappointed us, and I think by the next time I meet you I shall be able to give you a good account of the working of that system.

We have also effected, I think, an important saving in a change we are making now in the Levant. As you are aware, the Island of Zante has been of late years subjected to very violent volcanic eruptions, and it has been very fortunate that our station has so far been saved, but if another eruption occurs, our cables might be interrupted, and that would be a serious inconvenience to us. We have, therefore, decided to remove the work which has hitherto been done at Zante to the island of Syra, where we have an important station. We calculate upon effecting a saving there of £1,700 to £2,000 a-year, and I think with greater stability and security for the Company's general system. That work is just being carried out, and I hope that by the time I address you again, if I am spared to do so, I shall be able to congratulate you on this having been a successful change.

I have now gone through the details generally, but before I sit down I may just mention again that the work which at the last two or three meetings I have told you was in hand has all been successfully carried out. It has all added to our general system—our great system, I now call it; and it has, I think, strengthened it. I believe that it will also help us to maintain the very good and sound and very proud position we occupy at the present time. Telegraphy must go on; it is impossible to stop it. I think that the business world would almost come to an end if the submarine telegraph companies, which unite the whole of the world together so closely, were to be stopped, or if their work were in any way interrupted. It will be our business to prevent interruptions. It will be our business to strengthen the system as much as we can and to connect it wherever the British flag flies. Wherever British commerce can show us that it will be a benefit to us to be connected with it, we shall make a great effort to attain this purpose. We have succeeded so far in connecting almost every part of the civilised world with our system. Some one said to me the other day that we shall be going to the moon next. (Laughter). I do not know that we shall do that, but if any part of the globe requires telegraphic communication, and can afford to pay for it, you may depend upon it that we shall see if it can be given. One is very apt to become a little egotistical in addressing a body of intelligent shareholders as to the work that has been done, but if you will allow me, I should like to say a few words on this subject. I have before remarked that our existence has been a comparatively short one. We have not yet been 25 years in existence, but we have done an enormous amount of work, the value of which is best tested by the opinion the investing public hold concerning it. I think I told you before that the debentures which have been issued by this Company stand remarkably well in the market, and to-day they are worth about £116 for the £100 debenture bearing 4 per cent. interest. I cannot give you any better idea of the opinion which the investing public hold of the position of the Eastern Telegraph Company. (Applause.)

I have given you, so far, a very rosy description of our position, but like other people we have a skeleton in our cupboard. We have the difficulties of exchange. The silver question has engaged the attention of some of the best heads and strongest brains that we know of, but as far as I can see they have rather made a mess of it as yet. They have given us no solution of the question, at any rate. This is a matter which very materially affects the remittances we receive from abroad. I am not going to tell you what we lose by it, because I have shown you that we have secured a very good result independently of these losses, but nevertheless our losses by exchange at the present time are very serious indeed. We try to meet them and remedy them by getting the countries where we lose by the exchange to allow us to increase our rates, but we can never do this to such an extent as to cover the loss which we sustain. We have to bear in mind many questions in connection with this subject. We have to see that people who employ the telegraph to such an extent as they do are fairly dealt with, and that while giving a thoroughly efficient service we do not exact too much from those who use it. We have these difficulties, however, and we do meet them to a certain extent. At all events, as long as I can come before you and present you with such a satisfactory account as I have done to-day, I think you will generally agree with us on this side of the table that we are doing fairly well, and nothing will please us more than to find that our shareholders are satisfied with their position—the shareholders who have stood by us and taken a part with us in building up the submarine system of telegraphy. I think that they must all feel satisfied that their investment has been not only a good one—useful to the commerce of the world—but for themselves a very satisfactory one also. With these remarks, gentlemen, I now beg to move the following resolution:

"That the report and accounts of the Directors to September 30, 1893, submitted to this meeting, be and are hereby received and adopted."

The VICE-CHAIRMAN (the Marquis of Tweeddale): I beg to second that.

The CHAIRMAN: If any gentleman has any question to put to me, I shall be very glad to hear him before I submit the resolution to the meeting.

Mr. BAINES: Before the resolution is put I should like to make a few remarks. We have met here very frequently, and we see that a very large sum is carried to the reserve fund. A good deal of this money has been used to duplicate and triplicate the cables. This has added to the value of our property, and has enabled you to present to the shareholders very excellent reports, but I notice at the same time that the dividend paid to the shareholders never improves very much. It has occurred to me that it may be well worth their while if the Chairman and his co-Directors will consider the desirability of giving the shareholders something to represent the large sum which has been diverted from their pockets in the way of dividend and apply this *pro rata* to their holding. You might make an issue to us in the shape of shares, and we should then be able to go and get the benefit if we chose to sell. This property has increased in value, but there is nothing to represent it. We never get very far beyond 6½ per cent., and in the early days of the establishment of the Company, the prospect of very different results was held out to the shareholders. These results have not been realised owing to various causes which the Directors could not very well have foreseen, but I think that the time has come when the Chairman and his co-Directors might in this way consider the interests of the shareholders. I was very glad to gather from what the Chairman said that their interests were being considered. The increased remuneration referred to by the Chairman is very small indeed, but I hope he will not forget the shareholders. There is one question which I should like to ask before I sit down, and that is whether, in the event of war, our cables are in any way neutralised.

Mr. JOHN NEWTON: Before you answer the question I should like to say a few words. Twenty years ago if you had proposed even such a modest increase to the Directors' remuneration as you have mentioned, I should have got up and probably opposed it very strongly. I daresay you think that that is quite my character. (Laughter.) I think it is only right, however, having had since then 20 years' experience of what the Directors have accomplished, that I should say that I heartily agree with the proposal, and I think, if anything, that its modesty is its fault, especially when we look around us, and see, for instance, what certain other Directors, who are connected with this building, have done for their shareholders, and then when we look at the reserve fund of this Company and see the character of the investments which have been made by our Directors. With respect to the suggestion which has been made as to issuing anything to represent the reserve fund, I think it is very well represented, and in the very best manner you can possibly have it. You have a reserve fund of a substantial sum, but it is represented in the market by something like £2,000,000, and I think the property of the shareholders is substantially represented by that sum. That is an addition to our property, and it results from the satisfactory dividends which have been paid to us. I think it is due to the Directors that I should make these remarks, knowing what has happened in the past, and that they have done so well for the shareholders as they have. I certainly think that the increased remuneration that has been mentioned will not be objected to by any of the shareholders. In the early days that I have alluded to our shares stood at something like 7½ or 8½, and I may say that I am interested in them at those prices.

The CHAIRMAN: If no other gentleman has anything to say I will now reply to the remarks that have been made. In the first place, I may say to Mr. Baines that our legal adviser tells me that his proposition is illegal, and we may, therefore, drop it on that account. It could not be carried out. In the next place, let me say this: While big dividends are very desirable on the part of the shareholders, who all want large returns, we are working a system respecting which we have yet much to learn. It is not like a railway. You can see a railway; you know how it is working, and how the depreciation is going on, but we cannot say so much yet with respect to submarine cables. It is, therefore, wise in your interests, and prudent on our part, so to increase our reserve fund that we shall not be placed in the position, if we require to renew a cable, of not having the means to do it with. It is with companies as with individuals—the bigger your account is at your bank, the richer a man is; in a time of trouble the more he is valued. We are valued because we do our work extremely well, and because we have paid a very fair and steady dividend all through. We do not want to make other people envious, and so excite competition. We have created a very powerful Company, and we have added to the value of your shares. Since the time that Mr. Newton refers to we have doubled their value, in fact, and you cannot have double the value of your shares and at the same time increased dividends. We are now paying you a steady 5 per cent. dividend, and at the end of the year we give you a bonus, which at that time we determine on. This is not the time when we deal with that question, but at the end of the year we shall, as usual, deal with it. We have heretofore given you a bonus of 1½ per cent., and I think that we can continue that, and I shall be delighted if we find that at the end of the year we can with prudence increase the bonus, and I do not mean to say that we shall not do so. We have, as I have told you, duplicated and triplicated our cables. We have thus added to the value of your property to a very large extent, and to an extent which we could not have done if we had divided the whole of our income in dividend.

Mr. BAINES: I suppose that I am not entitled to reply?

The CHAIRMAN: I think not. I think that you had better come here six months hence, when we shall be very pleased to hear you again, but I now wish to answer the question which you have put to me, as to how our cables stand in time of war. I will tell you a little story, affording the best illustration which I can give you of the position you occupy. Many years ago I mentioned to a gentleman holding a confidential and very high position at the Foreign Office, "We are laying these cables, which are costing us a great deal of money. Would you agree to sign a document getting the nations of Europe—the nations of the world, I may say—to neutralise our cables in time of war?" His reply was, "I will sign it to-morrow, but the general in command on the spot, or the naval commander, would break it if a war were to occur." There it is, and the whole thing depends upon the action of the cables at the time. I only hope that they will not be destroyed either by the military or naval commander. Still, they have the power to enter our offices and shut them up, but I trust that they won't destroy the cables. War does not continue now so long. I think that the cables will be used to a very great extent either in war time or peace, but they are made for peace. When, however, they are used for the purposes of war, they will be employed by the power which has the greatest opportunity of dealing with them. I think I have now answered all the questions, and I will

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therefore ask you to vote. Those in favour of the resolution will please hold up their hands. To the contrary. Carried unanimously.

The VICE-CHAIRMAN (Lord Tweeddale): Gentlemen, the next motion is as follows:—

"*That Sir John Pender, G.C.M.G., M.P., who now retires, be and is hereby re-elected a Director of the Company.*"

Sir John Pender, as you are all aware, has devoted his great abilities, and the whole of his time to the direction of this Company and other allied telegraph companies, and with what success you are the best judges. Probably there are no more successful companies in existence than these telegraph companies, and that success is due in a very great measure to your Chairman. I therefore move this resolution with the utmost pleasure, and I believe that it will receive the unanimous approval of all who are present.

Mr. GEORGE GARDEN NICOL: I have the greatest pleasure in seconding the motion, and in endorsing all that has been said by Lord Tweeddale.

The VICE-CHAIRMAN put the motion in the usual way, and it was carried unanimously.

The CHAIRMAN: I thank you, gentlemen, for this renewed mark of your confidence in your Chairman. Every man has his hobby. I have made submarine telegraphy to a great extent my hobby. I do not hunt, I do not shoot, I do a little bit of yachting; but the greatest pleasure of my life is to attend to the interests and the duties devolving on me as your Chairman. I thank you again for your renewed confidence in me. I have now to move—

"*That Charles W. Stronge, Esq., C.B., who now retires, be and is hereby re-elected a Director of the Company.*"

As you are aware, Mr. Stronge has had to do with us, more or less, during the whole period of our existence. Mr. Stronge, as you know, was a high official at the Treasury. We had to make hard bargains with him sometimes, but he was so just, so generous, and took such an interest in the work, and knew it so well over so many years, that we thought it would only be a proper compliment to him, and at the same time a great benefit to the shareholders, if we asked him to take a seat at our Board. I have very great pleasure in asking you now to re-elect him.

Lord SACKVILLE A. CECIL: I beg to second that.

The CHAIRMAN put the resolution, which was carried unanimously.

Mr. STRONGE: I am much obliged to Sir John Pender for the handsome manner in which he has proposed my re-election, and to you, gentlemen, for the way you have responded. You may depend upon it that my best exertions will always be at the service of the Company.

Mr. JAMES GIBB: I beg to move—

"*That the firms of Messrs. Deloitte, Dever, Griffiths and Co. and Messrs. Welton, Jones and Co. be and are hereby re-elected auditors of the Company at a remuneration of £100 to each firm.*"

Capt. GOODSALL: I have great pleasure in seconding the resolution.

The CHAIRMAN, in putting the resolution to the meeting, said: Previously, as you are aware, we had independent members of one of these firms as auditors, but we thought it better that the firms themselves should become our auditors, because if one partner was ill another could act for him. I think, however, that I mentioned many years ago that our accounts are audited not merely every six months, but that there is a continual audit of our accounts being made by these gentlemen, so that they are really practically responsible to you. We do not dictate in any way to the auditors. They are the servants of the shareholders, not the servants of the Board, but we generally manage somehow or other to pull along in perfect harmony. We want nothing that is not right, and they want nothing that is not just and proper. The motion was then put, and having declared it carried unanimously, the Chairman said: I think that finishes the business of the day. As you are aware, this is an interim meeting, and I am only too happy to find that we have been able to present you with such a good statement.

Mr. BAINES: Perhaps, as I have put a question or two, I may be allowed to propose a vote of thanks to the Chairman and Directors of the Company for the way they have managed our affairs.

Mr. W. GRIFFITH: I am very happy to second the motion. We are indebted, I think, to the gentleman who has just spoken for introducing a very important point respecting the neutralisation of the cables in the time of war. Our very able Chairman I find has, however, considered that question; but I would suggest that there is one advantage to us from the neutralisation of our cables, even though the general in command might break them. In that case we should have a claim for damages if they were neutralised. I am connected with a society for promoting the amendment and the reform of the law of nations, and this matter has been considered both in connection with the Suez Canal and in connection with our cables. We cannot do away with all war, and it would be the duty of the commander in the neighbourhood of the cables to take possession of them; but if the nations of the earth consented to the neutralisation of this valuable property we should have a claim for any damage that was done. That, however, is by the way. The very interesting statement made by our Chairman is most satisfactory, and shows that our prosperity continues and is likely to continue. It seems, as far as human fallibility can prognosticate things, that we shall have a prosperous future, and I think that we are greatly indebted to those who have brought about this position. It is only a proper mark of our gratitude that we should return our thanks to our Chairman and his able colleagues for what they have done for us in the last six months.

The motion was put to the meeting and carried unanimously.

The CHAIRMAN: Gentlemen, nothing pleases me more than to find that the shareholders appreciate the work of the Directors. When I look back to our early times and remember the remarks that were then made, and look at our present and improved position, I am glad to find that those who used to hit us very hard at one time come here to-day and approve generally of what we have done. I do not dislike criticism; I rather like it; but I am glad to see that you approve what we have done for you. We have got a very efficient staff. As you know, we have attended to the interests of the staff as much as we have attended to yours, because if you want work well done you must have good tools to do it with, and I can only say that we have the most perfect harmony throughout our system. The staff are very well pleased with what we have done for them with regard to their future; I refer to the pension fund. Altogether, gentlemen, the more you look into our affairs, the more you inquire into them, the more, I think, you will be satisfied that we have a machine which is working harmoniously in all its parts. As regards the Directors, I may say that we act upon this principle, gentlemen, that we must be just to those who are dealing with us, just to those who are working with us, and just to those who are dependent on us for their dividend. I hope that we shall continue to satisfy all interests, and maintain the successful position which we have enjoyed for so long.

The proceedings then terminated.

Anglo-American Telegraph Company (Limited).

The ordinary general half-yearly meeting of the proprietors of this Company was held at Winchester House, Old Broad-street, E.C., on the 26th inst., the Most Hon. the Marquis of Tweeddale presiding.

The SECRETARY (Mr. T. H. Wells) read the notice calling the meeting and the minutes of the previous meeting. The report of the Directors and statement of accounts were, as usual, taken as read.

The CHAIRMAN: Gentlemen,—The amount available for dividend this year is less by £13,893. This sum is made up of three principal items. The traffic receipts show a falling off of £8,493, and this time last year we had an item of £3,000 for the charter of our steamship "Minia," and at that period we transferred £1,619 from the interest of the renewal fund account to revenue, making altogether £13,112. This year there is a slight increase —not a very considerable one—in the expenses amounting to £622. You will have noticed, I daresay, from the accounts, that under abstracts "B" and "C," namely, expenses at head office and stations, there is a substantial reduction in the expenses. Against these decreases, however, there is an increase in the cost of repairs amounting to £2,194. The net result is, as you are aware, that the dividend is 13s. 6d., as against 17s. 6d. this time last year, and on the year £2. 11s., as against £2. 15s. The reduction of the receipts, it is hardly necessary to tell you, is due considerably to the dull trade which has prevailed for so many years, and which was very great during six months of last year. You can easily understand that it was impossible for us to recommend that any portion of the interest on the renewal fund should be applied to dividend, and the failure of our expedition to repair the two cables which were interrupted, and regarding which I warned you at the last time I met you, caused us to adopt this course. We regret very much the failure of those expeditions, which was mainly—I think that I may say exclusively—due to the bad weather that prevailed at the time. I may just give you an idea of how unfortunate we were in that respect by mentioning to you that the ship "Minia," which was employed in repairing the Brest-St. Pierre cable was 47 days out, being 36 on the spot, and the weather was unfavourable throughout. Thirteen dredges were made, and the cable was hooked 12 times, but owing to the badness of the weather no further progress could be made. In the case of the "Calabria," sent to repair the 1874 cable, she was out 100 days, 78 of which were spent on the ground, and seven only could be said to be calm and smooth. Fifty-one dredges were made, and the cable was hooked no less than 27 times. Now, with regard to the condition of these two cables, I am glad to say that the 1874 cable was found to be in a very good state, and we have no doubt whatever that it will be easily repairable when the time comes for sending out an expedition for that purpose. The Brest-St. Pierre cable, on the other hand, is by no means in the same condition. You all know how much trouble this cable has given us. We have not formed any opinion as to what steps should be taken to put it into proper condition. It will require a great deal of consideration, and we shall have first to obtain the opinions of the best experts in connection with the cable, and then we shall act accordingly. I am glad to be able to say also that both the Western Union Company's cables are in good order, the one which was interrupted the other day having been repaired. Having regard to the age of our cables, and to the possibility of one or more of them failing, as well as to the absolute necessity of providing means for carrying our large traffic as efficiently in the future as it has been done in the past, the Directors, after very careful consideration, have decided to lay a new cable of superior type and carrying capacity. This decision was not come to, as your report tells you, without due thought and consideration. The expenditure is a large one, but we felt that if we were to maintain our position in the Atlantic as carriers of traffic we were bound to see that we should have ample means at command for that purpose. Now, the cost of this cable will be £450,000, which, I think, will be regarded by you as moderate, and as a great deal cheaper than any other cable laid in the Atlantic, having regard to its quality and carrying power of 45 words a minute, which is better than anything yet laid, either in the West or in the East. Then there will be a sum of £5,000 or £6,000 required, partly to duplex this cable and to repair the duplex portions of the other cables which have fallen into disrepair. The expenditure on this cable will naturally reduce considerably our renewal fund, although it must be borne in mind that the renewal fund, as it stands, is for the very purpose of doing what we are going to do, namely, to renew our cables when they fall into a condition to require it. We should have been very glad if we could have delayed a little longer the time when we considered it necessary to lay a new cable; but we came to the conclusion that it would be imprudent, having regard to the age of the cable, to delay this

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any longer. If all the facts in connection with the laying of a cable were as well known as those connected with a railway or any other undertaking of that kind, we should have no difficulty in telling you exactly how much money on account of depreciation should be put to reserve fund, but we have no reliable data to go upon. Therefore I think that you will agree with me that the proper mode of dealing with this is to deal with it at the close of each half-year, as circumstances appear to require. We recognise the necessity of not only maintaining the cables in good order, but of providing the means of renewing them when required, and in pursuance of this view and policy it is incumbent on us that we should lay by every half-year, or every year, a substantial sum to renewal fund. Without saying very definitely what will be done at the end of the half-year—it would be impossible to do so—I do not think that you can expect that we can recommend the laying by of a less sum than, say, £40,000 or £50,000, inclusive of the interest on the renewal fund as it exists. Assuming the interest were £16,000, and it would naturally increase every year, as the fund increased, that would require, on the basis of £40,000, something like £24,000 from the revenue account. Of course, if we thought it necessary to put aside £50,000, that would be about £10,000 more. What I want to point out is this, that we recommend that the renewal fund should be increased by a substantial sum each year, and that the exact amount should depend on the circumstances of each half-year. I think I have said enough on that subject, and you will understand exactly the policy I have indicated. With regard to the French lawsuit, I am able to say now, I think with some confidence, that it will be settled in the course of the next month. Well, we have reason to believe that it really will be settled—at any rate, as far as the particular Court in which it is at present is concerned. The only other subject I have to refer to is the death of Mr. Henry Weaver. That gentleman, as you know, was connected with telegraphy from its very early days. He was Managing Director of this Company for twenty-three years. He was a man of great ability, of great energy, and of great vigour of mind, and he devoted the whole of his time to the interests of the Company. He earned the respect of every person who came in contact with him, not only on this side of the Atlantic but on the other as well. We consider that we have sustained a very severe loss through his death. In conclusion, gentlemen, I am afraid that I cannot say that the year has opened very auspiciously. The turning in the proverbial lane does not appear to have been arrived at as yet in commercial circles. There is an improvement in some quarters, and we can only hope that this improvement will go on rapidly, and that when I have the opportunity of meeting you again six months hence we shall be able to give you a better account of our affairs than I have been able to do to-day. I beg to move—

"*That the report of the Directors and accompanying statement of accounts to the 31st December, 1893, submitted to this meeting be, and the same are hereby, received and adopted; and that the following dividends, as recommended by the Board, be now declared and paid, less income-tax—that is to say: (1) A final dividend of 13s. 6d. per cent. upon the Ordinary Consolidated Stock for the year ending 31st December, 1893, making—with £1. 17s. 6d. per cent. interim dividend already declared and paid by the Board by way of dividend on account—a total dividend for the said year of £2. 11s. per cent. on the said stock; (2) a final dividend of £1. 7s. per cent. on the Preferred Ordinary Stock for the year ending 31st December, 1893, making, with £3. 15s. per cent. interim dividend already declared and paid by the Board by way of dividend on account, a total dividend for the said year of £5. 2s. per cent. on the said stock.*"

The DEPUTY CHAIRMAN (Mr. Francis A. Bevan) seconded the motion.

Mr. GARDNER said that he was not quite so sanguine as the noble Chairman as to the largeness of the renewal fund being a criterion of a good price for a company's stock in the market. He was under the impression, moreover, that it was decided some years previously that a new line would not be laid without first consulting the shareholders. He was of opinion that a small reserve fund was better in their case at any rate, because when there was a large amount of money on hand there was a temptation to fall back upon it and lay a new cable where no cable was required. He advocated first the examination of the two existing cables to see if they were not amenable to being repaired.

Mr. BOURNE said that if the Directors had taken the advice which he tendered years ago they would have abandoned the Brest St. Pierre cable altogether. The repairs on that cable alone had already cost more than £450,000. He wished to know why the Company should have branch offices in different parts of the City, incurring an immense expense by way of rent, &c.

Mr. SEELEY said that they had arrived at this position, that, being once a most successful Company—he had been a shareholder from the time when they received 12 per cent. dividend—they had dwindled down and down till they had got below the price of Consols as a dividend-earning concern. They had amalgamated and "pooled" with different companies, but in all their arrangements, by some peculiar process, the Anglo-American Company had always got the worst of the bargain. He suggested, therefore, that they should alter their existing agreements with the various companies, with a view to improve their own position. He thought that they had made particularly bad bargains.

The CHAIRMAN: With whom?

Mr. SEELEY: With all the companies that you have ever amalgamated with.

The CHAIRMAN: I wish Sir John Pender were here, for he could tell you a very different story.

Mr. GOODSALL quite agreed with the Board in the desirability of laying a new cable, and expressed his opinion, as an old hand at submarine-cable work, that there were several cables which might be recovered with very little difficulty. Cables could be recovered at any depth with care.

Mr. GRIFFITH said that Sir John Pender, who was undoubtedly a great authority on telegraphs, said at the meeting of the Direct Company, that there were more cables for carrying messages at the bottom of the sea than were wanted, and that if they put more cables down these would diminish the value of those already existing. The Telegraph Construction and Maintenance Company was not the only manufacturing company of sub-marine cables. There were others in the field, and the terms on which they did business were that the manufacturing company received a certain rent every year for so many years—until such time as the cable was paid off, when it became the sole property of the company for which it was made. He ventured to put forward the suggestion whether some such policy should not be adopted in the case of the Anglo-American Company.

After a few remarks from Mr. FRY, Mr. CLARKE, Mr. GLOVER, Mr. BRADFORD and Mr. JOHN NEWTON,

The CHAIRMAN, in reply, said: I shall endeavour briefly to answer some of the questions. Mr. Gardner seemed to think that we take a pleasure in laying new cables. It is perfectly true that there are already more than sufficient cables to carry the traffic; but let me remind Mr. Gardner that the initial cables were not laid by us, but by other people who were perfectly entitled to lay out their money in laying cables if they chose to do so. The difficulty that we have always had in the Atlantic was that there were others laying cables there. There was first the French Company, then came the Direct, then the two American cables, and the Bennet and other lines. We could not prevent these from being laid; we could not prevent them from taking traffic. That was the difficulty. That makes ours about the most speculative stock that you could imagine. There is nothing to prevent anybody else in America from laying another cable. It is not our fault. With regard to the Brest cable, it is in a very indifferent state, and it will be a difficult question how we are to deal with it. With regard to the branch offices I must remind you that it is impossible to do without them. On the contrary, we find that the establishing of offices in every instance brings more traffic than the office costs. It is very remarkable that with both the Eastern and Atlantic Companies the more centres they have the more the public want them. I want to point out to Mr. Seeley that there have been as many as three cables out of working order at one time, which points very strongly to the necessity of maintaining our system in efficient order and laying a new cable. In reply to Mr. Goodsall I have only to say that you may be quite sure that every endeavour will be made to find the best place in which to lay the cable. We shall lay it in a position which will render it safe for probably a great many years to come. Mr. Griffith made one or two suggestions as to the way in which the renewal fund was being dealt with by the Direct Company. As that gentleman has referred to that, I should like to point out to him that the Direct Company's renewal fund is far from sufficient to renew their cable when it comes to be renewed. He suggested that something should be done, as was the case with the Cuba lines. These, however, are short lengths, and laid in shallows seas, and I can understand that a Company might be got to undertake to keep them in order; but I should like to see any company which would undertake to keep the Atlantic cables in order on the same terms. Mr. Griffith suggested that it was in the interest of the Construction Company to get more cables laid, but I do not think that you need be in the least afraid that we shall be guided by them in the future. In reply to Mr. Fry, who spoke from the point of view of a Deferred shareholder, I have to say that what is good for the holder of the Ordinary stock must be good for the other two. As to the amount of the renewal fund, I endeavoured to make that as clear as possible. We believe that something like £40,000 or £50,000 will be required every year. When this perfectly new cable is constructed in the very best possible manner and laid in the safest part of the Atlantic I think we may confidently regard the amount invested in that as if it were invested in the renewal fund. It is fair to consider it for three or four, or even five, years as a substantial part of our renewal fund, so that we shall be able to build up an amount gradually and sufficient for that. Mr. Clarke thought that we should have taken the shareholders into our confidence. Well, some of them are. Among others I represent a million and a-half of stock in the Anglo-American Company, and I am alive to my responsibility in connection with that sum. Mr. Glover seemed to think that we did not take sufficient pains to get as cheap a cable as possible. I believe that it is recognised by those who are acquainted with the price of cables that this cable is a very cheap one. Our engineers tell us that its price is very substantially less than the estimate formed by them (and they are very competent men)—in fact, something like £30,000 less.

Mr. GLOVER: Why was it not put up for tender?

The CHAIRMAN: We have been connected with the Telegraph Construction and Maintenance Company since the formation of our Company, and we have found that they have done our work admirably. It is a responsible Company with a large capital, and we feel safe in their hands. But if you suppose that we give to that Company always what they ask you make an entire mistake. We take ample means of ascertaining what should be the reasonable price for a cable, and that is what we did in this case.

The resolution was then put, and carried unanimously.

The CHAIRMAN moved, and Mr. BEVAN seconded, the re-election of Sir Albert J. Leppoc Cappel to his seat at the Board.

The motion was agreed to *nem. con.*

The CHAIRMAN next moved the re-election of Mr. Samuel Barber, the other retiring Director.

Mr. BURT seconded the motion, which was also carried unanimously.

On the motion of Mr. JOHN NEWTON, seconded by a SHAREHOLDER, the auditors, Messrs. Joshua Dean and John Caine, F.C.A., were reappointed.

Mr. GARDNER proposed, and Mr. BOURNE seconded, a vote of thanks to the Chairman and Directors, which having been cordially passed,

The CHAIRMAN expressed his acknowledgment, and the proceedings ended.

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St. James' and Pall Mall Electric Light Company (Limited).

The ordinary meeting of this Company was held at the Offices, Carnaby-street, Golden-square, W., on Tuesday last, Mr. Eustace J. A. Balfour presiding.

The GENERAL MANAGER and SECRETARY (Mr. Frederic J. Walker) read the notice calling the meeting, and the report of the Directors and statement of accounts were taken as read.

The CHAIRMAN proposed—

"*That the report and accounts of the year ending December 31, 1893, as submitted by the Directors be received and adopted, and that the dividends recommended therein be declared and paid on February 7th.*"

He said: Gentlemen, in moving the adoption of the report and accounts I am anxious to give the shareholders full information on the various points raised, as well as some facts which bear on the prospects of the company for the coming year. It is a matter of great regret that it is impossible to pay a dividend of more than 4½ per cent. on the Ordinary shares. The following are, however, the chief causes which have led to this state of things. The year has been peculiarly free from fogs. The ordinary citizen, when he wakes up in the morning and sees the atmosphere in the street of the colour of thick pea soup, certainly does not regard life from a more cheerful point of view. But the Electric Light Director, who has the interests of his shareholders at heart, pays no attention to his personal discomfit, as he realises that the day's earnings of his company will increase about 50 per cent. The peculiarly aggravating part of this year has been that some of the few fogs we have had have come on Sundays, when they are equally unpleasant, and do us but little good. Another cause is the increase in our parish rating by about £570. The amount we shall now have to pay to the parish is equal to about 8½ per cent. of the sum available for distribution in dividends. The chief cause has, however, been the lowering of our charges, forced upon us by the competition of the London Electric Supply Corporation. In this connection I cannot help referring the shareholders to the speech made by the Chairman of that Company in May last, in which he referred to the position occupied by the London Supply Companies in regard to their tariffs, and the reduction in the price per unit of supply. I was so astonished at his remarks that I inquired if the report was correct. The correctness of the report has not been denied, and the statement has not been withdrawn. In justification of ourselves, therefore, I am bound to say that, so far as this Company is concerned, Mr. Forbes was misinformed. It was only with great reluctance, and because our customers threatened to leave us and go to the London Company, whose charges had already been reduced, that we consented to lower our rates. We dislike this policy, but we have no choice. Perhaps a time will come when the London Company will look at the matter as we do. If this happy result were to occur, and if we can diminish in the coming year our law charges, as we hope to do, we ought to be able largely to increase the sum available for distribution among the shareholders. Another cause is the increased economy shown by consumers, especially those on a large scale. There are many satisfactory features in our year's working, which show that the business of the Company is on a sound basis. The number of lamps wired has increased by 25 per cent. At the same time the cost of production has sensibly diminished, and the Directors will use every endeavour to maintain and possibly to increase this economy of working and management. The Directors regret that, contrary to anticipation, they have been obliged to exceed the estimated capital expenditure by about £11,000. This is due to the absolute necessity they were under, of purchasing additional properties in contact with this station, and further to the necessity of increasing the output of this station by putting down additional boilers and machinery. This is of course in itself a satisfactory feature. The remainder is accounted for by the charges in connection with the Hopkinson patent. The working of the system has been very satisfactory, and the Directors have every reason to believe that their customers as a whole are thoroughly satisfied with the light furnished to them. Finally, I wish again this year to take the opportunity of thanking our staff for the energy and ability with which they have assisted us in carrying on the business of the Company. Mr. Dobson, our chief engineer was unfortunately taken seriously ill in July last, and although happily much better, is still abroad. His place has however been ably taken by Mr. Andrews and Mr. Leach, in which they have been assisted by the special engineering knowledge of the Secretary, who has added this to his ordinary labours.

Mr. LATIMER CLARK seconded the motion.

Mr. DAVISON thought that they ought not to allow the present opportunity to pass without expressing their disapproval of the cost of management of this Company. The return of 4½ per cent. for the whole year on the Ordinary shares, less income-tax, was a very poor dividend for the money invested. The cause of the present state of affairs appeared to arise from keen competition and very heavy expenditure. He considered that it was the duty of the Directors to lessen that expenditure. He thought that the shareholders would agree with him, that strict economy should be exercised to produce the favourable result which was expected on the formation of the Company.

Mr. WILLIAMS said that he had three questions to ask, namely, why it was that the Company acted in conjunction with the low tension supply companies in resisting Dr. Hopkinson's claim when the unsuccessful result showed that they were not justified in doing so, and by whom were they principally advised to litigate this claim? What was the proportion of the sum of £4,446 attributable to law expenses, and did the proportion include the costs of the company's solicitor in that unsuccessful litigation? If it did not, had the Company's solicitors' costs been delivered, and what was the amount? The Judges having expressed the opinion that the claim of the holders of Founders' shares was clear, notwithstanding that it would have been desirable to have provided for following another policy, was that claim protested, and heavy law costs incurred?

Mr. F. BOURN said that he understood at a former meeting that the question of the Founders' shares was to be referred to arbitration. He thought the cost of the action for the infringement of the patent should have been spread over several years.

Mr. SAMS said that he saw they were about to increase their premises. Was it because they had such an immense business that it could not be managed at Mason's-yard and Carnaby-street?

Mr. A. TOOTH said that under the circumstances of the litigation he wished to know whether since the drop in the price of the shares the Directors had unloaded their holding.

Mr. LIBERTY, referring to the cost of the legal action, asked on what grounds it was carried to capital instead of being shown, as he submitted it was, as a real loss during the current year. If it was not a loss in the current year, why should not some such hypothetical sum have been added to capital account in former years on similar grounds? He noticed that the reserve capital fund had been invested in other securities bearing a larger rate of interest. Did that circumstance carry with it any larger risk? He was very pleased to bear testimony to the very efficient manner in which the work of the Company was performed. The question of the Directors' remuneration ought to receive their careful consideration. Why was it suggested to add another member to the Board?

Col. FRANCIS could not congratulate the Directors on the straightforwardness of their statement on the actual position of the Company. There had been litigation on three important points. He firmly believed that Dr. Hopkinson had no antagonistic feeling to the Company, and that that gentleman, if he had been met in a straightforward manner, would have let the Company use his patent for a small remuneration. If they looked to last year's account they would find that £659 was put to expense account for the costs in connection with the action, so that the whole outlay on that unfortunate business had been £5,105. Coming to the Founders' shares, these, he said, were selling in 1891 in the open market for £350 each, the last one being sold to his knowledge by a Director of the Company for £365, and it was important that the shareholders should know that the litigation connected with these shares had been forced upon them by the action of the Board. The case had been several times dismissed without a reply, showing that there never really was one for them to go to law about. He was deeply sorry to tell them that if there was anything more calculated to injure the Company and ruin its prospects than another, it was the settlement enforced on the directors by the Windham Club. It had formerly been distinctly stated that the lighting capacity of this and the other station was framed for 100,000 lamps; their present supply was 58,000 lamps, and yet they were asked to enlarge their premises to carry on their work.

Mr. SCRASE said it would be interesting to know what had been paid for Dr. Hopkinson's patent rights, and what had gone in legal expenses. They had, he thought, acted *ultra vires* in transferring what should have been put to redemption fund into revenue account. Again, in 1892, when the machinery was smaller than it was now, they put depreciation at £3,500 odd, whereas now, when the machinery was larger, £1,292 was thought sufficient for the item. Reasonable business men naturally concluded that either the former sum was too much or the latter was too small. On what terms also was it proposed to issue Debenture stock?

The CHAIRMAN, in reply, said that the cost of management had decreased during the year under review. He did not think that there was another Company in London conducted at so small a proportion of outlay to receipts. The Directors' fees had slightly decreased per unit of light supplied since last year. He was certain that they were not extravagant. In reply to Mr. Williams as to the action brought by Dr. Hopkinson against the Company, he would merely repeat what the Directors stated in the report:—"They are happy to report that a compromise was effected on very favourable terms, under which the plaintiff waived his costs and granted a licence to the Company for the remaining term of the patent and any extension thereof. The cost of the licence and the proportion of law expenses attributable to this Company, amounting together to £4,446. 8s. 9d. is considerably less than the additional sum that would have been expended on the mains had the Hopkinson system not been adopted." It was also less than they should have had to pay for a licence, so that they were actually the gainers by having gone to law on the point. The owner of the patent was not Dr. Hopkinson, but the Westinghouse Company. The solicitor employed in the action was the solicitor of the joint companies, and not their own one. The cost of the action was practically equal to the purchase of the patent, and it was clearly capital expenditure. One of the directors only had unloaded 30 shares during the year, which was the only change. The investments were changed to get a larger interest. They proposed to add another member to the Board, but this would not involve a greater expense to the shareholders—the Directors individually would receive less. The Directors had not yet determined how to raise further capital, but the present proposal was to issue 4 per cent. Debenture Stock to the shareholders. It was not to the interests of the Company that he should enter into the settlement of the dispute with the Windham Club. No Director had sold Founders' Shares.

The report and accounts were then adopted.

The retiring Directors, Mr. Eustace Balfour and Mr. Latimer Clark, F.R.S., were, on the motion of Sir JOHN H. MORRIS, seconded by SHAREHOLDERS, re-elected to their seats at the Board.

The CHAIRMAN next proposed the election of Mr. Bennett Fitch, M.I.C.E., as a Director of the Company.

Mr. FRY seconded the motion, which was carried *nem. con.*

The auditors, Messrs. Deloitte, Dever, Griffiths and Co., having been reappointed, a vote of thanks was passed to the Chairman and Directors, and the proceedings ended.

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Crompton and Company (Limited).

An extraordinary general meeting of the above Company was held at the City Terminus Hotel, Cannon-street, E.C., on Tuesday last, for the purpose of considering, and, if approved, of passing the following resolution:—

"*That the Directors be, and they are hereby, authorised to borrow any sum or sums of money on such security and upon such terms as to interest or otherwise as they may deem fit, provided that the amount borrowed shall not exceed in the whole, without the further sanction of a general meeting of the Company, the sum of £100,000.*"

Viscount EMLYN presided, and said that he did not think he would have to detain the shareholders for any great length of time on that occasion, as the facts which he had to put before them were of a very simple nature, although there were matters of very great importance. The notice calling the meeting gave the proprietors information as to what the Board proposed to do, and it would be his duty on that occasion to direct their attention to three points. First of all, the views which the Board held that justified the proposed issue of debenture stock; secondly, the exact position of the shareholders in event of the issue being carried out; and thirdly, the inducements which the Board offered the shareholders to take up the issue. With regard to the first point—the merits of the proposed issue—the shareholders would remember that in the last balance-sheet laid before them there was a sum of £18,000 which the Company had borrowed from its bankers. Since that time, with a view of extending the business of the Company, and of enabling it to take up large contracts, the Directors had found themselves obliged to go to the bankers of the Company for more money, and he must say that looking to the fact that their bankers had the fullest possible information with regard to the Company, its transactions, and the accounts, it was most satisfactory to find that they were willing to make whatever advances the Board found necessary. The business of the Company was such that they were obliged to have a great deal of money locked up, as it were, when they were carrying out heavy contracts, and they had then to rely upon the consideration of their banking friends. At one time they might have a large sum paid to them, and then they were able to alter very materially the position of their account, so that the sum borrowed from the bankers was really a very fluctuating amount. It had been, however, higher than it was in the balance-sheet submitted in March, 1893. The Directors did not consider that that was a satisfactory state for the Company to be in, and they therefore asked the shareholders to sanction the additional capital in order to place it in a stronger position and enable it to deal with the business which he was sure would come, and was at the present time coming, in a very satisfactory manner. There were a good many companies with which they were doing business, and they had, therefore, a considerable amount of capital locked up. The Hove Company was one of these, and he believed that it had a great future before it. The work which they had done for that company represented a considerable sum of money. Then there was the Chelmsford Electric Lighting Company, which was another in connection with the same question. He thought that what he said at the last meeting had been amply justified. He said at that time that the prospects were that within a very short time the electric lighting of Chelmsford would be placed on a satisfactory and commercial footing, and he was now able to say that a provisional order had been obtained which would place the Company upon a business footing different to what it was in the past and in such a position that they would, he hoped, be able to liberate a considerable portion of their capital. There was another matter to which he alluded with regard to Australia, where he stated that he considered there were very good prospects, and he also said that within the last few months ended July last, the company had received more orders than they had obtained during the previous twelve months. He was glad to say that that state of things had continued, and that the Australian company was in a very satisfactory position. Within the last week that Company had taken a contract for £10,000. Their company had a large contract with the Great Eastern Railway, the Crystal Palace, a large contract at Antwerp and many others. The share holders knew that such large contracts could not be carried on without cash, and it was ready money that they required to enable them to take advantage of lower rates and discounts, and so enable them to carry on their contracts in a cheaper and better way. He need scarcely tell them what an immense advantage it was for a company doing contract work to be able to promise to pay cash, and so obtain a good discount and other facilities. As regarded the position of the shareholders, he would like to explain at once what that would be. What the Board proposed to do was to issue £100,000 Debentures, with which they would redeem the £50,000 Five per Cent. Debentures now issued, pay off the whole of the loan from the bankers, and free the Company altogether from those debts; in addition to which they would be able to deal with the trade creditors. As far as the trade creditors went, compared with the trade debtors, he thought the account was extremely satisfactory. They had only put down those they believed to be good debts, and they practically represented twice as much as the creditors. He thought that that was an answer to any shareholders who thought that the Board were putting a great deal before them. As regarded the interest, the Directors had worked it out as carefully as they were able, and they believed that the issue on the whole £100,000 would not cause an increase of more than between £500 and £600, and they felt sure that with the saving on the purchases for cash they would be able to make in the market they would cover that sum. With regard to that subject they were not speaking entirely prophetically, as they had some experience in the matter when the first issue of debentures was made. The next point he had to refer to was what inducements could be offered to the shareholders to take up the debentures. They had had up to the present time very fairly satisfactory returns, and they had no doubt that the whole amount would be raised on moderate terms. The inducement to subscribe was to bring the business into a firm, efficient, and satisfactory condition, and to enable them to accept large contracts and to carry out the works with more economy, to develop the business, and to ensure a better dividend than would be obtained otherwise. He thought that the loans which the bank had granted, acquainted as it was with the whole of the transactions of the Company, was a very good sign of the position of the undertaking. There was nothing which the Board wished to keep back from the shareholders with regard to the object of the meeting, as they were most anxious that they should have their full confidence and support. In conclusion the Chairman moved the resolution as above.

Mr. R. E. B. CROMPTON seconded the motion.

The CHAIRMAN, in reply to questions, said that the basis on which the valuation of the assets had been made was the value shown in the books and balance-sheets of the Company. The shares in other Companies stood at a value of £12,004 in the last balance-sheet, and at £12,375 in September. With regard to the interim dividend, he could not state what the Board would do if they got the whole of the £100,000 subscribed, but he might say, although he would not pledge himself on that matter, that they had every hope that they would be able to declare an interim dividend of 2s. 6d. per share within a reasonable time.

Mr. KITCHIN said that he and some of the other shareholders were of the opinion that the Company was in the habit of undertaking contracts and receiving its remuneration partly in shares and partly in cash. He considered that that was a very unsound policy, and if the £100,000 was to be issued for the purpose of continuing that policy he should have to oppose it. He did not consider it a business-like way of carrying on the operations of the Company.

The CHAIRMAM, in reply, said that he was of the same opinion as Mr. Kitchen, that the more business-like you could make a contract the better. He understood that when the contract for the Pretoria Company was taken some three or four years ago a certain number of shares were accepted representing a portion of the profit—not of money expended, but a portion of the profit on the transaction—but since then nothing of the kind had been done. With regard to the Hove contract, the Company had taken £2,000 in shares for the purpose of assisting that Company in its formation. They had a contract for £35,000 in Hove, the whole of which was payable in cash. It was his wish that that should always be done, although he could not pledge himself it always would be.

The resolution was then put to the meeting and carried, and the proceedings closed with a vote of thanks to the Chairman.

Brighton and Rottingdean Seashore Electric Tramway Company (Limited).

The first ordinary general meeting of this company was held at the Town Hall, Brighton, last week.

The CHAIRMAN made a statement with regard to the present position of the Company. The property they posessed was one which the Directors thought would prove to be very valuable. It was the first time that the Crown had consented to allow a long length of the foreshore to be used for a purely commercial undertaking. They had allowed piers to be run out seawards; but that was another matter altogether. They might think that the Directors had been rather tardy in getting to work, but he could assure them that in the face of many preliminary difficulties they had not lost any time. Their Bill was actually given up by their Parliamentary agents; but, by dint of perseverance and tact, they obtained the Act in the face of most serious opposition. They had settled the question of rental to be paid the Corporation for the part of the line within the borough and the station at Kemp Town, and all the necessary plans were virtually passed. The detail plans had also been passed by the Board of Trade. With regard to the practical aspect of the undertaking, the various points had been carefully considered by eminent engineers and experts on their behalf. The rails, which were of steel and of a heavy type, would be embedded in the solid rock with concrete, and this method of filling had been duly approved by the Government authorities. When the rails were covered by water to the maximum extent, a reasonable speed would be maintained; but when the water was low the speed would only be limited by the requirements of the Board of Trade. The cars would be very handsome, commodious, strongly built, and capable of carrying a large number of passengers, in fact, travelling drawing-rooms. They hoped to commence work early next month, and to complete the line in about six months, contracts having been entered into for the plant and material necessary to carrying out the undertaking. The undertaking was not started in the interests of any private adventurers, but by Brighton and Hove residents for the benefit of the town, with a hope of being recouped for their outlay by receiving a handsome dividend. Their nominal capital was £20,000, but after going carefully into the figures the Directors were of opinion that between £14,000 and £15,000 would be sufficient for the purposes of the Company, and this, he was delighted to tell them, had already been subscribed privately. No commissions had been paid for the sale of shares, nor had any expense been incurred beyond what was absolutely necessary. In fact, not a penny had been wasted. The time was rapidly approaching when the whole sea front from Rottingdean to Portslade would be lined with houses, and every method of conveying the population to and fro would be a mutual benefit both to the town and the driving interest. They firmly believed that this line would be a permanent and increasing attraction to Brighton. Its novelty, in that there was nothing like it in existence, would attract both scientists and engineers. Considerable interest would be aroused by it.

Messrs. E. G. Bleackley, J. J. Clark, Magnus Volk, and R. J. Pope were elected as Directors, and, in proposing the election of Mr. Volk as Managing Director, Mr. J. J. CLARK pointed out the great importance of the Company carrying out the construction of the line themselves in order to secure efficiency in the work. The Directors proposed, therefore, that

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Mr. Volk should carry out the work for them, acting as Managing Director, and receiving remuneration for his work at the rate of 5 per cent. on the outlay. He was asked also to mention that, as Mr. Volk had assisted their engineer very considerably in the preparation of the plans and in getting them passed through Parliament, it had been arranged that he should receive 1 per cent. out of the engineer's remuneration. That was a perfectly straightforward, business-like arrangement, and was mentioned that everything might be above board. Mr. Volk would, of course, act as engineer in the electric work required, and receive the usual commission. He therefore moved "That Mr. Magnus Volk be appointed to superintend the construction of the line, and that his remuneration be at the rate of 5 per cent. on the cost of construction in addition to the 1 per cent. he is permitted to receive from the engineer to the Company for assistance rendered to him, and that Mr. Volk be paid the usual 5 per cent. commission on the cost of the electric work." That meant that the whole of their work would be carried out at a cost of 10 per cent. over and above the cost of material and labour.

After a brief discussion, the resolution was adopted.

Mr. J. G. Haslam and Mr. E. J. W. Sang were appointed auditors, and the meeting terminated.

NEW COMPANIES, STATUTORY RETURNS, &c.

T. CHESTERS AND SONS (LIMITED).—This Company has been registered with a capital of £4,000, divided into 200 Preference and 200 Ordinary shares, of £10 each, to carry on the business of bell-hanger, electrical engineer, &c., carried on by Thomas Chesters at Bootle.

EASTON, ANDERSON AND GOOLDEN (LIMITED).—This Company was registered on January 26th, with a capital of £200,000, divided into 10,000 £6 per Cent. Cumulative Preference and 10,000 Ordinary shares of £10 each, to acquire and take over as a going concern the undertaking of Easton and Anderson (Limited), and all or any of the assets and liabilities thereof, with a view to such acquisition to enter into and carry into effect an agreement with the said Company and its liquidators, and to carry on the business of civil, mechanical and general engineers, millwrights, shipbuilders, ordnance manufacturers, manufacturers of and dealers in mechanical, hydraulic, pneumatic or other apparatus, iron and brass, founders, smelters, wire drawers, galvanisers, electro-platers, metal workers smiths, metallurgists, manufacturing chemists, suppliers of electricity, cable and rope manufacturers, &c. The subscribers (with one share each) are Thomas P. Wilson, Frank S. Courtney, J. E. Compton-Bracebridge, Edward W. Anderson, Walter T. Goolden, Llewellyn B. Atkinson, and James R. Easton. The first Directors are T. Perceval Wilson, J. E. Compton-Bracebridge, Edward W. Anderson, Frank S. Courtney, Walter T. Goolden, and Llewellyn B. Atkinson.

MARINE STEAM TURBINE COMPANY (LIMITED).—This Company was registered on January 23rd, with a capital of £25,000, in £50 shares, to acquire certain patents and inventions relating to the construction, propulsion and equipment of vessels, with a view to such acquisition to enter into and carry into effect an agreement to be made with the Hon. Charles A. Parsons, of Newcastle-upon-Tyne, and to carry on the business of engineers, forgemen, shipbuilders and repairers, iron and steel manufacturers, electrical engineers, suppliers of electricity, &c. The subscribers are:—The Earl of Rosse (20 shares), Hon. Charles A. Parsons (20), Nathaniel G. Clayton (40), C. J. Leyland (40), John B. Simpson (20), A. A. C. Swinton (20), and Herbert C. Harvey (20). The first Directors are the Earl of Rosse, Hon. Charles A. Parsons, Nathaniel G. Clayton, Christopher J. Leyland, John B. Simpson, and A. A. Campbell Swinton.

MILDE TELEPHONES AND ELECTRIC SUPPLY COMPANY (LIMITED).—This Company was registered on January 29th, with a capital of £20,000, divided into 15,000 £7 per cent. Preference and 5,000 Deferred shares, of £1 each, to acquire, deal with, develop, and turn to account business concerns, letters patent, monopolies, licences, concessions, rights, and privileges relating to telephones, electric apparatus, and the like, to construct, maintain, lay down, carry out, work, sell, let on hire, and deal in telephone cables, wires, lines, stations, exchanges, reservoirs, accumulators, lamps, meters, engines, &c., to transact and facilitate the transmission of telephonic and telegraphic communications and messages, to undertake the lighting of towns, streets, buildings, and other places, and the supply of electricity for public and private purposes, and to carry on the business of a telephone, telegraph, and electric light, heat, and power supply company in all or any of its branches. The subscribers (with one share each) are:—Vaughan W. Jones, Quentin A. McConnell, William Milford, E. Duchamps, Egerton F. Hodge, L. D. Tottenham, and W. Saurin. The first Directors are to be appointed by the above subscribers.

ECONOMIC GOLD EXTRACTION COMPANY (LIMITED).—The annual return of this Company, made up to September 14, 1893, has just been filed. Out of a nominal capital of £175,000 in £1 shares, 139,880 have been taken up, of which 122,000 have been issued as fully-paid. Upon the remaining 17,880 shares a call of 17s. per share has been made, resulting in the payment of £14,410. 19s., leaving £802. 1s. in arrears, while £15 has been paid in respect of 120 forfeited shares.

ELECTRIC CONSTRUCTION COMPANY (LIMITED).—The statutory return of this Company, made up to November 30, 1893, was filed on December 14th. But of a nominal capital of £400,000, divided into 150,000 Ordinary and 50,000 £7 per cent. Cumulative Preference shares of £2 each, 120,000 Ordinary and 12,845 Preference shares have been taken up, and all issued as fully-paid, in accordance with the terms of the agreement with the Electric Construction Corporation (Limited).

ELECTRICAL PLANT (LIMITED).—The annual return of this Company made up to December 26th, has been filed. Out of a nominal capital of £10,000 in £10 shares, 575 have been taken up, and 500 issued as fully paid. Upon the remaining 75 the full amount has been called and paid.

ELECTRICAL INSTALLATION COMPANY (LIMITED).—By special resolution passed October 19, 1893 (and recently filed), this Company raised its capital to £2,800, divided into 1,800 "A" and 1,000 "B" shares of £1 each, by the addition of 1,000 new "A" shares. The first annual return, made up to December 29th, has also been filed; the whole nominal capital of £2,800 was taken up, and the full amount called and paid thereon.

ELECTRIC METER COMPANY (LIMITED).—The annual return of this Company, made up to January 3rd, has been filed. The Company has a nominal capital of £50,000 in £10 shares, of which 2,007 have been taken up; 2,000 of these were issued as fully paid, and the full amount called on the remainder. The calls paid equal £30, while £40 is yet in arrears.

ELECTRICAL PURIFICATION ASSOCIATION (LIMITED).—The annual return of this Company, made up to and filed on December 30th last, shows that 18,326 shares of £1 each have been taken up out of a nominal capital of £25,000; 5,000 of these were issued as fully-paid, and the full amount called on the remaining 13,326 shares, resulting in the payment of £13,226, and leaving £100 unpaid.

LATIMER CLARK, MUIRHEAD AND CO. (LIMITED).—A notice filed on January 26th states that at an extraordinary general meeting held at 23, Regency-street, Westminster, S.W., on that date, the members resolved to wind up voluntarily, and appointed James Worley, of 27, Leadenhall-street, London, E.C., liquidator. The Company was registered on October 22, 1883, with a capital of £100,000, in £10 shares, to acquire and take over as a going concern the business of electrical engineers and telegraphic apparatus manufacturers, carried on by J. Latimer Clark and John Muirhead at 23, Regent street, Westminster, S.W. At the time of the last return in July, 4,709 shares were taken up, all of which, with the exception of the seven signatories' shares were issued as fully paid. The principal shareholders are John Muirhead (1,769), Francis L. and Henry J. Muirhead (1,350 jointly), and J. Latimer Clark (469).

CITY NOTES, &c.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended January 28th, were £951, as against £976 for the corresponding period of last year, being a decrease of £25. The total receipts for the half-year amount to £3,839, as against £3,954 for the corresponding period of 1893, a decrease of £115.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—For the half-year just ended the Board recommends a distribution at the rate of 8 per cent. per annum.

FINANCIAL MOVEMENTS.—The following is from the *Financial Times*: "The past month has witnessed a fair business going in the shares of the leading Electric Light Supply Companies. The subjoined table shows the movements which have taken place. It is expected that the reports, which in most cases are about due, will show favourable results:—

Stock.	Price Jan. 2nd.	Price Jan. 22nd.	Rise.
Brush	2⅜— ⅝	2⅝— ⅞	¼
City of London	11¼— ¾	11¼— ¾	...
St. James's and Pall Mall	5½—6	6 — ½	½
Ditto Preference	7¾—8¼	8 — ½	¼
Westminster Supply	5 — ½	5¼— ¾	¼
Metropolitan Supply	7¾—8¼	8¼— ¾	½
Ditto Debentures	103 —6	104 —8	1½

INDIARUBBER, GUTTAPERCHA, AND TELEGRAPH WORKS COMPANY (LIMITED).—Subject to audit, the accounts to December 31st last show the following result:—Net profit for 1893, £94,605; brought forward from 1892, £46,845; total, £141,450; less interim dividend, £25,000—£116,450. The directors have resolved to add £50,000 to the reserve fund, and to recommend a further dividend of 5 per cent. (making 10 per cent. for 1893) and a bonus of 2½ per cent., carrying forward £28,950.

MACHINERY TRUST.—The Directors of this trust have declared an interim dividend to December 31st last, at the rate of 10 per cent. per annum, free of income tax.

ROBEY AND CO. (LIMITED).—Letters of allotment and regret for the issue of £125,000 Four-and-a-Quarter per Cent. First Mortgage Debentures in this Company have been posted.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the week ending January 26th (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, (Limited), were £3,445.

YORKSHIRE BOILER INSURANCE AND STEAM USERS' COMPANY (LIMITED).—Mr. W. Dale Shaw, J.P., stated at the twenty-first annual meeting of this Company, held at Bradford, on Monday, that the Company

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was in an eminently satisfactory position, and was able to announce the payment of 7½ per cent. on its capital, and to add £1,200 to the reserve fund, and carry forward the sum of £277. 15s. to the next account. He had the pleasing duty to announce that, owing to the regularity and efficiency of their inspections, they were still able to record that no explosion had taken place with any boiler under the Company's care since its formation twenty-one years ago. The report and accounts were unanimously adopted.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Jan. 24.		Price Wednesday, Jan. 31.		Rate per Cent. Yielded. £ s. d.	Dividend Due	Business Done During Week Ending Jan. 31. Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	12/6	Anglo-American xd	43	45	42	44	6 5 0	Jan., Apr., July, Oct.	44	42
£2,932,680	Stock	25/0	Do. Preferred xd	79¼	80½	78½	79½	6 18 4	" "	81	79½
£2,932,680	Stock	5/0	Do. Deferred	7¼	7¾	7¼	7¾	..	" "	7 7/16	7⅜
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	100	103	100	103	3 17 8	January and July	..	..
130,000	£10	3/6	Brazilian Submarine	11¼	11¾	11¼	11¾	5 10 8	Mar., June, Oct., Dec.	11⅝	11⅜
£18,700	£100	5%	Do. 5 per Cent. Bonds xd	101	104	99	102	4 18 0	January and July	..	..
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	110	–
10,000,000	$100	7%	Commercial Cable Capital Stock	130	140	130	140	5 0 0	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11½	12½	11½	12½	6 8 0	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	18¾	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	..	..
60,710	20	3/0	Direct United States Cable, 1877	10¾	11	9¾	10	7 0 0	Jan., Apr., July, Oct.	10¾	9¾
400,000	10	2/6	Eastern	14⅞	15⅛	14⅞	15⅛	4 5 11	" "	15⅛	14⅞
70,000	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16¼	3 13 10	" "	16⅛	16 1/16
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	116¼	116
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	108	111	108	111	4 10 1	February & August	..	..
250,000	10	2/6	Eastern Extension	15½	15¾	15½	15¾	4 8 11	Jan., Apr., July, Oct.	15 11/16	15 9/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock xd	115	118	113	116	3 9 0	February & August	..	116
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	101	104	101	104	4 16 2	January and July	101½	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	101	104	101	104	4 16 2	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103	106	103	106	3 15 6	February & August	..	–
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	106%	109%	106%	109%	3 13 5	May and November	107½	..
180,227	10	1/3	Globe Telegraph and Trust	8½	8¾	8⅜	8⅝	5 4 4	Jan., Apr., July, Oct.	8 11/16	8½
180,042	10	6%	Do. 6 per Cent. Preference	15¼	15¾	15¼	15¾	3 17 5	" "	15½	15½
150,000	10	5/0	Great Northern	20	20½	20¼	20¾	4 2 2	Jan., April, and July	20¾	20½
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	105	108	4 12 7	March & September	..	..
17,000	25	12/6	Indo-European	41	43	41	44	5 13 8	May and November	41¾	–
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	3 6 8	" "	..	–
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	105	108	5 11 1	March & September	–	–
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red 1942	101	104	101	104	3 16 11	..	..	..
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	..	..
3,881	£100 Cert	35/0	Submarine Cables Trust 6 per Cent.	114	119	114	119	5 0 10	" "	114	..
15,609	10	4/0	West African Telegraph	5½	6½	3	5	..	January and July	..	..
£249,900	100	5%	Do. 5 per Cent. Debentures	100	103	100	103	4 17 1	March & September	101½	101
30,000	10	2/0	West Coast of America	2	2½	2	2½	..	January and July	..	2¼
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	97	101	97	101	7 18 5	June and December	..	..
88,321	10	1/0	West India and Panama	1	1¼	1	1¼	..	..	1½	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10¼	9½	10	6 0 0	May and November	10	9¾
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	" "	8½	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 7	June and December	..	..
64,242	15	4/6	Western and Brazilian	5¾	6¼	5¾	6¼	3 12 3	May and November	6¼	5¾
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5¼	5¾	5¼	5¾	..	..	5¾	–
33,129	7½	4/6	Do. 5 per Cent. Deferred	1	1½	1¼	1¾	..	..	1⅜	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	104	107	104	107	5 12 2	February & August	..	–
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	104	107	104	107	5 12 2	" "	..	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	105	102	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	..	..	–
224,850	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
220,000	£1	4·76d.	Oriental Telephone and Electric (11s. paid)	¼	⅜	¼	⅜	5 6 5	Yearly	..	–
484,597	5	2/6	National	4¾	5	4⅝	4⅞	5 2 7	June and December	4 13/16	4¾
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½	15½	14½	15½	3 17 5	"	15	14 11/16
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	14	15	14	15	4 0 0	" "	14½	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¼	5½	5¼	5½	4 10 11	..	5 7/16	5⅜
925,017	£100	4½%	Do. Deb. Stk. 4½%	112	114	112	114	3 18 11	January and July	113½	112½
58,000	5	1/0	United River Plate	1½	2	1½	2	..	" "	–	–
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	–	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10		City of London Electric Lighting (fully paid)	11¼	11¾	11¼	11¾		..	..	..
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	13	13½	13	13½	..	–	13½	13
19,900	£5	..	Electricity Supply Co. for Spain	..		..					–
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	–	..	–
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	..	–
8,322	£5	..	House to House Electric	..		..		–	–	–	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		–	–	–	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	–	–
30,000	£5	1/9	Liverpool Electric Supply (£3 10s. paid)	4⅜	4½	4⅜	4½	..	–	–	–
15,000	£5	2/6	Do. (fully paid)	6⅛	6⅝	6⅛	6⅝	..	–	–	–
111,000	5	..	London Electric Supply	½	¾	½	¾	..	..	..	–
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	8¼	8¾	8¼	8¾	2 5 7	..	..	.
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	104	108	104	108	4 12 7	June and December	..	..
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½		.	..	..
19,980	£5	9½%	St. James' and Pall Mall xd	5¾	6¼	5½	6		.	6 3/16	.
20,000	£5	7%	Do. 7 per Cent. Preference xd	8	8½	7¾	8¼	4 4 10	-	8⅜	8¼
59,900	5	1/6	Westminster Electric Supply (fully paid)	5¼	5¾	5¼	5¾	3 0 10	-	..	.
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	2/1	Brush Electrical Engineering	2⅝	2⅞	2⅝	2⅞	6 5 4		2⅞	2 11/16
90,000	2	6%	Do. 6 per Cent. Preference Non-Cumulative.	2⅛	2⅜	2⅛	2⅜	5 1 1		2¼	..
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	104	106	104	106	4 4 11	March & September	105	–
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	3½	4½	3	4	..	January and July	..	–
12,139	5	..	Edison and Swan United	–		–			–	..	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	–	..	..
120,000	2	..	Electric Construction	½	1	½	1	..	–	..	..
12,845	2	..	Do. 7% Cumulative Pref.	1	1½	1	1½			..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	⅛	⅜	⅜	⅝	..	..	–	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½		–	–	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	23½	24½	23	24	5 4 1	February & August	24	23¼
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	..	..
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2		..	..	–
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	..	..	–
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/16	5/16	3/16	5/16	..	December and June	–	..
78,949	5	3/6	Swan United (£3. 10s. paid)	2¼	2¾	2¼	2¾	..	May and November	2¼	..
37,350	12	12/0	Telegraph Construction and Maintenance	36	38	36	38	4 9 1	March and July	37¼	37
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	103	106	103	106	4 14 4	January and July	..	..
37,514	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	–		..			–	–	–
41,098	£5	..	Do. Preference (fully paid)	–		..		–	–	–	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	¾%	City and South London Railway	28	33	28	33	2 5 5	May and November	..	–
87,500	£10	–	Liverpool Overhead Railway	4¾	5⅛	5	5⅛	–	–	–	–

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THE ELECTRICIAN:

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NOTES.

The Paper by Mr. W. Worby Beaumont on "The Automatic Balance of Reciprocating Machinery and Prevention of Vibration," read before the Society of Arts on Wednesday last, was remarkable in several respects. He dealt with a number of dynamical problems, and succeeded in explaining them to the audience without a single word of mathematics. By the use of plain and homely language he avoided even such expressions as moment of inertia and kinetic energy. The lecture was clearly illustrated by working models, which must be seen to be appreciated. Up to the present Mr. Beaumont has concerned himself chiefly with such reciprocating machinery as jigs and sieves, and has apparently found a complete cure for the jarring and racking of the framework, rendering, indeed, all framework unnecessary. The problem of chief interest to electrical engineers, namely, the prevention of vibration of high-speed engines, was only briefly touched upon; but it is clear that Mr. Beaumont's principle, when properly applied, will go far towards the cure of this nuisance. The practice of attempting to balance armatures by rolling them on knife edges was mentioned, and the erroneous nature of the method was explained. The following lines sum up the whole principle; but the literary style is not to be taken as a sample of the Paper which they conclude:—

> In a general way it may be said that when a piece of mechanism wants to wobble, it is obviously either wrongly constructed, or if it is not and wants to wobble, then let it wobble; but make it wobble something you want wobbled. In most cases it will not wobble so much and never so forcibly if we don't try to stop its wobbling.

Whether or no electricity will in course of time supersede all other modes of tramway traction we do not care to prophesy, but it may be predicted with some confidence that it is destined to take a very much larger share of the business than is at present the case. It is with this contingency in view that we give elsewhere in the present issue a few figures relating to tramway matters. For a country admittedly unfavourable to tramway enterprise, the totals are by no means small. Over £14,000,000 has been sunk in tramway buildings, lines, and equipment, and during the twelvemonth ending June 30, 1893, nearly 600,000,000 passengers travelled on the 960 miles of line then open for traffic. But, big totals notwithstanding, the tramway business in this country is not a mine of wealth, at least to the shareholder; the net return on this fourteen millions sterling is but a beggarly 5½ per cent., no allowance being made for depreciation, &c. Of course, some tramways are remarkably prosperous. Thus, at Glasgow, the net receipts are 9·8 per cent. on the total capital expenditure, and at Edinburgh 7·4 per cent., but on the other hand many a line works at a loss. From the figures published by the Board of Trade it would appear that where a municipality is concerned a mile of tramway is constructed on the average for a little over £11,000, as against £16,000 for a company. This on the face of it looks like a corroboration of the theory of the economy of municipal enterprise. But it would be instructive if we could discover how much of this excess is due to the bleeding of private tramway enterprise, not by the company promoter, but by the local authorities themselves. The future of electric traction in this country, like that of electric lighting, would seem to depend on its gaining the favour of the municipal mind.

Leeds has been worrying itself over this question of tramway municipalisation—firstly, as to the sum it should pay for the tramway system; secondly, as to whether it shall work the tramway system which it has purchased, or lease it out to some company. Ratepayers' opinions are divided on the second head; the first has been settled, and a purchase sum of £130,000 handed over to the vendor Company. Very curious indeed are some of the reasons in favour of municipalisation which are advanced by the ratepayers who advocate this system of working. One reason is that "a company would think first of its dividends"; another is that the city ought to know a good thing when it sees it, and "should make the greatest possible money returns" on its purchase. A third reason put forward to induce the Leeds Corporation to "have a shot" at tramway running is, that if it should fail it really does not matter, for at any time it gets tired of the game "it will be as free as it is at present to hand the undertaking over to a public company on conditions framed after actual experience of working." Is this the innocence of sweet simplicity, or is it that species of shrewdness which always has an eye on the bogus company promoter?

The use of an electric arc as a tool is to some extent restricted by the Benardos patents, and there are other practical objections to its employment either for welding or for soldering when the current is derived from the mains of a supply company, and when the work is in electrical connection with the earth. A plumber, for example, using an arc

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for work on water service pipes would rather annoy the engineer of the supply station by putting twenty or thirty amperes to earth. So amenable, however, is electrical energy to transformation that the difficulty is not insurmountable. A handy form of electro-chemical blowpipe, the invention of Mr. H. N. Warren, is described in a recent number of the *Chemical News*. It consists of a simple water voltameter, arranged so that the electrolytic gases pass up a couple of tubes to the oxy-hydrogen blowpipe. Placed on the house electric light wires, say fifty in series, this apparatus ought to maintain a long, steady flame of intense temperature. Some difficulty might be experienced with the acid vessicles which are invariably carried away from the acidulated water by the escaping gases, especially where the evolution of gas is abundant. It would be very objectionable to find that acid was being carried on to the work which was being heated. To obviate this defect the gases might be passed through a pair of wash-bottles or through scrubbers.

One of the knottiest problems connected with the interior economy of Government departments is the maintenance of a healthy flow of promotion. Provided the public purse be long enough there need not be a single gray-beard in the service of the State, nor, on the other hand, provided it be compatible with efficiency, need any one be retired under three score years and ten. But as is ever the case, it is the *juste milieu* that is so difficult of attainment. An instance of this is the hubbub that has arisen in India in connection with the supposed desire of the present Director-General of Telegraphs to extend his tenure of that office until March, 1897, that is to say, two years beyond the regulation period of five years. Mr. Brooke, whose services to the State were, as was recently recorded in these columns, recognised by a New Year's Honour, will, when his term of office expires in March next year, have completed 38 years' service, all of which, with the exception of about a couple of years, have been spent in India. Notwithstanding this long record, the Director-General will only be 53 years of age on his retirement, having joined the service in the year of the Mutiny at the early age of fifteen and a-half. Length of service, coupled with comparative youth, are an unusual combination, and might well at a critical moment warrant the over-riding of a cast-iron regulation; but in the piping days of peace the arbitrary suspension of rules of this kind naturally begets a sense of injustice amongst those who do not benefit by the arbitrary act. Promotion deferred maketh the heart sick, and not least so in the Far East, where so much depends upon it. Surely the "infinite variety" of our orders of chivalry cannot be put to a more graceful use than in rewarding a servant of the State without injury to others.

The Guilds' Central Technical Institute.—The headquarters of the City and Guilds of London Technical Institute in Exhibition-road, South Kensington, is henceforth to be known as the Guilds' Central Technical Institute.

A Proposed Long Telephone Trunk Line.—According to the Vienna *New Free Press*, a scheme is on foot for connecting Vienna and Odessa by telephone. These two towns are some 700 miles apart as the crow flies.

The Heilmann Electric Locomotive.—Public trials of this locomotive will take place between Havre and Beuzeville to-day and to-morrow, two journeys being made each way each day. The distance from Havre to Beuzeville is about 15½ miles.

The Harness Case.—The week allowed by Mr. Hannay for the prosecution in the Harness case to consider whether they would proceed under the Vexatious Indictments Act having elapsed, and they having taken no steps in the matter, the case may now be considered at an end.

The Testimonial to Prof. Garnett.—In connection with this movement a preliminary meeting of subscribers was held on Saturday, January 20th. It was agreed that as it is now known that Prof. Garnett will continue Principal of the Durham College of Science until June, the subscription list should remain open until April 21st.

Appointment Vacant.—The authorities of the Bradford Technical College require a master for mathematics, physics and engineering, at a salary of £200 per annum. Applications (which must be accompanied by no more than three recent testimonials) giving age and general qualifications must be addressed to Mr. John Nutter, the secretary, by February 14th.

Telephone Trunk-Wire Extensions in Italy.—The Italian Minister of Posts and Telegraphs has under consideration a scheme, says *Industries and Iron*, for an important extension of the telephone system of the country. It is proposed to establish trunk lines between Turin, Milan, and Genoa; between Florence, Pisa, and Leghorn; and between Rome and Naples.

Memorial to the late Sir Arthur Blackwood.—The Post Office servants resolved some few months ago to raise a fund for the purchase and maintenance of a lifeboat to be named "Sir Arthur Blackwood," as a memorial of the late Permanent Secretary to the Post Office. The sum of £1,115 has been raised, and the boat when purchased will be stationed at Greenore, County Dundalk.

Cable Interruptions:

	Date of Interruption.
Cayenne-Paramaribo	October 15th, 1893
Bissao-Bolama	November 24th „
Cayenne-Vizeu	November 25th „
Garachico-Santa Cruz de Palma	December 27th „
Constantinople-Odessa	January 31st, 1894
Saigon-Thuan-An	February 1st „
St. Thome-Loanda	February 5th „

Personal.—We are informed that Mr. Gisbert Kapp has accepted an appointment with the "Verband Deutscher Electrotechnicker" in Berlin. Mr. Kapp has done such good work in this country for the last twelve years as an English engineer that his departure is a matter for regret.——Mr. J. Stewert has been appointed engineer and manager of the electric light works in Derby, with Mr. A. E. P. Moore as assistant engineer.

Expiring Patents.—The United States Commissioner of Patents has initiated an innovation that will be of value to inventors and the public generally. The *Patent Office Gazette* now gives a list of patents expiring each week. The date of issue of each expiring patent is also given. Electrical people in America will by this means know from week to week the state of the electrical business, as regards the patents covering electrical inventions.

Switching-in Motor Cars.—In case of a sudden stoppage of the current, electric tramway conductors in America are ordered to close the switches of their electric light circuit and to wait until the lamps light up before switching on the car motor, To prevent the whole load coming at once on to the engines. one set of conductors are ordered to switch the car motor on immediately, whilst another set are told to wait half a-minute, and another a minute, and so on.

Cavendish Laboratory Extension Scheme.—A syndicate, consisting of the Vice-Chancellor, the Master of Peterhouse, the Master of Christ's, Prof. Thomson, F.R.S., Prof. Liveing, F.R.S., Mr. Glazebrook, F.R.S., and Mr. Shaw, F.R.S., is about to be appointed to consider the best means of extending the Cavendish Laboratory. A site for the extension is reserved; but the standing difficulty of funds is likely to prove a serious one unless outside help can be obtained.

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The Electric Lighting of Windsor.—It is said that it has been found necessary to stop running the electric light in this town. The mains laid down for the Electric Light Company are now practically useless on account of being eaten through in several places by electrolytic action. No more light will be supplied until the new mains are laid, which will be done at once if the Corporation will allow the Company to proceed

Blackpool.—At Tuesday's meeting of the Town Council it was resolved to borrow £24,000 for electric lighting extensions, over and above the £26,000 already spent. At a meeting of the Electric Lighting and Tramways Committee, on the 2nd inst., it was resolved that the terms of Mr. Holroyd Smith, for estimates of cost and supervision of the works required for placing the permanent way and plant of the tramways in thorough repair and working order, be accepted.

Air-Core Transformers.—Messrs. Bedell and Crehore inform us that Mr. Rimington's Paper on "The Behaviour of an Air-Core Transformer when the Frequency is below a Certain Critical Value," read before the Physical Society in October last (see *The Electrician*, November 3rd, p. 18), in which attention was called to the case in which the primary current of a transformer falls off when the secondary is closed, was anticipated by them in the *Electrical World*, June 17, 1893, in Article V., on the "Theory of the Transformer."

"Dielectrine."—At a recent meeting of the Société Française de Physique, M. Hurmuzescu exhibited various electro-static experimental apparatus, in which a dielectric substance called *dielectrine* was employed. According to M. Hurmuzescu, *dielectrine*, which is a mixture of paraffin and sulphur, is harder and less easily melted than the former, and less easily cracked and less hygroscopic than the latter. M. Chabaud, the electrical instrument maker, of Paris, has succeeded in turning out the material in a hard, easily-worked, homogeneous state.

Newport—The *South Wales Daily Star* states that the Electric Lighting Sub-Committee of the Parliamentary and Improvement Committee of the Corporation have, after a protracted discussion, decided to stand by the original recommendation to the Council, *i.e.*, to accept Messrs. Fowler's tender. A letter, it is further s ated, was received from Messrs. Crompton offering to carry out the whole of the contract at a sum even less than their previous tender, and further undertaking to run the whole installation by contract over a series of years, upon terms which would leave the Corporation an absolute profit on the transaction from the very first.

Operating Lock Gates Electrically.—Mr. Thomas Monro, Superintendent of the Soulanges Canal in the Province of Quebec, has experimented with an electric motor, which transmits power through a train of gears to a pinion which works into a rack placed on the side of a 6in. I beam. The end of this beam is attached to the top of a lock gate which it shuts or pulls open as may be required. The operation takes about 55 seconds, and is performed with perfect ease. It is proposed to operate two pairs of gates and four filling and emptying sluices from one point in the centre of the lock, and upon whichever side may appear advisable.

Electric Light and Coast Defence.—In a lecture on "Some Aspects of Coast Defence," recently given at the Royal United Service Institution, Col. J. B. J. Jocelyn, R.A., argued that the question of electric light was in an unsatisfactory state. The creation of a large and brilliantly illuminated area might work well if a very large number of pieces bore upon a narrow obligatory place of passage, but it seemed to him impossible to make certain of stopping, at night, a swarm of torpedo-boats by defences at one portion only of a channel. The arrangements for electric lighting should not be left to be settled under the pressure of imminent war, and the present uncertainty was a serious embarrassment to the preparation of practical schemes of defence.

Gas and Electric Lighting Concessions in France.—As we have frequently recorded disputes are constantly arising between gas companies and municipalities in France on account of the violation by the latter of contracts entitling the companies to a monopoly. St. Etienne and Montluçon were three years ago ordered by the Conseil d'État to compensate the gas companies for allowing the introduction of the electric light. Recently the same tribunal gave judgment in favour of a claim for the assessment of damages by the gas company of Argentan against the municipality. The latter had not only allowed an electric light company to lay down wires, but had allowed it the use of a site for its works. The judgment contains a recital that, whenever a gas company has been accorded a monopoly for any fixed period, compensating advantages have always been given to the local authorities in the shape of cheap rates or participation in profits.

The Accident at Prescot.—An inquest was held at Prescot on Thursday last week on the body of Henry Waide, 14, employed by the British Insulated Wire Company, which light Prescot by electricity. On the previous day the boy was engaged with an electrician named Jones in a cellar of some premises in Eccleston-street. Jones left him for a few minutes, and on his return found him lying on the floor. The lad's finger and thumb were burnt, showing that he must have pulled the wire. Jones said that Waide was a careful lad and knew the danger. The wire was insulated, and was put up two days before. The joint was broken by some means where he touched. The pressure was 2,000 volts. They were about to fix a wooden guard over the transformers. The wire had evidently been grasped, as it was pulled from its position. The boy had no right to touch the wire. He had been at the work for five months. The jury found that the boy died from electric shock.

The Science and Art Department.—The following permanent inspectors have been appointed under the Science and Art Department :—E. J. Ball, Ph.D , Instructor in Assaying, Royal College of Science, London; R. Blair, M.A. (Edin.), B.Sc. (Lond.), Head Master of the Public School of Science, Cheltenham ; S. F. Dufton, M.A., D.Sc., Fellow of Trinity College, Cambridge; C. Geldard, M.A., formerly Scholar of Trinity College, Cambridge; H. H. Hoffert, D.Sc., Demonstrator in Physics, Royal College of Science, London ; Prof. D E. Jones, B.Sc., late Professor of Physics, University College of Wales, Aberystwyth, Director of Technical Education under the Staffordshire County Council; D. S. McNair, B.Sc. (Lond.), Ph.D., Lecturer in Chemistry at the People's Palace, Mile End, London ; C. McRae, M.A., late Scholar of Exeter College, Oxford, Assistant-Examiner and Occasional Inspector for Science, Department of Science and Art; T. Preston, M.A., Fellow of Trinity College, Dublin, and Professor of Physics to the Catholic University, Dublin ; F. Pullinger, M.A , B.Sc., late Burdett Coutts' Geological Scholar, Oxford, Organising Secretary of the Technical Instruction Committee of the Devonshire County Council; Gapt. T. B. Shaw, R.E., Occasional Inspector of the Science and Art Department ; H. Wager, Lecturer in Botany at the Yorkshire College, Leeds. It is proposed that these gentlemen should each take charge of a special district, and reside in one of the chief towns in their district.

The Eckert Bimetallic Wire Patent.—A patent has been recently issued to Mr. W. H. Eckert, 80, Broadway, New York, for an improvement in telephonic transmission, and, generally, in the distribution or transmission of rapidly alternating currents, the claims of which, says the *Electrical World*, are startling in their character. Mr. Eckert, says our New York contemporary, "is so well and honourably known in the electrical circles, however, where he has occupied positions of the greatest prominence, that claims made by him are entitled to respectful consideration, particularly as they relate to a branch of electricity in regard to which, with our present knowledge, it would be hazardous to dispute the improbability of any assertion from a competent source." According to the patent specification the invention for the most part consists in the discovery that telephonic transmission, or rapidly alternating currents in general, may be more perfectly effected upon a bimetallic conductor, such as steel and copper in substantially equal parts, than upon a conductor of one material, such as copper ; and with the advantage that such transmission may be effected upon a circuit consisting of a single composite wire and an earth return as perfectly as though two copper wires, each of equal conductivity, were arranged in a closed metallic circuit. It has also been discovered that less insulation is

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needed to protect a bimetallic wire than is necessary for copper or other single-substance conductors, in the transmission of rapidly alternating currents. The patentee has no theory to account for his claims.

Obituary.—We regret to announce the death of Mr. G. B. Prescott, at New York, at the age of 63. He was born in Kingston, N.H., September 16, 1830. After leaving school, in 1850, he engaged in the telegraphic business as an operator, and was employed in 1850 and 1851 in the Boston office of the Merchants' Line, which was then working the Bain chemical system between that city and New York. Soon afterwards he entered the service of the Commercial or "House" line in the same city, where his marked ability as an operator and electrician soon raised him to the position of superintendent of that line, and also of the local system known as the "Marine Lines," extending from Boston to Cape Cod and Cape Ann. In 1859 a general consolidation of the competing telegraph lines in New England occurred, after which Mr. Prescott was appointed to the superintendency of a district comprising most of the lines in western New England, with headquarters at Springfield. In the course of the controversy respecting the proposed establishment of a Government telegraph, which raged with much vehemence in 1868-69, Mr. Prescott took a prominent part in opposition to the scheme. One of his statistical articles, published in a local newspaper, presented his views of the matter in such a forcible way that the attention of President William Orton was attracted by it, which led to the removal of the author to New York, and to his employment in the general office of the Western Union Company in more extended services of the same character. When the office of electrician of the company was established, Mr. Prescott was chosen to fill the position. Mr. Prescott was the author of a number of works on telegraphy and allied subjects, among which are his "History, Theory, and Practice of the Electric Telegraph," 1860; "Electricity and the Electric Telegraph," 1876; "Speaking Telephone and Talking Phonograph," 1878; and "Dynamo Electric Machines."

A Curious Electrical Fire.—One of those peculiar complications which sometimes arise in connection with losses chargeable to electricity was adjusted by the Supreme Court of Massachusetts a few weeks ago. The building and machinery of an electric company had been insured against fire. The fire itself was confined to a remote corner of the building, but it established a short circuit between two of the lightning-arresters, which short-circuited a dynamo. This increased the strain on the gearing, which, in its turn, broke a jack-pulley. The jack-pulley destroyed the governor. The loss of the governor wrecked the fly-wheel, and the whole machinery went to pieces. In the opinion of the Court fire was the direct cause of loss. It was, remarks the *Insurance Monitor* of New York, "a curious and complicated chain of causes, and while other Courts would probably have held the same view, the connection between the fire and the ultimate destruction of the machinery seems a very remote one. The incident suggests numerous variations which might have made a still more complex question. For instance, the machinery might have been in a separate building. That building might have been covered either as a separate item in the same policy or under an independent contract, or the building containing the machinery might have been any distance away, and insured in another company altogether. Mere distance was not an essential element in the reasoning. The continuity of the casualty was not affected by the length of wire through which the current had to run. The causes would have operated after the same fashion if the fire had occurred in New York and the dynamo and its engine had been planted at Niagara Falls. But it would require a great stretch of imagination to talk of a fire damage at the latter which was an integral part of a small fire occurring in the former. Such illustrations show the haziness of the logic by which this chain of causes was defined as so many subordinate features of the original fire."

The Gibbs Light and Heat Tender. — The Chicago, Milwaukee, and St. Paul Railway Company, says *Engineering*, began experiments in 1889 to devise an economical and reliable system of electric train lighting. The first plan tried was the combined accumulator and direct-current system. The service in which the lighting was used related to heavy through express trains, making a continuous run of 430 miles daily. As these trains were practically a unit for the entire distance, it was considered feasible to use a direct-current lighting system, doing away entirely with batteries. By using in such a system a moderately high-speed engine, belted to a reliable type of dynamo, there seemed to be no reason why the lighting should not be as unfailing as in the case of stationary isolated plant. Upon this basis the present system was introduced, and has been in very successful use up to this time. The cars equipped to date for electric lighting, upon the St. Paul Railway, are about 100 in number, and six through trains are run each night so lighted. These trains are from seven to ten cars in length, and the number of lamps lighted varies from 150 to 225 per train, the lamps being 110-volt, 16 candle-power incandescents. After the introduction of the system, some difficulty was experienced in obtaining in winter, when the weather is often very severe—the thermometer at times falling to 35 degrees Fahr. below zero—sufficient steam of regular pressure from the locomotive to give uniform light. At such seasons the problem is further complicated by the use of steam from the locomotive for heating the train. Experiment proved that in zero weather about 1 per cent. of the steaming power of the locomotive was required to heat each car. It therefore became an open question whether it would not be more economical and practicable to use a separate boiler for heating and lighting. Accordingly the "light and heat tender," was designed, and two were built. The use of these cars has been an entire success, and up to the present they have run about 196,000 miles each without a single mishap. The reason for their success may be found in the fact that, while they add to the resistance of the train, the additional steam required for hauling them passes through the cylinders and the blast-pipe, and so urges the fire, while without them the drain of steam for heating and lighting is a dead loss, adding nothing to the capacity of the furnace to burn more fuel. The car is a complete central heat and light station on wheels. It is run immediately behind the locomotive tender, is 34ft. long, very strongly built, and encased in sheet steel. Including full equipment of boiler, engine, dynamo, storage for three tons of coal and 270 gallons of water, it weighs 64,000lb. It is carried upon two four-wheeled trucks of the usual American pattern. The interior is divided into two sections: a boiler-room with coal tank, and an engine-room with the water tank set on edge at one side. The boiler is of the locomotive pattern, the crown sheet being supported by radial stays, and the firebox and ash-pan inclosed in a water bottom. The feed water is normally obtained by means of the injector pump, pulling the water over from the locmotive tender through a rubber hose; in case of failure of this supply, however, the water in the car tank is used, and is calculated to be about two hours' supply. The engine is a Westinghouse automatic, with cylinders 6½in. in diameter by 6in. stroke, capable of indicating 18 horse-power with 100lb. steam. This engine is belted to a 15-kilo-watt Edison dynamo. The exhaust from the engine may be run either directly to the air through the "exhaust head" in the roof, or may be sent through the boiler uptake to urge the fire. One special attendant is run with this car, and he is expected to perform all the operations of firing the boiler and regulating the light and heat for the entire train. The great feature of the car is its ability to supply at all times ample steam for heating and for a reliable light, without expensive batteries or complicated machinery. The value of this feature is most appreciated in bad weather; at such times the drain upon a locomotive is greatest for hauling the train, so that it is at least able to stand an additional drain for lighting and heating, and at the time when the requirements for these are most urgently needed. The boiler in the car has been found sufficient to heat ten cars in the severest weather, and to supply power for 250 lights. In summer, when steam is not required for heating, the tender cars are laid off and the lighting outfit placed in the forward end of the baggage car, steam for the engine being taken from the locomotive. The apparatus is the same as that above described, and the manner of handling is the same.

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MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(*Continued from page 345.*)

Flame.—It will be well, at this stage, to consider more fully some of the phenomena attending the combustion of coal and other fuels. One of the most important of these to the engineer is the production of flame. There are two kinds of flame: the one arises from the combustion of volatilised portions of the fuel; the other arises from the combustion of the inflammable gases produced by the imperfect combustion of the fixed, or non-volatile, portions of the fuel. The first kind of flame is luminous, and possesses a bright yellow or reddish-yellow colour; and it is usually long and abundant. It arises from the fact that a considerable part of the fuel is volatilised by the furnace heat before it can receive oxygen enough to burn it. The inflammable gases thus formed pass upward and burn, at some height above the solid fuel, in the shape of flame. These flames are composed of various hydrocarbons, produced by the destructive distillation of the bitumen or resins in the solid fuel; and they owe their luminosity to the presence of minute particles of solid carbon in great abundance. The carbon particles are developed by the precipitation of elementary carbon, and the formation of higher hydrocarbons, when the lower or heavier hydrocarbons become raised in temperature very much above their vaporising point. Such flames are a necessary contingent upon the use of fuels with volatile components; and, properly treated, are a source of economy in the furnace. The second kind of flame chiefly arises from the production of carbon monoxide, and the subsequent combustion of this gas. The air supplied to the fixed carbon will, if not abundant, produce combustion in one stage only, forming the lower carbon oxide. When this gas has ascended above the level of the fuel it meets with fresh oxygen and burns with a faint, short blue flame. Very dry coals and coke usually burn with short flames and well-concentrated heat, or "glow-fire"; but it is sometimes convenient and efficient to cause the flame to become longer by deferring the combustion of the fuel. In order to do this the solid must be turned into gaseous fuel in greater proportion than occurs in the dry fuel. This is effected by moistening the solid fuel with steam or water; either directing a steam jet on to the fuel or previously damping it, or placing water below the grate so that it is evaporated and passes up with the air through the solid fuel. The following chemical reaction takes place:—

$$H_2O + C = H_2 + CO.$$

The C is supplied by the solid fuel, while the two gases, H and CO, which are produced, give rise to lengthy flames. Moisture occurring in the composition of a fuel will, of course, give rise to deferred flame-combustion in a similar manner.

Smoke.—Another highly-important circumstance attending combustion of fuel is the production of smoke. Smoke consists of a mixture of finely-divided particles of carbon and heavy, oily hydrocarbon with the products of combustion. Ammoniacal compounds also add to the smoke, and give it a thick whitish appearance. Smoke is therefore indicative of imperfect combustion; and for this, as well as for other reasons it is to be avoided. The direct cause of smoke is the incomplete combustion of volatile hydrocarbons; and the conditions which produce it are as follows. To produce smoke there must be the combustion of bituminous or resinous or other volatile hydrocarbon fuel, together with one of the conditions following:—(1) an insufficient supply of air, (2) too great an excess of cold air, (3) improper distribution of the supply of air, or (4) premature abstraction of the heat of the flame, sufficient to reduce its temperature below the combustion point. With an insufficient supply of air, while the volatile matter is turned into gas by the furnace heat the air is robbed of its oxygen by the fixed carbon, so that there is not sufficient oxygen in the space above the solid fuel to burn the combustible gases. These gases pass into a colder part of the furnace, forming smoke. With an excess of cold air, over and above the proper excess, smoke arises from the fact that the large bulk of cold air admitted into the region of the flame is sufficient to cool the flame below that temperature at which it is capable of combustion. The result is that excess of air and unburned smoky fuel pass away together. An improper distribution of the air supply may cause smoke from the fact that the combustible hydrocarbons are not properly mixed with the air, or from the fact that the mixture takes place too late in a part of the furnace which is not sufficiently hot. Premature abstraction of the heat of flame may arise from the contact of the flame with relatively colder surfaces of metal, on the other side of which there may be water. If this abstraction is so great as to lower the flame-temperature below the combustion point, while yet there is unburned hydrocarbon gas in the flame, smoke will inevitably result. From the conditions of its production it is evident that smoke is more liable to be produced when first the fuel is thrown into the furnace than after the greater portion of the volatile matter has been evaporated out. And the density of the smoke will, other things being equal, be greater in proportion to the richness of the fuel in hydrocarbons, as well as to the suddenness with which it is heated. The tendency of a fuel to cause smoke is usually measured in terms of the shade and the number of minutes during which smoke can be seen issuing from the chimney after a charge has been distributed over the furnace grate. This is a crude method of measurement, but is a fairly practical one. Some engineers and steam-using associations employ a graduated coloured scale of shades, with gradations from white to dense brown and black, each shade having an index number. There is no uniform adoption of such a scale, nor any generally recognised system of measuring smoke density. It is evident that by suitably regulating the quantity and the distribution of the air supply, as well as by enabling richer fuels to gain the furnace temperature more slowly than poorer ones, it will be possible to prevent smoke and to obtain almost, if not quite, perfect combustion. Turning now to fuels which are not bituminous, and which, therefore, cannot develop smoke, we must notice that these are none the less liable to become imperfectly burned. In the one case the incomplete combustion is visible; in the other case, though equally real, it is insidiously invisible. Any of the causes which develop smoke in the case of bituminous fuel, may lead to the escape of unburned carbon monoxide where fixed carbon only is concerned; and the perfect invisibility of this gas renders the faulty condition less easy of detection. In every case the direct remedy lies in the proper regulation of the supply of air to the fuel.

Coke.—The combustible portion of coke is almost entirely fixed carbon, the remainder of its weight being made up of a small amount of mineral matter and the water which the coke has absorbed. In coking a coal the mineral matter is of course left behind in the coke, so that the percentage of ash can be calculated from an analysis of the coal. The percentage of water, which is all hygroscopic, can be obtained from the loss of weight of a sample of coke after several hours' desiccation at a high temperature in a current of hot air. The remainder, after these two have been subtracted, will generally be found to be pure carbon, and the thermal value of the fuel, as well as the air concerned in its combustion, can be calculated from this remaining percentage. Sheltered coke will gradually absorb water amounting to from 15 to 20 per cent. of its weight when taken from the retorts, the amount of water depending upon the porosity of the coke. Exposed to rain, it will retain as much as 50 per cent. of its weight of water. The porous character of coke is determined by the nature of the mother coal, highly bituminous coal giving, in general, a very porous residue of coke. This property in coke is valuable on account of the facility to the access of air which it gives in the combustion of the fuel. According to analyses by Dr. Muspratt, the average of 19 samples of coke from British coals gave 93·44 per cent. of carbon, the samples having been previously desiccated. About 10lb. of air will be chemically required for the complete combustion of this average sample, neglecting air required for dilution, and the total heat of its combustion would be equal to 13,550 units per lb. of the fuel. This would give an evapora-

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tive power of 14lb. of water, from and at 212° Fah. The heat produced by the combustion of coke is very regular, the character of the heat remaining constant during the entire process; and it may be made very intense by the aid of a rapid supply of air. On the other hand, the heat is almost entirely concentrated within a space quite close to the solid fuel itself, there being practically no luminous flame and only a short non-luminous flame of carbon monoxide. Coke, is, of course, perfectly free-burning and smokeless.

Wood and Straw.—When coal and its products are unobtainable or excessively dear, it is a common practice to use dried wood-tissue, either of trees, corn stalks, or in some countries sugar canes, as fuel. Intrinsically, all these things are inferior combustibles, owing to the large amount of water contained in them; but, from a commercial point of view, they are often superior to coal and enable a motive-power plant to be carried on more cheaply that if this richer material were purchased and used. Wood-tissue from trees does not appear to differ very much in composition among the principal exogenous trees nor among the various parts of any one tree. When cut down and air-dried for a considerable time such fuel still retains as much as 25 per cent. of its weight of water, besides a considerable proportion of lower hydrocarbons containing oxygen. There is therefore very little active fuel stuff in the tissue; and what there is has to evaporate a large burden of water in the fuel itself. There is consequently very little heat available for external and useful heating. The following analysis represents an average sample of air-dried timber:—

Water (hygroscopic)	25 per cent.
Carbon	37·5 ,,
Hydrogen	4·5 ,,
Oxygen (other than in water)	30·75 ,,
Nitrogen	0·75 ,,
Ash	1·5 ,,
	100·00 ,,

This sample of fuel has an evaporative power of only six pounds of water, from and at 212° Fah., per pound of the fuel, the weight of water evaporated including the quarter of a pound of water in the fuel itself. Its external evaporative power is therefore only 5·75lb. Wherever possible the thermal value of wood should be improved by drying it at a high temperature, waste heat of some sort being utilised for this purpose. After being raised to 284° Fah. for some time, the foregoing quality of wood has been found by M. Chevandier to have the following improved composition:—

Carbon	50 per cent.
Hydrogen	6 ,,
Oxygen	41 ,,
Nitrogen	1 ,,
Ash	2 ,,
	100 ,,

Even this, however, is a poor fuel, possessing an evaporative power of but little over 8lb. The thermal value of wheat straw is about 7lb. of water evaporated from and at 212° Fah.

Fuel Testing.—Estimating the thermal value of a fuel upon the basis of its chemical analysis, although giving results which are of some importance and which indicate the theoretical merits of the fuel, is manifestly not sufficiently practical to be considered as final by an engineer. Reasons have already been stated why it is not possible to trust the mere chemical analysis of a fuel, in determining the available heat of its combustion; and what is needed, in addition to the chemical estimate, is an experimental method of actually measuring the total heat of combustion of a sample of fuel, as a check upon the chemical estimate. Two coals from different seams, for example, which may be found to have exactly the same chemical analysis, as regards the percentages of the elementary constituents, will yet be found very frequently to have quite different thermal values when actually tested in a calorimeter. But beyond even this, there is the important fact that neither the actual nor the estimated heat of combustion is necessarily a prime index of the value of a fuel, as compared with any other fuel, when the two are used in furnaces under ordinary conditions. The better fuel, as regards its total heat of combustion, may and often will be found to give results in practice which are inferior to those given by a chemically poorer combustible. Again, two fuels which may have the same thermal value, as estimated or experimentally determined, and which may give equally good results in the same furnace, when the furnace is kept at full load and under normal conditions, will frequently be found to possess very different values when the conditions of their combustion are made slightly abnormal, either by a fall or an excessive rise in the load on the furnace, or by some variation of draught or quantity of fuel in the furnace. There are, therefore, three kinds of fuel tests which are of importance to the engineer:—(1) calorimeter tests, by which the total heat of combustion is actually measured; (2) short furnace trials under normal conditions, by which the normal commercial value of the fuel, in regard to the actual type of furnace employed, is determined; and (3) long furnace trials under all the varying conditions of actual practice, by which alone the suitability of any fuel to the particular class of work it will have to do can be satisfactorily determined. We will now consider more fully the first of these, leaving the others for consideration after we have studied the various types of practical furnaces.

Calorimeter Tests of Fuels.—Select eight or ten small pieces of the fuel having an average appearance, and reduce them to a fine powder in a clean and dry mortar, taking care to thoroughly mix the samples. Sift off the larger powder and reduce this to finer powder, repeating the operation till the whole will pass through a fine sieve. Then weigh out about two grammes of the powder in a chemical balance, noting the weight to at least four figures, and set the weighed sample aside in a dry place. Next, prepare the oxygen mixture which will be used for the combustion of the sample. This mixture is usually kept ready made up, but requires to be dried and reduced to the finest powder immediately before use. The oxygen mixture may be made up of one part of saltpetre to three parts of chlorate of potash; though sometimes only the latter chemical is used. The salts must be of the purest quality and especially free from any organic impurities, such as dust. Water, either of crystallisation or hygroscopic, must be removed from the oxygen mixture immediately before the test by drying the salts at a temperature of from 220° to 300° Fah. in an air bath. When quite cold the dried mixture should be reduced to a fine powder in a clean and dry mortar, and by no means in the mortar which was used for the fuel unless every trace of the fuel stains has been removed. The function of the mixture is to supply oxygen to the fuel, and it will be necessary to provide sufficient of the salts to ensure complete combustion of the entire weighed sample. It will be best to calculate the weight of mixture which will theoretically be necessary, and then to allow a very wide margin by supplying excess of the salts. Usually from ten to fifteen times the weight of the fuel sample is taken, according to the amount of volatile matter in the fuel. Having weighed out the oxygen mixture, the two powders must next be intimately mixed, care being taken to use the whole of both weighed powders. The whole is then placed in a suitable small furnace inside a water calorimeter and ignited. Vigorous chemical action ensues, and the heat of combustion is passed through the metal walls of the furnace into the water. The weight of water in the calorimeter is known, having been previously measured, and the rise of temperature of the water is ascertained by means of a thermometer. The number of British units of heat added to the water can be calculated from these two data. Besides the heat given to the water, a portion of the heat of combustion is retained by the furnace and its contents. The proportion between the two can be ascertained by experiment with a fuel of known thermal value; and the constant for each particular form of fuel-testing calorimeter is usually supplied with the instrument. If the heat added to the water is multiplied by this constant, the product will give the total thermal value of the sample of fuel. Various forms of calorimeters are used

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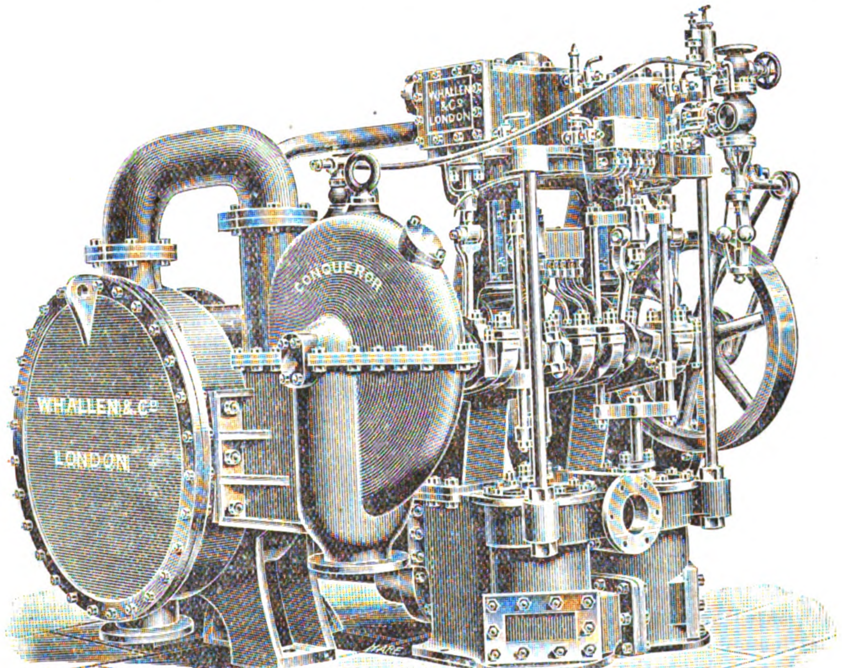
for this purpose. In some the sample of fuel is contained within a cylindrical copper furnace placed beneath a bell jar in a glass vessel of water, the products of combustion bubbling up through the water from the inverted mouth of the bell jar, and giving up their heat to the water. Some are placed within thick cylinders of concrete, to prevent escape of heat by radiation. Some are ignited by a time fuse, which is lit by hand before the furnace is immersed in the calorimeter water; others are ignited by a drop of strong sulphuric acid let fall on the mixture; while in a recent form of calorimeter the ignition is effected by a spiral of platinum wire in the midst of the mixture, the spiral being rendered incandescent by a measured supply of electrical energy. It will be seen from this brief description that the calorimetric determination of solid fuel is by no means a difficult, complicated, or expensive process; but that it is one which any works manager or generating-station engineer could very well, after a little practice, conduct for himself. The check on the quality of fuel supplied would be much more complete if this were more frequently and extensively done by managing engineers. All the apparatus that is necessary can, with the exception of a delicate chemical balance and a set of gramme weights, be obtained in sets for the purpose, costing little and requiring no more than the care ordinarily expended on electrical testing apparatus in use.

(To be continued.)

ALLEN SELF-CONTAINED CONDENSING PLANT.

We illustrate this week a novel form of combined condensing plant designed and manufactured by Messrs. W. H. Allen and Co., of York-street Works, Lambeth. The feature of the design is that all the parts are combined and form one complete machine, so that the space occupied is much less than with the most modern improvements. The condenser is circular in form, the body being of cast iron, with gunmetal tube plates and tubes, the tubes being secured by a special form of ferrule, so that they cannot become slack, and leakage is entirely prevented. The plant is particularly suitable for



in the ordinary arrangement. There are two air pumps and one centrifugal circulating pump, all worked by the same engine, the air pumps being driven from the engine crossheads, and the circulating pump direct from the crankshaft. The engine is of Messrs. Allen's compound type, and fitted moderate-size electric-light stations, and has been specially designed for this class of work. For very large lighting stations Messrs. Allen construct their condensing plants on a different plan, the condenser and machinery in such cases being separate.

THE ELECTROLYSIS OF SALTS OF THE ALKALI METALS.

BY BERTRAM BLOUNT, F.I.C.

During the slight lull in the endeavours of inventors to put the production of alkali and bleach by electrolysis upon a commercial footing, which has distinguished the last half-year from that which preceded it, an opportunity presents itself to examine rather more closely than was practicable previously the nature of the reactions upon which the electrolysis of the salts of the alkali metals primarily depends. The subject is engaging attention abroad, two Papers of interest having appeared, one by Nourrisson before the Chemical Society of Geneva, and the other, which is in some sort a commentary on the first, by Oettel, in the *Chemiker Zeitung*. The chief facts and conclusions with which they deal appear worthy of consideration, both from their electro-chemical interest and their technical significance.

The fundamental relation which exists between the chemical energy involved in the reactions taking place in an electrolyte and the voltage, either requisite to induce those reactions when they are endorthermic or conversely resulting from the occurrence of the reactions when they are exothermic, permits of the calculation of the critical voltage corresponding with a given electrolytic reaction from thermo-chemical data. Our present incomplete knowledge of these data sometimes obscures this relation, and renders results deduced therefrom inaccurate, but in many instances the links of connection are known with

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a sufficient approximation to exactness to be immediately available. Thus, in the present case, the efficiency in terms of energy of such processes for the electrolytic manufacture of alkali and bleach as have reached the stage of large-scale experiment, can be determined closely enough for all technical purposes.

Taking the case of the decomposition of sodium chloride and accepting the usual values for the heats of combination of sodium chloride and water and allowing for the formation of oxygenated compounds of chlorine, the measure of the energy required for the electrolysis of an equivalent of sodium chloride in aqueous solution is 470 Cal., corresponding with 2·02 volts. Similarly, the decomposition of sodium sulphate requires 2·15 volts. Extending his investigations in this direction, Nourisson has arrived at the conclusions that the voltage requisite for the decomposition of all the alkali salts of the same acid has the same value, and that, as the heat of neutralisation of all oxyacids is nearly identical, the critical voltage for the electrolysis of their salts is also nearly a constant quantity. The rational character of these conclusions is evident from a comparison of the observed and calculated values which are given below:—

——	Chloride.	Bromide.	Iodide.	Sulphate	Nitrate.
Potassium	2·00	1·76	1·15	2·40	2·32
Sodium	2·02	1·71	1·19	2·40*	2·36
Lithium	2·01	...	...	...	...
Calcium	1·95	1·71	1·16	...	2·28
Barium	1·94	1·72	1·17	...	2·37
Ammonium	1·83	1·46	...	2·29	...
Calculated value	2·02	1·70	1·16	2·15	2·07

On examining these figures it will be noticed that the chief tendency to irregularity is in the ammonium salts, a result quite consistent with the fact that the radicle corresponding with the alkali metal of the remaining members of the series is itself capable of reactions impossible for an elementary substance. The uniformly higher voltage needed for the electrolysis of the sulphates and nitrates than is deducible from the heat of combination of these salts, is noticeable, and indicates that the process of electrolysis takes place less smoothly than it would were it confined to the decomposition of the salts into acid and base. In the case of the sulphates the formation of persulphuric acid is a probable explanation of the discrepancy, but in that of the nitrates no corresponding change suggests itself in the present state of our knowledge. It does not follow that no such change takes place, for the potentialities of nitrogen are far from being exhausted, as witness that most remarkable substance azoimide. The settlement of these points may, however, be left for the time, inasmuch as the only alkali salt commercially electrolysed as yet is sodium chloride, the critical voltage of which is known within a small proportion of its value. When this voltage is compared with that claimed to be used by inventors of plant designed to oust the carbonating tower, the salt-cake furnace and the chlorine still at a stroke, a large divergence is apparent. Instead of 2·02 volts, or thereabouts, the best claimed is not less than 4, and 5 or more may be set down as generally nearer the mark, whence it follows that the theoretical efficiency of such a plant is not more than 50 per cent., and its actual efficiency 40 per cent. or less. A process is not necessarily unworkable with an efficiency of this order where the product has a value in the market only remotely related to its energy value, but it is just as well to realise that with the most recent figures determined by experiment, and checked by calculation from other experimental data totally independent in origin, more than half the electrical output of a plant for the manufacture of alkali and bleach is wasted by causes that cannot be considered altogether inevitable.

The Giffard Prize.—The Société des Ingénieurs Civils, which has been entrusted with the task of selecting a subject for the Giffard Prize Competition, has chosen the following:—The electric transmission of power, either to workshop tools, to railway or tramway engines, or to bridge, ship, dock and yard machinery, &c. The prize will be awarded in 1896 and will be worth £240.

TRAMWAY STATISTICS AND FINANCE.

The growth of "municipalisation," coupled with the recent decision in the Court of Queen's Bench concerning the valuation of tramway property when acquired by a Local Authority, and the possible adoption of electric traction, combine to add interest and importance to the Board of Trade statistics relating to tramways, and the following figures, based on some recently published in the *Glasgow Herald*, serve to show how the tramway has developed in the United Kingdom:—

Mileage and Financial Summary for United Kingdom.

——	No. of under-takings.	Length open for traffic.	Capital expenditure on lines and works open for traffic.	Total expenditure on capital account.
		m. ch.	£	£
‡ Tramways belonging to Local authorities	35	274 27	2,307,003*	3,105,636*
Tramways belonging to other than Local Authorities..	118	686 45	8,494,149†	10,998,516†
Total U. K.	153	960 72	10,801,152	14,104,152

* These figures include the amounts expended by lessees on buildings and equipment for working the line.

† These figures include cost of buildings and equipment in respect of the lines of Local Authorities worked in conjunction with other lines.

‡ Tramways belonging to, are not necessarily worked by, Local Authorities.

From these figures it will be seen that the average total capital expenditure per mile of line open for traffic is close on £14,700. In the case of the 274 miles of line constructed by Local Authorities this figure averages £11,335, and for the 686 miles of Companies' lines £16,032.

The distribution of total capital expenditure over the three parts of the United Kingdom up to June 30, 1893, is: England, £11,418,828; Scotland, £1,399,355; Ireland, £1,285,969. The total capital expenditure during a term of years thus appears, for the whole United Kingdom:—

Total Capital Expenditure, 1878—1893.

1878	£4,207,350	1891	£14,162,650
1882	8,261,815	1892	13,870,234
1886	12,573,041	1893	14,194,152
1890	13,786,762		

The greatest development, it will be observed, was made between 1882 and 1886. The figures relating to more recent years have been considerably affected by rearrangements of capital, the transfer of old undertakings to new companies with reduced capital, and by defective returns. Passing now from capital we invite attention to the following

Details of Rolling Stock and Passenger Traffic.

—	England and Wales.	Scotland.	Ireland.
Length of lines, miles open for traffic	761	86	113
Number of horses	23,653	4,356	2,216
Number of locomotives	522	20	21
Number of cars	3,327	429	342
Number of passengers carried in year ended June 30, 1893..	476,928,832	82,095,160	39,265,517

The development of the passenger traffic which has now attained a grand total of nearly 600,000,000 per annum, is very remarkable, and it is interesting to note how this stupendous figure has been reached. The following shows the total number of passengers carried in the United Kingdom in the same years as selected for comparisons of capital:—

Year.	Total passengers carried.	Year.	Total passengers carried.
1878	146,001,223	1891	565,621,478
1882	257,760,060	1892	581,678,546
1886	384,157,524	1893	598,289,509
1890	526,369,328		

At what cost has this enormous traffic been carried? What have the public paid for it? And what have the companies received from it? The following tables will show this at a glance:—

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1853.	England and Wales.	Scotland.	Ireland.
Gross receipts	£2,904,026	£444,438	£257,640
Working expenses...	2,298,573	347,482	191,391
Net receipts	605,453	96,956	66,248

—	Gross receipts.	Working expenses.	Net receipts.
1878	£1,145,165	£868,316	£230,956
1882	1,970,350	1,556,793	414,557
1886	2,630,338	2,021,556	608,782
1890	3,214,743	2,402,800	811,943
1891	3,429,686	2,630,929	79?,757
1892	3,531,431	2,853,3?6	678,075
1893	3,606,095	2,837,446	768,649

On a total capital expenditure of £14,194,152 the net receipts for 1893 amount to a trifle over 5½ per cent., without, however, allowing for depreciation of ways, plant, motors, &c. Thus the tramway business is by no means a mine of wealth; and there are several instances in which the receipts only equal the expenditure or leave an actual loss. It is also of interest to note the remarkable difference in *net* earning power of a mile of tramway when laid in Scotland (£1,127), in England (£795), or in Ireland (£586).

At the date of the Board of Trade returns only three Local Authorities or Corporations were working their tramways under special Parliamentary authority. These Corporations were Blackpool, Huddersfield, and Plymouth.

The Blackpool Tramways have been worked by the Local Authority since September 19, 1892, and the returns cover the period between that date and June 30, 1893. The capital expended is £28,964, of which £21,976 has been laid out on lines, works, and buildings, £2,619 on engines, £1,691 on cars, £686 on Parliamentary expenses, and £1,992 on miscellaneous expenses. The total length of line open for traffic is two miles, the gauge is 4ft. 8½ins., the use of mechanical power is authorised, and the following are the working results.

Blackpool Corporation Tramways.

Gross receipts—

From passengers	£4,638	
From parcels and mails	3	
From other sources	214	
		£4,855
Working expenditure—		
Maintenance of way and works	704	
Locomotive power	456	
Repairs and renewals of engines	598	
Ditto of cars	215	
Traffic expenses	872	
Management	60	
Rent	33	
Rates and taxes	412	
Other expenses	124	
		3,474
Net receipts		£1,381
Number of passengers carried	665,112	
Number of miles run by cars	95,718	
Number of cars	10	

The Huddersfield tramways have for some years been worked by the Corporation. The length of line open for traffic is 18½ miles, of which only one mile is double line. The gauge is 4ft. 8½in. The capital expenditure has been £133,625. The use of mechanical power is authorised, and the following are the working results for the year ended June 30th last:—

Gross receipts	£24,229
Working expenses	£19,279
Net receipts	£4,950
Number of passengers carried	3,732,320
Number of miles run by cars	371,·97
Number of locomotive engines	24
Number of cars	22

The net receipts, it will be seen, are equal to about 3¾ per cent. on the expended capital, and are at the very moderate rate of £275 per mile. The fares are not stated.

The Plymouth tramways have been worked by the Corporation for only a short time, and not much instruction can be gained from the figures. It would appear that the receipts have just covered the expenditure, so far as the work has gone.

We conclude with a table giving some statistics relating to four large leading tramway concerns:—

Statistics of the Birmingham, Leeds, Edinburgh, and Glasgow Tramways.

Company.	Miles of line open.	Motive power.	Capital Expenditure.	Ditto per mile.	Gross receipts.	Net receipts.	Ditto per mile.	% Net receipts / Capital expd.	Car miles.	Passengers carried.
			£	£	£					
Birmingham	25	Electricity, Steam, Cable, Horses	...	...	154,684	37,715	1,508	...	2,655,802	26,277,089
Leeds	14	Steam, Horses	200,222	14,301	44,691	4,623	330	2⅓	875,437	18,282,304
Edinburgh	18½	Cable, Horses	377,629	20,412	204,608	28,046	1,516	7⅔	1,584,031	15,425,666
Glasgow	30¼	Horses	489,201*	15,180	260,866	45,325	1,498	9⅓	4,702,089	51,506,451

* Of this sum £390,666 has been expended by the Glasgow Corporation itself, including an item of £52,247 on legal and Parliamentary expenses.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, February 9th.

Physical Society.

5 p.m. Annual General Meeting. The following Paper will be read: "The Viscosity of Liquids," by O. G. Jones.

Northern Society of Electrical Engineers.

8 p.m. Ordinary Meeting at the Palatine Hotel, Manchester. The following Paper will be read: "Blackpool Electricity Works," by J. Hesketh.

Junior Engineering Society.

8 p.m. Meeting at the Westminster Palace Hotel. Paper to be read and discussed: "The Construction and Working of Electro-motors," by A. H. Dykes.

Royal Institution.

9 p.m. Evening Discourse on "Fortuitous Variation in Animals," by Prof. W. F. R. Weldon, F.R.S.

SATURDAY, February 10th.

Royal Institution.

3 p.m. Afternoon Lecture on "Light," with special reference to the Optical Discoveries of Newton, by the Rt. Hon. Lord Rayleigh, F.R.S.

MONDAY, February 12th.

Society of Engineers.

7:30 p.m. Ordinary Meeting at the Town Hall, Westminster. Distribution of Premiums, by Mr. W. A. McIntosh Valon, Past President, and Inaugural Address by Mr. G. A. Goodwin, President for the year 1894.

Society of Arts.

8 p.m. Cantor Lecture: "The Detection and Measurement of Inflammable Gas and Vapour in the Air." By Frank Clowes, D.Sc.

TUESDAY, February 13th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. Paper to be further discussed: "The Transport of Petroleum in Bulk," by Boverton Redwood.

WEDNESDAY, February 14th.

Society of Arts.

8 p.m. Ordinary Meeting. "The St. Pancras Electric Light Installation," by Prof. Henry Robinson, M.Inst.C.E.

FRIDAY, February 16th.

Royal Institution.

9 p.m. Evening Discourse: "Bacon's Key to Nature," by Prof. Nichol, M.A.

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The Electrician.

(The Oldest Electrical Journal, 1861—1878.)

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THE MISCALCULATION OF MAINS.

When engineering practice is found to differ in two countries, we must assume that the conditions are unlike, or that one is enjoying a higher degree of development than the other. A case in point is the elaborate calculation of conductors for electrical supply. In Germany this has received the careful attention of several mathematicians, and the art of solving the problem has arrived at a high degree of perfection. To many engineers who are actually engaged in proportioning the mains for new or for existing systems of supply, these niceties of calculation appear somewhat superfluous. The diagrams and calculations which Prof. FORBES has more than once described, serve to elucidate certain abstract principles rather than to guide engineers in the choice of section for any particular service main, or even in the selection of a feeding point. The whole question turns on the data upon which such calculations are to be based. We are informed that it is recognised by German engineers that it is impossible to predetermine the demand, but that by comparison between the character of the locality and the existing distribution of gas lights, they arrive at a scheme which is considered worthy of some tedious research. Promoters of electric supply undertakings are well aware of the difference between the results of a preliminary canvass, the

original system of mains, and the network that is actually employed after the experience of a year or two. We can well imagine that in a socialists' Utopia, where each man enjoyed a fixed "living" income and lived rent free, a supply network might be pre-determined. The problem, indeed, would be easy, for everyone would demand electric supply as a "right." The design and arrangement of feeders is much more calculable; but even here the necessity for guesses as to the probable demand renders any exact statement of the problem impossible; after supply has commenced, the demand is often found to grow in unexpected districts and to languish in streets of which great things had been expected.

Recognising, of course, that the conditions of electric supply in this country differ from those of Germany, we are not prepared to admit that English engineers exhibit ignorance or carelessness in failing to pay much attention to these calculations. They all know Lord KELVIN's law well enough, and most of them are acquainted with the further considerations of Profs. AYRTON and PERRY. Shrewd judgment and experience rather than algebra are required in determining the section of a feeder, for the mere C^2R losses present but a trifling difficulty compared with the forecasting of the probable future load, and the excess of copper which must be laid to-day in order to meet the conditions which may be expected a year or two hence. The study of existing gas supply cannot of course be ignored, but who can judge of the character of a locality? Unless it can be expressed as a single coefficient it is of little use. Will future treatises on electric supply give us the proper constants for Piccadilly, London, and for Piccadilly, Manchester, and enable us to compare Belgrave-square and the Broomielaw? Nice calculation of mains is no doubt a pleasant pastime for mathematicians; even the resistance of a stranded conductor presents several agreeable and perfectly useless problems, useless because it is impossible to assign values to the constants. But besides the considerations which depend on the mere geometry of conductors, such as the selection of the best site for a supply station by calculating the centre of gravity of all the proposed lamps, and the Kirchhoff relations of the currents in the supply network, there is no end to the complications when losses and their cost come to be examined. There is reason to believe that the scant literature upon the subject in this country is partly due to the existence of Edison's feeder patent. Although it is generally supposed that no claims will be enforced, more than one engineer declines at present to call certain conductors "feeders"; and men who have been practically engaged in designing systems of mains are not likely to be very communicative about their work until after September 24, 1894.

Losses in feeders must be separated from losses in networks. The economic examination of losses in networks ought to be neglected for the simple reason that these ought to be negligible. The requirements of the Board of Trade are satisfied "so long as the pressure does not at any point vary more than 3 per cent. from the corresponding pressure in the case of a general supply at low pressure, or 2 per cent. in the case of a general supply at high pressure, unless changes in pressure recur so frequently as to cause unsteadiness in the supply." Well-managed companies succeed, for their own credit, in keeping well within these limits; and if two feeding points were kept at 103 volts, and the midway customer got only 97 volts, these six lost volts would be a misfortune. It would not be proper to calculate the lost watts, and debit the cost of the energy wasted per annum against the interest on the supply conductors. Let the loss be reduced, if the company can afford it, either by shifting a feeding point or by drawing in more copper. This is where common sense comes in. When once an ardent mathematician gets entangled in network-problems, he will not stop until he has debited a proportion of the interest and depreciation of the chimney stack to the watts wasted in the station ammeter.

The steady growth of electric supply brings into prominence questions of adaptation of an existing system of conductors to a gradually changing load. The strength and steadiness of this growth in London is clearly shown in the diagram which will be found in another column. The changing or shifting of the load is felt chiefly in the extensions of the mains in new streets. If the load merely increased in streets already supplied, the loss on the feeders would rise until it became necessary to draw in more copper, and the loss on the network would rise until the Board of Trade limit was reached, unless the supply company for their own reputation increased the conductors. A simple case of that kind might be calculated in great detail, but the addition of new streets, being those streets in which business is promised, or, on rare occasions, streets which lie in the route to new business, altogether upsets previous calculations; and though calculation might show whether a new feeder, a branch feeder, or the shifting of an old feeder would be the best course to adopt, business considerations would generally carry more weight with the engineer than mathematics, and as the chances of business are beyond the powers even of ellipsoidal harmonics, mathematics must give way to sound common sense.

REVIEWS.

British Locomotives: their History, Construction, and Modern Development. By C. J. BOWEN-COOKE. (London: Whittaker and Co.)

This attractive work ought to meet with a welcome from everyone interested in the railway locomotive. It is mainly written for the outside public, but will, it is clear, be useful to the engineering student and to railway men, be they on the locomotive staff, drivers, or firemen. From the earliest road carriage down to the "Empress Queen," exhibited at Chicago, the author gives the history of the locomotive; every part is clearly and concisely described, and even the duties of drivers and firemen are set out in a readable form. For the professional reader many of the chapters on construction, and particularly the ones on valve motion and brakes, will prove interesting. There is perhaps a little too much of the London and North-Western and Mr. Webb in the book, and too little about the North-Eastern compounds, and we should have liked a chapter devoted to the great work done by private engineering firms, but one cannot have everything, and it must be confessed that Mr. Bowen-Cooke has made a good book. The work is well and plentifully illustrated from sketches and drawings by Messrs. C. E. Jones and R. A. McLellan, and reproductions from official drawings and photographs of engines built by the leading lines. Many of the twenty odd drawings of the earliest engines will raise smiles when contrasted with pictures of the latest types.

Helical Gears. By A FOREMAN PATTERN-MAKER. (London: Whittaker and Co.)

The pattern making and moulding of helical gears is discussed in this volume, with a rather inadequate introduction on their design. A couple of pages only are devoted to the question of the strength of helical teeth, but no definite information is given. The limits of accuracy which the author expects do not seem to promise success with helical gear. It is generally admitted that unless of first-rate work, little or no advantage is offered over ordinary gear. Mr. Longridge's feathered wheel, to accommodate side thrust, is alluded to; but the importance of high accuracy to minimise end thrust is not insisted on with sufficient emphasis.

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Modern Shafting and Gearing. By M. P. Bale. (London: W. Rider and Son. 1893.)

We have here a little book giving, in a condensed form, the author's recommendations for the design and management of shafting and gearing. The writer is too sparing of his materials—his engineering materials, we mean—he does not use a sufficiently high factor of safe working. The table of shafting puts too great a load on the shaft; and the practice, if followed, would lead to vibration and unsteady running, with all their consequent evils. The same remark applies to many of the writer's other rules for gearing design.

The Electric Transformation of Power. By Philip Atkinson, A.M., Ph.D. (London: Crosby Lockwood and Son; and New York: D. Van Nostrand Company. 1894.)

Treating the subject mainly from an American point of view, this work is a short and descriptive account of the application of the electric motor to mechanical operations. The introductory chapter is on "Definitions," and makes a by no means happy commencement. We are told, for example, that "electric potential is that condition in bodies which represents the relative electric energy manifested by them. When the quantity of this energy differs in bodies associated together, those in which it is greater are said to have positive potential with respect to those in which it is less, and the latter to have negative potential with respect to the former; but when it is equal in all, they are said to have zero potential with respect to each other." With far less cudgelling of the reader's brains, and far less printer's ink, it would have been easy to give the correct version of the definition of potential.

Chapter II. is on the "Principles of the Electric Motor," and is well written; but it contains nothing new either in the subject-matter or its treatment. Chapter III. describes a number of "Stationary Motors," mostly of American design; and the following chapter discusses their application to various purposes, the special details necessary for adaptation being particularly described. The chapter on "Electric Railways and Railway Motors" covers the ground of the various systems in a brief, descriptive style, but the treatment is too condensed to be of much real value. The American trolley system receives the largest share of attention, but some paragraphs at the end are devoted to conduits and battery cars. A short chapter on "Central Stations" concludes the work, which is copiously illustrated throughout.

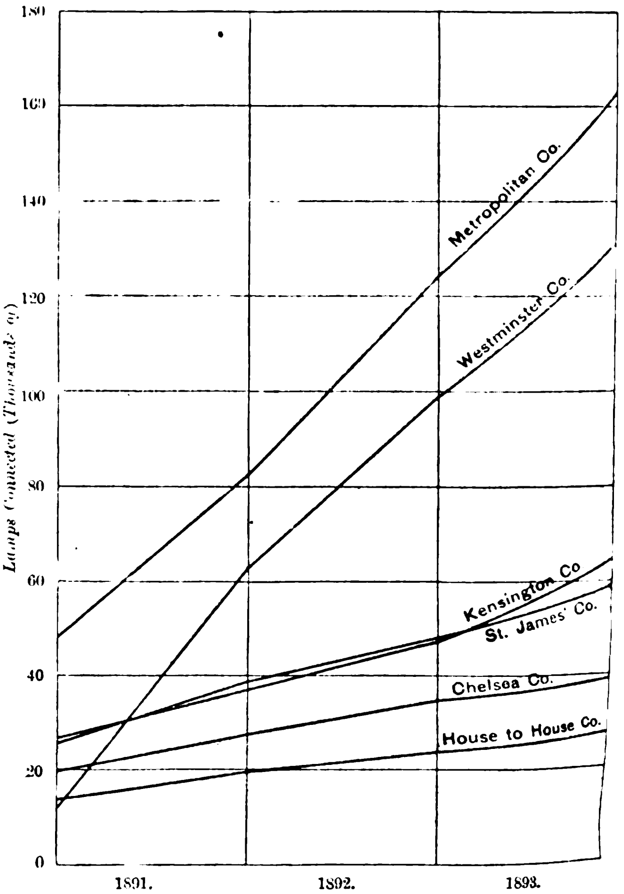
Continuous-Current Dynamos and Motors. By F. P. Cox, B.S. (New York: The W. J. Johnston Company. 1893.)

This work is offered as an elementary treatise for students. The electrical parts are treated on the lines usual in elementary books on such subjects, and call for no special comment. But we do not quite see the necessity for sandwiching two chapters on "Indicator Diagrams" and "Steam Engine Calculations" between the electrical sections. Even in a work for practical dynamo users such a plan might be deemed irrelevant, but elementary students at least may expect to be supplied with the various sections of their studies in separate suitable treatises. Moreover, although it is quite right to save these beginners from the obstacles presented by advanced mathematics, it is not just to offer them a popular version in place of exact science. The statements on page 17, to cite one of numerous cases, are misleading for this very reason: "When a wire sweeps across a magnetic field the lines of force, being elastic, tend to wrap themselves around the wire. But when these lines are created around a wire there will be a current of electricity in the wire. Therefore . . . . . a difference of potential or pressure is created between the ends of the wire." The principal mistake in this sentence is the statement that a current would be induced, whereas only an electromotive force might be induced. Another mistake lies in the inference that *because* there is a current, therefore there is a difference of potential; for the former might exist without the latter, or the latter without the former. Still another error arises in the subsequent sentence, in which, by means of the ubiquitous hydraulic analogy, it is attempted to show that the difference of potential is a fall in the direction of the current, whereas, in a wire in which a current is being induced, the difference of potentials, if any, is opposite to the induced current.

We select this example of the author's treatment of his subject, not because we wish to be hard on him for any single blemish (for we do not), but because we believe this sentence we have chosen to be typical of the general treatment throughout the book. The matter selected for this little work is well chosen, and it is dealt with in an interesting and simple manner, which is well adapted to the needs of an amateur who makes no pretence to serious study of the subject.

THE INCREASE OF ELECTRIC LIGHTING IN LONDON.

It has been suggested that the falling off of the revenue of the St. James' and Pall Mall Electric Supply Company during the past year was due to the "saturation" of their district. There are two chief quantities which may tend to a saturation or, as it is called by mathematicians, an approach to an asymptotic

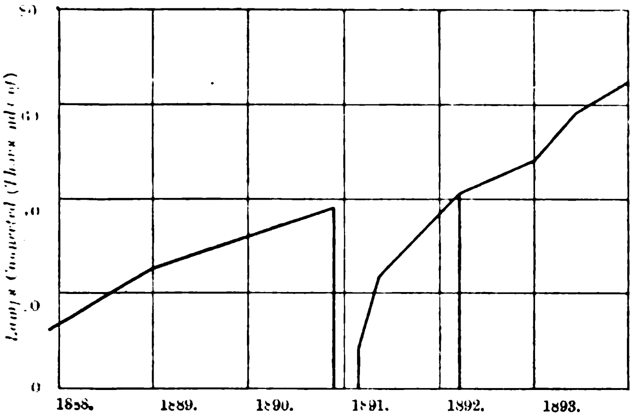


limit. The one is the total number of lamps fixed, the other the revenue. The latter we will leave for the present, but hope to return to it when the 1893 accounts of the London companies are before us. The growth of the total number of lamps can be obtained from the tables of statistics published in our New Years' numbers, and from the reports of the companies. Discarding events prior to 1891 and the doings of companies who have only begun work since that date, the diagram, Fig. 1, shows very clearly the steady and very satisfactory increase of business of six companies.

The average rate of increase seems to be about ten thousand lamps per annum for each Company, if the Westminster and Metropolitan Companies be excluded. It is to be noticed that these two great concerns have three and four supply stations respectively, and that the steepness of the lines is roughly three and four times that of the average of the other companies. In other words, if separate stations had been taken, nearly all the lines would have been closely similar. A

slight increase of steepness in the Kensington and Knightsbridge line is observable, and a slight decrease in that of the Chelsea Company. The latter does not indicate any approach to saturation, for these features are explained by the transfer of part of the district and of the business of the one company to the other. Had this transfer not been made, the lines would have been almost exactly stra ght. A mathematically-minded man might say that the tangent of one of these lines to the horizontal axis is a function of the product of the richness of the district into its area, and he would proceed : let θ be the angle and any instant, and ρ the richness of the area at that instant, &c., &c. We do not propose to follow him nor to pretend to construct a formula by which the point of saturation and the date at which it may be expected can be calculated. Suffice it to say that not in the poorest nor in the most prosperous district is there as yet any sign of that drooping towards the horizontal, which is, of course, some day inevitable.

The London Electric Supply Company has a diagram to itself, not only because it would somewhat confuse the others if plotted with them, but because the historical tale it tells deserves it. Fig. 2 shows the lamp connections of the London



Company as found by careful examination of back numbers of *The Electrician*. We have no information of the Grosvenor Gallery business prior to Christmas, 1887. The line begins here, and rises briskly during 1888, but the plant was becoming overloaded, and during 1890, while the dynamos were being removed to Deptford, fresh business had to be refused. On November 15, 1890, the Grosvenor Gallery substation was burned, and no sooner was another set of transformers hurriedly repaired and connected than they broke down, and the supply was stopped altogether. On February 16, 1891, it was resumed, and 9,000 lights were at once connected. Additions went on well until March 10, 1892, when owing to a fire in one of the South-Eastern Railway Company's arches, all four of the Ferranti mains were injured. The supply was completely stopped for only a few hours, but the result, as shown by our curve, was a distinct shaking of confidence in the supply. Since the beginning of last year, however, business has been excellent, and the rate of increase during the end of 1891 has been regained. Curves showing the increase of lamps month by month or week by week would be of interest. We have such a curve before us, for one company and for one year. It has a gentle curvature, flattening in the spring and becoming steeper in the autumn. To ask the secretaries of companies to send us data for a set of such curves would probably be to trespass too much on their time.

TELEGRAPHIC COMMUNICATION BETWEEN ENGLAND AND INDIA, ITS PRESENT CONDITION AND FUTURE DEVELOPMENT.*

BY E. O. WALKER, C.I.E.

My plea for bringing this Paper before you lies in the fact that I have spent many years in the telegraph service of India, that I have been witness of the gradual growth of its traffic, and of the careful building up of its telegraphic communications with other countries, and that in dealing with telegrams in such important places as Bombay, Calcutta, and Madras, I have been brought into contact with the commercial publics which have the larger interests in foreign telegraphs, and to whom the cost, as well as the accuracy, rapidity, and regularity of dispatch of messages are so important ; that I have been privileged to know, perhaps better than those outside the telegraph service of the State, what can and should be done to meet the wants of the public in these respects. The time seems to have arrived when it may be useful to review what has been done in the past towards bringing India and the United Kingdom into closer community of interests by the telegraph, and to offer some suggestions which may lead to the telegraph becoming a more important factor in trade, by making its use cheap.

The telegraph soon made its influence felt among commercial communities. It was being found that it made trade brisk, by aiding a quick interchange of commodities ; and profitable, by preventing the accumulation of large stocks through the early information it afforded of the state of the large markets ; and rendered trade safe, by strengthening the control by Government of the foreign affairs of the State. It was beginning to be realised that the material welfare of a country would, therefore, be largely dependent in the future upon its connection by telegraph with the foreign territories with which it traded.

In 1854, Mr. Gishorm* put forward a project for a cable from the Dardanelles to Alexandria, as a first step towards establishing communication with India. A concession was obtained from the Porte, but the scheme fell through. At this time, although early in the history of submarine telegraphs, some were found to favour the cable route exclusively ; while others placed their faith entirely in overhead wires, save in localities where frequent damage to such lines was to be apprehended. Events have proved that India has benefited by this difference of opinion, since it has secured to her two good working routes. In 1855, advocates of the overland telegraph formed the European and Indian Junction Telegraph Company, to erect telegraphs from Alexandretta, on the coast of Palestine, to Korna, at the junction of the Euphrates and Tigris ; but Turkey eventually refused the desired concession. It must be confessed that the fears as to the stability of our overland communication were, in some respects, verified, but, fortunately, did not at the time so far prevail as to frustrate the scheme. All this would be far from encouraging to those who would rely upon overhead wires, did we not know that by firm control of the people through whose territories they pass, by incessant attention to the strengthening of the lines, and by the elimination of weak points, interruptions such as I have described have been rendered rare, and further that, owing to land lines being cheap, we can afford to have two or three alternative ones with plenty of wires, for the same cost as our submarine cable.

An influential section of the commercial community favoured a submarine telegraph to India, and in 1857 the Red Sea Telegraph Company was formed,† with a guarantee from Government, to lay a cable from Suez to Kurachi *viâ* Aden, in connection with a direct cable from Malta to Alexandria, projected by the Anglo-Mediterranean Telegraph Company. It was true that the sea route to India would require 5,000 miles of cable, but the supporters of the scheme thought that the cable once laid would be lasting, that the liability to interruption in war and times of political disturbance would be much less than by the overland route by Turkey or Persia. For an enemy to grapple and raise cables for the purpose of cutting them would require not only a knowledge of their exact positions, and a ship specially fitted, but above all, would take up too much time. In 1859-60 Messrs. Newall laid the Red Sea cable at a cost of £800,000. The bold scheme, unfortunately, ended in total failure ; the cable was never worked throughout, and Government became involved in heavy pecuniary obligations. The manufacture and laying of cables were not so well understood then as was the case a few years later. The cables‡ were not, as was subsequently found to be necessary, tested for insulation under water from the time of manufacture until paid out from the ship, and, in the present case, are said to have been laid too taut, so that they were suspended across the inequalities in the ocean bottom, instead of being slack enough, as they should be, to lie evenly with the irregular contour. Then, again, the route had not been, as is invariably done now, carefully surveyed, and the consequence was that damage was done by the cable chafing on the coral reefs. Further, the Red Sea cable was covered externally with light wire guards only, unprotected by bituminous compound. These wires, which should give strength to the cable, rusted so quickly in the intensely salt water, that in a short time the cable could not be lifted for repairs. In the idea, probably, that signalling would be accelerated by so doing, the cable was divided into short sections, touching at Cassiri and Souakin in the Red Sea, and at Hellania and Muscat on the east

* Abstract of a Paper read yesterday before the Indian Section of the Society of Arts.

* "Telegraph and Travel," by Sir F. Goldsmid.

† "The Telegraph to India," by Sir C. Bright.

‡ Paper read before the Statistical Society by Sir James Anderson, 1872.

§ "The Telegraph to India," by Sir E. Bright.

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coast of Arabia. The course taken lay through much shoal water, notoriously bad for a cable. The failure of this cable and of the first Atlantic one, which worked for only one month, which involved a loss of £450,000, greatly discouraged further enterprise. Sir James Anderson summarised the causes which led, in the early days of submarine telegraphs, to the failure of cables, as follows :—(1) Inexperience of insulating material ; (2) impurity of the copper conductor ; (3) the mechanical difficulty, in keeping the copper wire in the centre of the insulating medium ; (4) laying cables from sailing ships in tow of steamers. He says that experience disproved also the notion that there was little motion in the sea at a depth of 100 fathoms. On the contrary, the Falmouth cable was moved, chafed, and destroyed at a depth of 500 fathoms ; and the Channel Islands' cable suffered in the same way. He mentions, likewise, the injuries caused to gutta-percha by the teredo borer even at a depth of 1,200 fathoms, an enemy which in more recent years has become well known, and to guard against which brass or copper tape is spirally wound round the core of cable.

To return to the overland route, the line from Scutari to Baghdad had been begun in 1859, under the direction of Col. Biddulph and Lieut. Houldsworth, and was carried on to Baghdad by Messrs. Carthew and McCallum. There was some doubt as to whether a line could safely be carried from Baghdad to Basra, owing to the troublesome character of the tribes in that locality, and it was not until October, 1863, that Turkey agreed to complete the line so as to meet the Indian Government cable projected from Bushahr to Basra. Meantime, in 1861, to overcome this difficulty, the Shah of Persia was approached by the Indian Government with a proposal to construct overhead telegraph lines from Bashahr to Khanikui, on the Turkish frontier, to meet a Turkish line from Baghdad. Persia did not at first welcome these negotiations, nor did Turkey desire to be united to a Persian telegraph system. Col. Patrick Stewart failed—early in 1862—to induce Persia to come to terms, but, at the close of that year, the Shah determined to erect the proposed line at the expense of Persia. Sir F. Goldsmid graphically describes in his book, "Telegraph and Travel," the difficulties met with by the working parties. However, persistent effort at length overcame such difficulties, and the line was completed in October, 1864. Mr. H. I. Walton, in constructing the land lines from Kurachi to Guadur, at the same period, had no easy task. For years they worked badly, owing to the insulators becoming coated with salt and fine dust, a common occurrence with coast lines in the tropics, but the insulators now used, which have a rim containing oil, appears to have improved communication.

Colonel Patrick Stewart laid the first Persian Gulf cable, from Guadur to Bushahr and Fao, in November, 1863, and it was completed to Kurachi in 1864. This was a gutta-percha cable* made by Henleys, 1,200 knots in length, and cost £411,751. The present electrician of the Indo-European Department considers that it was one of the best ever made. In connection with the work the name of Mr. F. C. Webb, of the staff of Messrs. Bright and Webb, who was electrician, should be mentioned. This cable, together with the Hooper's india-rubber cable, laid in 1869 from Bushahr to Jask, has had many accidents. Friction on the rocks, and consequent chafing, decay of the iron guards, the attacks of the teredo, ships' anchors in shallow water, and fish bites on the core, where the guards had rusted off, have given much trouble. Once an earthquake buried part of the cable ; on another occasion a swordfish attacked and pierced the cable ; and one instance was found where a whale got its tail entangled in it and produced a loop or twist. Up to 1892, the capital outlay by the Indian Government on the land lines to Jask and the Gulf cables, with the signal offices, amounted to £1,151,507. That Government had performed its share in establishing communication with Europe by April, 1864 ; but owing to delay in uniting Baghdad with Basra in Turkish territory, communication between Kurachi and London was not established until February, 1865, when a message took eight and a-half hours in transit. Sir F. Goldsmid describes as wretched the service on the European lines, and for five years, by conferences and negotiations with the administrations concerned, endeavours were made to supply wants, to remedy failings, and to remove obstacles. Even in 1872 Col. Champain, the Director-in-Chief of the Indo-European Department, describes the "Turkish route as hopelessly behind the requirements of the age." Messages to and from India had occupied 24 and even 48 hours in transit. The multiplicity† of routes to Constantinople, *viâ* Paris, Berlin, and Frankfort, led to confusion, and to the order of telegrams being inverted. There were three re-transmissions in Turkish territory, effected often by ignorant and over-worked Greek and Armenian clerks, and three more between Fao and Kurachi, and those who are intimate with telegraphy will readily appreciate the liability to loss and error that these re-transmissions would involve. The line through Russia *viâ* Tiflis to Teheran, by which Anglo-Indian messages could travel, was also wretchedly organised (1865), Russia being unwilling to spend money on it, and the clerks at the offices *en route* being ignorant of English.

* "History of the Persian Gulf Cables," by Passman.

† "Existing and Projected Telegraph Routes to India," by Sir J. Andrew.

In 1868, a telegraph congress was held at Vienna to fix tariffs and to arrange with the different powers concerned to regulate the Indo-European service across the continent, but even after settling upon eight Continental routes, five for the Indo-Ottoman and three for the Russo-Persian lines, the service to and from the East still remained indifferent. In January, 1870, the delay by the Indo-European route * was over 24 hours, the difficulty of keeping the lines in order being described as worse than on the Turkish route. Between Teheran and Bashahr the line is said to have been chronically interrupted.

With the pioneer systems of international telegraphs, and especially those in the East, it was easy to find fault. No doubt the same experiences gained then will be reaped by those who have to carry out the Trans-Continental African telegraph, and any similar scheme in primitive and barbarous countries. But the commercial world, having tasted—by means of the pioneer lines—of the advantages of the telegraph to India, now bestirred itself. It was felt that an irregular service was worse than none at all. The success of the Atlantic cables of 1865 and 1866 had proved that an ocean cable, when carefully treated, could be relied upon as a permanent and regular means of communication, and showed, what was of immense importance in stimulating telegraph enterprise subsequently, that a heavy cable could be picked up from the ocean bottom and be repaired. The Telegraph Construction and Maintenance Company applied to Government for a guarantee towards the expenses of a cable from Suez to Bombay, 3,654 knots in length, estimated to cost, with stations and instruments, £1,100,000. It was pointed out that the necessity for taking lines through desolate countries and among semi-barbarous races would be avoided, and that, by the experience gained in the case of the Atlantic and other cables, the depth of the ocean was shown to be the best guarantee for the permanence and security of the wire. As to the objection then raised, that part of the proposed circuit would lie in Italy and France, it was explained that the traffic was guarded by conventions, and the line in Italy worked by English clerks. The cable from Alexandria to Malta was already laid, and the Company was even prepared to lay one from Falmouth to Malta to obviate the possibility of disturbance. But Lord Cranbourne, then Secretary of State for India, rejected the proposal that the Indian revenues should be applied to the guarantee, and pointed out that a large amount had been spent on the Persian Gulf cables to co-operate with other countries in completing the land line to India. Again, in July, 1867, the Anglo-Indian Telegraph Company was formed for a similar purpose, with Captain Sherard Osborne as Managing Director. In April, 1868, the City of London again renewed the attack. A memorial, signed by the Lord Mayor and many of the merchants of London, advocating the cable, was presented to the Secretary of State. No satisfactory reply was received, the recollection of the obligations assumed for the Red Sea cables being then too lively.

There were those who foresaw that in times of peace, at all events, the overhead lines, if well administered, would go far to meet commercial needs, and, thanks to an eminent firm of telegraph engineers and manufacturers, Messrs. Siemens and Halske, of Berlin and St. Petersburgh, a concession for a term of 25 years was obtained from the Russian, Prussian, and Persian Governments, for the purpose of uniting Teheran and the lines of the Government of India with those of North Germany, which Prussia agreed to erect. England and the Continent would thus work direct, through a specially-reserved circuit, to India. The system was to be under English management. Out of this arrangement grew the Indo-European Telegraph Company, formed in April, 1868, with a capital of £450,000, which has, now that the difficulties of the initial work have been overcome, provided an excellent service to and from India, *viâ* Lowestoft, Emden, Berlin, Odessa, Kurtch, and Teheran, in conjunction with the Indo-European Government department, which controls the circuits from Kurachi to Teheran. The improvements in the latter are largely due to the efforts of Mr. Ffinch, for the last 18 years Deputy-Director of the Persian Gulf section ; of Major Wells, R.E., occupying a similar position in Persia; and of their efficient staffs. The overland lines have in the past suffered both from wilful damage and from snowstorms, and, as I have mentioned above, the Persian Gulf cables give no rest to those charged with their maintenance; but the constant vigilance of the officials of the two administrations has certainly been rewarded by the speedy and accurate service now afforded.

To those who came forward in the years 1868 and 1869 to subscribe £2,000,000 for laying cables from England to India, the gratitude of both countries is due. Had the scheme failed it is most probable that the telegraph service would still have remained

* "The Ocean Telegraph to India," by J. C. Parkinson.

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slow and irregular; but the issue being successful, the healthy stimulus of competition came into play. I believe that Sir John Pender—whose name is so well known in the cable world, and under whose able direction many of the cable systems have flourished—Sir R. Glass, Sir George Elliot, Sir Daniel Gooch, Sir James Anderson, and a few others, subscribed £400,000 of the required capital. The Falmouth, Gibraltar, and Malta Telegraph Company was formed in July, 1869; the Anglo-Mediterranean Company in May, 1868 (for a cable from Malta to Alexandria); and the British Indian Telegraph Company, for uniting Suez and Bombay, in January, 1869. The total length of the cables was 6,456 knots. The "Great Eastern" left Portland on November 6, 1869, with over 2,000 miles of cable, accompanied by three other steamers, and by March 15, 1870, Bombay was in communication by cable with England. The various companies above referred to were amalgamated in November, 1872, under the title of the Eastern Telegraph Company. Communication was successful from the outset. The marvellous skill shown in contriving appliances by which the retardation caused by electrical charge and discharge of a cable could be overcome was such, and the instruments by which feeble undulations could be recorded so delicate, that even in the year 1872 the cable from Aden to Bombay (1,818 knots) could convey messages more quickly than could a wire of less than half that length from Bombay to Madras. As an instance of the celerity with which a telegram could be received from England, I may mention that on the evening of Derby Day, 1872, when a few of us were watching for the news in the Calcutta Telegraph Office, Reuter's telegram, with the name of the winner, arrived a few minutes after the horse had passed the post. The success of the cables, financially, was at once secured; in 1872 a dividend of 6 per cent. was paid on the capital stock. The service has been rendered still more perfect since then by the duplication of the cables throughout, and by a third from Suez to Bombay, laid within the last three years.

Yet another company for carrying the telegraph to the East was formed in 1869—the Great Northern—to connect England and France with the north of Europe, China, and Japan, with a capital of £1,500,000. Its land lines cross Russia and Siberia to Vladivostock, whence a cable proceeds to Japan, and another to Amoy. This telegraph, which affords another route to India, by way of Hong Kong and Singapore, through the cables of the Eastern Extension Telegraph Company, has also been a decided financial success. In 1874, 5 per cent. was paid on the capital, and larger dividends have been earned since. At the present day there is another line through Siberia, connecting China and Russia, and one projected, which will be the shortest route from Pekin to Europe.

(To be concluded.)

NOTES OF A TRIP TO THE UNITED STATES AND TO CHICAGO, 1893.*

BY W. H. PREECE, C.B., F.R.S., PAST-PRESIDENT.

(Concluded from page 359.)

Rates.

The rates or rentals demanded from the various subscribers differ very much in the States. At Buffalo they charge a toll rate on each talk; they do not demand an annual rental; they simply demand a minimum amount of business per annum. This rate in Buffalo is 10 cents for five minutes' talk, and they have adopted a system of charging one-fifth of this rate for each extra minute beyond the five. The rate in San Francisco is a small annual rental for each installation, and 5 cents for each talk. A somewhat similar plan is in use at Milwaukee. But, with these three exceptions, the toll system has not found favour in the States, and at every other exchange an annual rental is demanded. The American Bell Telephone Company are now considering the advisability of limiting the time for talks to three minutes instead of five, of reducing the minimum toll in proportion, of making additional charges for each minute *pro rata*, and of considering a fraction of three minutes as equivalent to the whole time.

The rates vary, and are, as will have been seen, very high; but although the enterprise is in the hands of private companies, it must be noted that they have great difficulties to contend with. In a place like New York the rents and the cost of buildings is excessive. In one small exchange they pay no less than $7,000 a year rental for one floor. Taxes everywhere are enormous. Not only are they taxed by the State, but they are taxed by the municipalities. Way-leaves are excessive. In New York alone they have to pay to the Company controlling the underground conduits no less than $80,000 per annum way-leave—$8 per renter for way-leave alone. The distances, too, that they have to carry their underground system in New York, in Philadelphia, and in other places are very considerable. They have been forced by municipal action to go underground. In the face of these restrictions no comparison between rentals in New York and those paid in this country can be made. The amount of the average rental in London scarcely exceeds £15 per annum. The average amount of rental throughout the country on our Post Office system is £9. 10s., but in New York subscribers have to pay up to £50 per annum.

* Paper read before the Institution of Electrical Engineers, January 25th.

I give below, in tabular form, the rentals charged in 25 of the chief cities of the States:—

Standard Yearly Rates for Subscribers.

	Residence.				Business.			
	Metallic circuit.		Single wires.		Metallic circuit.		Single wires.	
	$	$	$	$	$	$	$	$
New York		240		150		180		100
Chicago		175		125		125		100
Philadelphia		160		120		130		100
Brooklyn		150	...			100	...	
St. Louis	...		100	120	...		60.80	100
Boston	156	160		120	110	134		96
Baltimore	120	160		78	90	160		78
Cincinnati & Covington		125		100	100			72
San Francisco	*72	90		*60	72	90		60
Cleveland		120		72		100		60
Buffalo	†	Toll	...			Toll	...	
New Orleans	...			96	...			62.50
Pittsburgh		126		84		112.50		75
Washington	120	160		100	90	160		72
Detroit	...			72	...			50
Milwaukee	‡80	90		60	70	80		50
Newark		150	...			100	...	
Minneapolis		120		72		100		60
Jersey City		150	...			100	...	
Louisville	...			72	...			60
Kansas City	...			72	...			60
Omaha	...			60	...			60
St. Paul		120		72		100		60
Providence		120		60		100		48

* Also "t ll" of 5 cents per conversation.

† Installation charge, $70 for first 500 messages.

‡ Rates cover installation and yearly business of 1,000 messages. $10 is charged for each additional 500 messages.

NOTE.—Where two rates are given in the same column against an exchange they represent different kinds of instruments furnished. In many cases single-wire rates are no longer quoted for new subscribers.

I have drawn up, with the assistance of the American Bell Telephone Company, a comparative statement showing the ratio between the subscribers and the population in twenty-four principal cities of the States. The details appear in the following tables:—

City Population compared with City Subscribers. Comparative Statement, January 1, 1893.

Twenty-four cities.	Population.	Subscribers in exchange.	Average No. of inhabitants to each exchange subscriber.
New York	1.515.301	9.066	167
Chicago	1.099.850	9.684	114
Philadelphia	1,046,964	3.620	289
Brooklyn	806.313	4 439	182
St. Louis	451.770	3.561	127
Boston	448.477	5.668*	79
Baltimore	434.439	2,116	205
Cincinnati and Covington	334.279	4.015	83
San Francisco	298,997	4.528	66
Cleveland	261.353	3.182	82
Buffalo	255.664	2,240	114
New Orleans	242.039	1.471	165
Pittsburgh	238.617	3.254	73
Washington	230.392	1.845	125
Detroit	205.876	4.287	48
Milwaukee	204.468	2.561	80
Newark	181.830	1.094	166
Minneapolis	164.738	2.053	80
Jersey City	163.003	970	166
Louisville	161.129	2,556	63
Kansas City	157.984	2,581	61
Omaha	140,452	1.738	81
St. Paul, Branch of Minneapolis	133,156	1,521	88
Providence	132,145	2,948	45

* Does not include express subscribers. With express, 72 inhabitants.

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It will be seen how very much these places vary. In Providence, for instance, with a population of 132,146, we find one subscriber to each 45 persons; while in Philadelphia there is one to every 289 only.

In 10 of the principal towns of our own country the results are as follows:—

—	Population.	Subscribers in exchange.	Average No. of inhabitants to each exchange subscriber.
London	4,263,294	6,700	636·3
Liverpool	513,790	4,500	114·1
Manchester	510,998	2,300	222·1
Glasgow	669,059	3,200	209·0
Edinburgh	264,787	900	294·2
Plymouth	85,610	300	285·3
Birmingham	483,526	1,200	402·9
Leeds	375,540	1,300	288·8
Hull	204,750	400	511·8
Newcastle	192,205	1,300	147·8

The telephone in the United States is essential to the business man, and its price is compared with that of an office boy. Labour in the States is expensive, and an office boy costs more than a telephone subscription. The present generation in America has grown up with the telephone. It has become a factor of business, and absolutely essential to the transaction of that business. Its use has passed its climax; it has reached its normal stage. There is no touting for business; business comes. Every new office must have it. The working is excellent, and they are alive to the necessity of maintaining its efficiency at the very highest point. Education is complete, not only of the staff, but of the customer. The apparatus itself is being perfected. Uniformity of practice is being introduced under the operation of the paternal control at Boston, and the influence of technical education and of technical institutions is being felt everywhere. I find a group of highly educated, clever young electricians being engaged and encouraged by the telephone companies. New blood is being introduced, and great zeal and activity is shown.

III.—The Electrical Congress.

Two Congresses were held in Chicago—the one, a general one, to which all electricians were invited; and the other, called "The Chamber of Delegates," to which nominees from the different Governments were sent. The latter was the more important of the two, but each secured considerable attention, and they were distinctly great successes. The following extract from an American technical journal very fairly summarises the results:—

"The Chicago Congress.

"The much-talked-of International Electrical Congress is now a thing of the past. Its record may be briefly summarised by saying that the attendance was good; that it was truly international: that there were just about enough papers; that some good work was done; that the social features were enjoyable; and that, while the general management left much to be desired, the Congress itself was a success—not quite as grand a success as we should like to have seen, but, nevertheless, a success. Among the Papers read were a few which created unusual interest, and some which will, doubtless, become standards of reference. The Papers and discussions were of such a character that the published volume of the proceedings will be interesting reading, and will become a book of reference. The foreign attendance was such that the Congress became truly an international one. Among the foreign countries represented England took the lead in numbers, and especially in Papers read and in the discussions. Germany and France came next. That it was an international assembly was shown by the fact that the French language was freely used in Papers and discussions, the only reason why German was not used being that educated natives of that country almost always understand and speak English. Thanks to a few energetic, experienced, and willing members and exhibitors, the social features were not entirely omitted. The social events that did take place were enjoyable, and will be long remembered by those who took part."

The Congress met on August 21st, at least 500 being present. Prof. von Helmholtz was appointed hon. president, Prof. Elisha Gray chairman. Each principal European country had a vice-president, and I had the honour of being selected to represent England. The Congress was divided into three sections:—(A.) Pure theory. (B.) Theory and practice. (C.) Pure practice. Some excellent Papers were read, and good discussions ensued. The most prominent subjects dealt with were the transmission of power to great distances, and general preference was shown for alternating current systems. The work being done at Niagara excited general interest, and some of us visited these works afterwards, with great profit and pleasure. Prof. Ayrton read a very able Paper on "The Variation of Arc Lamps," so much used in America; while much interest was created by the reading of a Paper by Prof. Silvanus Thompson on "Ocean Telephony," a possibility in the future. My Paper on "Signalling through Space" also created much interest. Perhaps the most useful result of the Congress was the bringing together of such an international mixture of electricians, making friendships, allaying jealousies, and breaking down national prejudices. Electricity is the only branch of science which has but one language, and it is now quite cosmical in its character. Congresses do infinite good in promoting friendliness among nations.

Chamber of Delegates.

The object of this meeting was really to consummate the work done by the British Association and by the Board of Trade, and to secure the official sanction of the United States Government to the units selected and adopted in England. This was done, and the report of the Chamber gives international support to the proposed legalisation of the ohm, volt, farad, ampere, watt, and joule, as defined by the Committee of the Board of Trade. There is no doubt that all European Governments will now accept these decisions.

A new unit was adopted, viz., the "henry," a unit of induction, which was sometimes called the "quadrant," as defined in Paris in 1889, and sometimes the "secohm," as proposed in England. The acceptance of the name "henry" pleased the Americans very much, for their nationality has hitherto been unrepresented among the celebrated electricians whose names have been applied to the standards of electrical measurements. Germany, Italy, France were represented by Ohm, Volta, Couloumb, and Ampere; while England absorbed no less than three, viz., Faraday, Watt, and Joule. America has now her Henry, and is satisfied.

The following is the official report of the proceedings:—

"*Resolved*,—That the several Governments represented by the delegates of this International Congress of Electricians be, and they are hereby, recommended to formally adopt as legal units of electrical measure the following:—As a unit of resistance, the *international ohm*, which is based upon the ohm equal to 10^9 units of resistance of the C.G.S. system of electro-magnetic units, and is represented by the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice 14·4521 grammes in mass, of a constant cross-sectional area, and of the length of 106·3 centimetres.

"As a unit of current, the *international ampere*, which is one-tenth of the unit of current of the C.G.S. system of electro-magnetic units, and which is represented sufficiently well for practical use by the unvarying current which, when passed through a solution of nitrate of silver in water, and in accordance with accompanying specifications, deposits silver at the rate of 0·001118 of a gramme per second.

"As a unit of electromotive force, the *international volt*, which is the electromotive force that, steadily applied to a conductor whose resistance is one international ohm, will produce a current of one international ampere, and which is represented sufficiently well for practical use by $\frac{1000}{1434}$ of the electromotive force between the poles or electrodes of the voltaic cell known as Clark's cell, at a temperature of 15°C., and prepared in the manner described in the accompanying specification.

"As a unit of quantity, the *international coulomb*, which is the quantity of electricity transferred by a current of one international ampere in one second.

"As a unit of capacity, the *international farad*, which is the capacity of a condenser charged to a potential of one international volt by one international coulomb of electricity.

"As a unit of work, the *joule*, which is equal to 10^7 units of work in the C.G.S. system, and which is represented sufficiently well for practical use by the energy expended in one second by an international ampere in an international ohm.

"As a unit of power the *watt*, which is equal to 10^7 units of power in the C.G.S. system, and which is represented sufficiently well for practical use by the work done at the rate of one joule per second.

"As the unit of induction, the *henry*, which is the induction in a circuit when the electromotive force induced in this circuit is one international volt, while the inducing current varies at the rate of one ampere per second."

The Chamber also voted that it was not wise to adopt or recommend a standard of light at the present time. An attempt was made to introduce other units, but the feeling is pretty strong that language-framing electricians must rest on their oars for a time. New ideas and new measurements must have new terms and new names, but the general public must become more accustomed to the new language already invented before proceeding to manufacture more novelties in phraseology. The new terms are even now very difficult to explain, and still more difficult to understand. Moreover, electricians themselves are not sufficiently unanimous either as to the necessity or upon the accuracy of the definitions of

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the new conditions, and therefore they can afford to wait for a final settlement for a another congress some years hence—perhaps in Paris in 1900.

IV.—The Exhibition.

Nothing grander in design or more beautiful in execution has ever been seen in this world than the group of buildings situated in Jackson Park, Chicago, and called the "World's Fair." It is a great misfortune that the world did not appreciate, nor respond to, the ambitious views of the conveners of this fair. Their conception was magnificent. Their architects, if they did not originate the plans, certainly rose to the occasion. Their builders realised their views. Every possible convenience and accommodation was provided for exhibitors, but the response was poor; and the internal management of the whole business, owing to inexperience and perhaps overweening confidence, was indifferent. The success of the undertaking hovered for some time over failure; but fine weather, patriotism, novelty, real beauty, and cheap fares at last attracted crowds, which, numbering about 200,000 a day, have converted what looked like a disaster into a well-deserved success. I have not much to say of the Exhibition as an exhibition. It was very like its predecessors. It did not attract me; for, having taken part in nearly every exhibition for the last 15 years, I am sick of exhibitions. I devoted much attention to the electricity building, and observed there several novelties, some of which I have referred to in other parts of this report.

Gray's telautograph attracted much attention. It is an improvement on Cowper's writing telegraph. It reproduces the motion of a pen, so that while you are writing in London a phantom hand seems to guide the pen and reproduce your own writing in Nottingham. You can see the pen move, dot the i's, and cross the t's. It makes corrections and erasures. It works well, but very weirdly. My writing and signature were clearly reproduced at the very first trial. But it is immature for practical trial at present. It has not reached its final stage. It is being improved every day. It is very complicated in construction, and it requires four wires to work it. The Western Union Company in Chicago have established a circuit between their head office and stores department, and are giving it a good test.

The French and German Administrations sent admirable and extensive displays of their historical and working apparatus, with a very large staff of men to attend to them; but I am pleased to say that our exhibit proved much more attractive and interesting. It was better arranged and more complete; and our one solitary assistant, Mr. J. Chapman, won golden opinions by the admirable way in which he attended to his duties, and by the excellent verbal explanations he gave of our show.

The United States of America made no historic exhibit; but the Western Union Company showed many relics and examples of Morse's early work. The American public were surprised to find how much we in England had anticipated their work. Morse's first message, "What has God wrought!" was sent only in 1844. Our history commenced in 1837. Our jubilee was celebrated in 1887. Theirs is to be celebrated this year.

An exhibit that attracted much attention was a door which opened before you as you approached it, and closed behind you as you receded from it. This was done by a small electric motor, which was set in motion when you stepped on a mat, and released when you passed through the door. It was worked with the same current that would light a glow lamp. Both on entering the harbour of New York, and on going by steamer from Chicago to the World's Fair, channels for the passage of the steamship were clearly marked out at night by glow lamps fixed on spar buoys, and lighted up in series. There was shown an electric selector of great merit and some originality. It was a plan by which any particular railway station could be selected and called, any particular signal cleared or put to danger, any office on a long circuit with several intermediate instruments selected and secured, any subscriber on a combination telephone circuit—that is, on a single circuit upon which several renters are fixed—could be called and isolated from the rest. All the great manufacturers in the United States made large exhibits of their wares. The American Bell Telephone Company, the Western Electric Manufacturing Company, the General Electric Company, the Westinghouse Company, the Standard Electric Company, had splendid shows but, few novelties. Their novelties have already been referred to, either under electric lighting or electric railways. Electric lifts were on exhibition, and in use. They worked very well indeed, and are rapidly coming into general use in the States. The new Postal Telegraph building in New York is being fitted with several of these lifts, which are going to be worked very quickly indeed (600ft. a minute). They are being installed by the Sprague Company. Electric welding was shown in full operation, and attracted much attention.

Power was transmitted all over the place by currents, and whole exhibits were shown in motion by means of electric motors. Along the machinery hall, 1,400ft. in length, an electric crane, 75ft. span, travelled, and formed an admirable point of observation for those who were allowed to travel on it. It was used in the preparation of the Exhibition to lift and fix all the machinery. It lifts and moves 40 tons. It is worked by five motors. Its weight is 58 tons, and its speed was excellent.

There were large exhibits of every class of cable manufactured in the States—Waring, okonite, kerite, Patterson, dry-core, &c.; and Felten and Guilleaume had in the German section a fine show of their own make. Sections of streets were shown, with pavement, manhole, conduits, joints, and everything complete.

England is the home of the alternator, but it has now taken firm root in America. In 1884 there was not a single one to be found in Philadelphia. Now they are everywhere, and alternate currents are being studied and developed in a way that is completely putting our experimentalists in the back row.

The paucity of real novelties, or of what are commonly known as "Yankee notions," was very marked. The necessity for such things—that is, the scarcity of labour—has apparently disappeared, and with its parent the child has languished. Moore's spark-interrupter—an automatic vibrating armature in a vacuum tube, by which glow lamps can be turned up or down without wasting energy—was described at a meeting of the electrical engineers at New York, but I did not see it at the World's Fair.

The distinguishing feature of the Chicago World's Fair was not alone its uniqueness, but its grandeur and its magnificence. It was not an exhibition of goods and manufactures in the old-world sense. No one seemed to care two straws for the mere trade exhibition *per se*; he admired the beautiful buildings, the waterways, the external attractions, and, above all, the congeries of people that assembled from all quarters of that great continent in such multitudes.

The distinguishing feature of American engineering is the great scale on which it is carried out, and the rapidity of its adoption. An electric railway from Chicago to St. Louis, 250 miles long, is not a difficult engineering feat, for the country is level, but it is novel for the fact that it is projected to travel at the rate of 100 miles an hour.

There were some things in the Exhibition that were extremely interesting. The first was a complete reproduction of an ancient Viking's war-ship—an open boat that would excite fear and trembling even in crossing the Channel, but of a type that probably crossed the Atlantic long before the famous fleet of Columbus. These vessels—the "Santa Maria," "Pinta," and "Nina"—were also reproduced in all their dimensions, and in all their colours and fittings. The contrast between these relics of the past and the modern war-ship built alongside the home of the British Commission, Victoria House, was, to my mind, more suggestive than all the innumerable wares and appliances so freely exposed in the vast extent of covered area.

One interesting building was a kind of baby cloak room, where mothers could book their babies for the day, and who were there carefully tended, nursed, amused, and fed for a very small charge. Each mother received a small brass check, which was her guarantee for the safe custody of her little beauty.

V.—Electric Lighting.

Electric lighting has not generally made the rapid progress during the past nine years in the States that was expected from its great rate of growth during the previous four years. Wild speculation, hasty construction, fatal accidents, and frequent failures have reacted on steady progress. At the same time the advance has been very great, principally in public street lighting. All towns and villages in all parts of the country, however small and isolated, or however distant, seem to have adopted public arc lighting. Arc lamps are found suspended over the roadways in a very rough-and-ready way, sometimes from stretched wires, sometimes from long balanced levers, but always effective. The arc lamp-posts are generally of timber, like telegraph poles; occasionally squared timber, as in Broadway, New York; and sometimes plain and neat iron poles, made of differing sections of iron pipes, but rarely so heavy, massive, artistic, and expensive, as in England. Clear glass globes appear to be almost universal in use. It is quite rare to see frosted glass or opaline shades.

The principal novelty introduced has been the use of flat carbons of oval or elliptic section, to increase the duration of the light. They are 310 millimetres long; the major axis is 25 millimetres, and the minor 11 millimetres. The ordinary arc lamp burns as a rule only eight hours, but this flat carbon doubles its life. Moreover, the flat carbon is found very advantageous and useful with alternating-current systems, on which arc lamps as a rule work badly. The standard current used is 10 amperes, and the energy expended varies from 400 to 500 watts. The lamps burn very steadily as a rule, and give a light of about 800 candles at the angle of maximum intensity.

An excellent self-regulating alternator for public arc lighting, designed by Stanley, was exhibited by the Westinghouse Company. It maintained its current quite constant, however much the number of the lamps was varied, between 0 and 24. Any number could be turned on or off without the least difference being detected in

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the current or the light. The favourite arc dynamo in the States is said to be that supplied by the Standard Electric Light Company. There was a large exhibit—six machines—of this type in the Exhibition. The largest size worked with 6,550 volts, and maintained 120 arcs in series. It is fitted with a very effective and rapid working automatic governor, regulating the range of the brushes, so that as lamps were turned off the current was maintained constant and the voltage changed. Six seconds only were needed to regulate the brushes from a load of one lamp to fifty lamps. Arc lighting is used very much for shop lighting, not only in the interior for general illumination, but for advertising and attractive purposes outside. Indeed, many of the streets of the principal cities—especially New York and Chicago—are more brilliantly lighted by the shopkeepers than by the municipalities. In fact, in many cities there are many more arcs supplied for private than for public purposes.

Incandescent Lighting.

Glow lamps are, within my observation, invariably used in telegraph offices, post offices, telephone exchange rooms, hotels, and in many railway stations. The electric light is more general in such public places than with us. I did not visit a single place that was not so fitted, and with glow lamps. In private houses it is much used, but not so generally as with us. In Chicago the residential lighting is only 33 per cent. of the total. In all large cities there are immense blocks of buildings fitted with lifts and used as offices, In all cases they were lighted by their own isolated plants. One of the most striking features of a bird's-eye view from some lofty spot of a great city, like New York or Chicago, is the white, fleecy, wool-like jets of vapour that float gracefully away from the top of every large building. They are to be reckoned by the hundred, and every one means steam plant working lifts and electric light. The Western Union Company of New York and Chicago have their own steam plants.

When I visited Chicago in 1884 no central electric lighting station had been built, and no current was supplied. Now, a capital of $2,233,000 earns an income of $320,000 yearly. The glow lamps (16-c.p.) fixed are 136,409, arc lamps fixed 4,376, motors supplied 3,612 H.P., and this is equivalent to 430,000 10-c.p. lamps fixed, or such lamps as we reckon with in England. The maximum load is 50 per cent. of these lamps alight at one time, which accords with our experience in England.

The price works out at 7½d. per kilowatt-hour, or supply unit, and this includes the cost of the renewal of the lamp. The cost of production works out at 3½d. per unit. The cost of the production of electric energy in the States differs, therefore, very little from that experienced here. It is steadily on the decrease. As the load increases, as the daily supply lengthens in duration, as the generators increase in size, so will the cost diminish ; and how low it will fall no one can predicate. Anyway, it will certainly far exceed in economy the production of gas. The price of lamps to the undertaker—that is, to the electric light company—is 1s. 4d. ; the life of the lamp is 600 hours. A 16-c.p. lamp takes 0·45 amperes and 110 volts. It is, therefore, a 50-watt lamp, and a better one than we get at present in England. The screw socket appears to be in universal use. I wish it were so here.

There are three central stations in Chicago. A new station is being built alongside the water in Harrison-street with a capacity for utilising 20,000 H.P., where every modern appliance for cheap fuel, automatic feeding, condensing, and economising will be used. The south side central station is worked by natural gas, which is brought in pipes 100 miles long from Indiana. It is very cheap compared with coal. I found in use in Chicago a system of raising the voltage on the feeders when the pressure falls, owing to the increase of load, by switching in motor-dynamos. They have given the name of "boosters" to these instruments. A somewhat similar system has been applied at the Midland Railway, Derby.

The Exhibition and its surroundings were, of course, brilliantly and entirely lighted by electricity.

The accumulator in America has been a failure for electric lighting, and a very strong prejudice exists against its use. It has led to much litigation, and the best forms seem little known there. The lagoons of the World's Fair grounds were, however, very successfully navigated by extremely pretty electric launches, worked and lighted by accumulators. The grounds at night, brilliantly illuminated and interlaced by winding waterways, with wooded islands and pretty bridges, along which illuminated gondolas and silent launches floated noiselessly, formed most beautiful and fairy-like scenes, superior to anything seen in Venice or pictured by art.

The feature that distinguishes American from English practice is the persistent use of belting and countershafting. In some stations the belting was to English eyes appalling. Direct-driving is only now making its way. There were several direct-driven engines and dynamos exhibited in the American section at the World's Fair, and some new stations now being built are to be direct-driven. The Willans and Robinson engines on show at the Exhibition, and steam turbine exhibited in the Swedish section by Laval—a form somewhat similar to that of the Hon. Charles Parsons, who unfortunately did not exhibit—attracted much attention. The reports of our performances in England are much sought after, and I think one influence of the Chicago gathering will be to convert American engineers to direct driving. The elastic character of direct-driving engines, gradually increasing in number and capacity with the load, and the ability to shut down or turn on engine after engine as the load varies, are economical advantages of immense value. The rapid regulation of small engines, the much smaller space occupied where space is so valuable, the smaller capital expenditure involved, and the reduced working expenses, all give direct driving an advantage which should recommend itself to such eminently practical engineers as the Americans.

The General Electric Company showed in the World's Fair a 1,000 H.P. triple-expansion vertical marine type engine, driving two 400-kilowatt multipolar dynamos, and the Chicago Edison Electric Light Company are fitting up their new central station with direct-driving engines.

The town work at such places as New York, Boston, and Chicago is as solid and substantial as anything we can show in England ; but when we inspect the outlying works in country towns, we can only express our thanks that we have the control of the Board of Trade and the protection of an Act of Parliament. It is the fashion to decry grandmotherly government, and to wince at departmental espionage ; but the protection of life on our railways, the absence of accident in our electric light undertakings, and the character of the work done everywhere, as compared with the same conditions in the States, can lead to but one conclusion, viz., that if we are slower, we do these things at least better in England. It is all very well in the pioneer stage of any industry to let private enterprise have its full swing, but when an industry becomes a public necessity, and when the interests of the whole community are at stake, Government, as the custodians of the public weal, must step in and assume the control. The accidents in the States are terrible in their number and fatality ; and they strike the observant Englishman with dismay. The value of life there seems to be very much below par.

VI.—Electric Railways.

The progress made in the establishment of electric railways is the most wonderful instance of growth of electric industry observable in the States. In 1884 I found only one railway so worked, and that experimentally, at Cleveland. Now every town has its electric railway. There are 4,000 miles of line so worked, 6,900 motor cars, and 4,000 trailing cars.* The capital embarked is $13,000,000, and the rate of progress is scarcely checked by the serious financial depression that has passed over the country. Electrical appliances of all kinds for railway working were among the most conspicuous exhibits at the World's Fair. A special track was laid down for test and trial, and along here I inspected a 30-ton locomotive, the heaviest yet made, having a horizontal pull on the level of 6,000lb., or enough to draw 500 tons on an ordinary English railway. The type of railway in general use over the United States of America is very uniform. We have only one true example in England, and that is at Leeds. A modification of the system has, however, been adopted on the South Staffordshire Tramways, and is about to be introduced in Coventry. The wires are all overhead. A heavy insulated copper wire is suspended over the centre of each pair of rails, or "track," and called the "trolley" wire. This conveys the current from the power-house. It is picked up by a trolley rod, which presses, by the action of a spring, upon this wire, and so conveys the current to the motors, which are geared to each of the two wheel shafts of the car. The current is thence transmitted through the wheels to the rails, and it returns thence to the power-house by heavy copper returns buried in the ground or suspended on the poles.

There are two very fine specimens of electric railways in Chicago. One, the intra-mural railway, conveying visitors to and from different parts of the grounds of the World's Fair, working very well, carrying an immense number of people, and financially very successful. It is not a trolley line, but it has a third rail acting as the main conductor. The other is the Chicago North Shore Street Railway, running to Evanstown. This is a trolley line having iron poles of strong design and good taste. It is 7½ miles long, with a power house situated in the middle of the line. It has 16 motor cars and 16 trailers. The feeders are carried on wooden poles, which are very unsightly. These feeders could have been more economically and more efficiently put underground. In the power house they are using a simple horizontal reciprocating engine, driving a Thomson four-pole dynamo, fitted with carbon brushes, by means of continuous rope gearing. No sparking whatever is observed at the brushes, and nothing can work more smoothly ; but the absence of condensing and the existence of rope gearing

* Trailing cars are not fitted with motors. They carry passengers only, and are drawn by motor cars.

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must render the engine part uneconomical. The maximum horse-power used is 246. The voltage varies with the load from 500 to 550. The current averages 200 amperes. The maximum number of cars on at one time is nine motors and nine trailers, and this averages at the power-station 13·7 H.P. per car running. The cars run on the straight at from 16 to 20 miles an hour. The rails are 85lb. per yard—a very heavy rail for a tramway. The usual rail is 52lb. per yard, as at Boston; but experience in the United States of America is leading to heavy rails. The pounding and hammering on the rails with heavy loads is very great, and in Philadelphia they are using even 90lb. rails.

The trolley wire alone is not unsightly, but when it is protected with three guard wires, as at Boston, and the same poles carry the feeders, it becomes hideous, and it is astonishing that the American community submit to it. Such a system is impossible in England. This trolley wire must be elastic, otherwise the trolley itself frequently jumps off and stops the car. Attempts have been made to improve the appearance of the road by using handsome central iron poles, with solid brackets on each side to carry the two trolley wires, but the want of elasticity has introduced evils. The trolley frequently comes off, and great sparking is evident.

An admirable illustration of a modern electric railway is the electric *portage* between Lakes Ontario and Erie, from Chippewa to Queenstown, 13 miles long. It is on Canadian soil, and built with Canadian capital, but the work was done by an American firm. It is an open overhead trolley line, with iron posts and brackets. It is worked by water power derived from the Niagara Falls.

The West End railway system of Boston is by far the most extensive electric railway system in any city in the States. In the power station, which is situated on the harbour, there are 24 Babcock Wilcox water tube boilers, each developing 250 H.P. Surface condensing is used, sea water being available for the purpose. There are six horizontal triple expansion engines, each developing 1,000 H.P., and driving by means of belting 18 Thomson-Houston four-pole dynamos, all capable of being connected up in parallel, but put on and off as the load varies. The chimney is 252ft. high and 13ft. 6in. in diameter. It does not smoke, and the steam is generated so economically that only 11½lb. are used for one H.P. hour. There are three power houses in Boston, the other two developing 2,000 H.P. each, so that there are 10,000 H.P. used in Boston for working their street railway system. The line is no longer run by contractors. It is entirely in the hands of the railway company itself. They have magnificent workshops, and a very fine staff. Their chief engineer, Mr. Hirt, was extremely attentive and communicative. He supplied me with capital drawings of the works and general arrangements. The use of belting was again surprising; but I was told that a very large railway system at Brooklyn was going to be worked by direct-driven power, so as to obtain an authoritative and convincing trial of the relative merits of the two systems. I did not learn the type of engine to be fixed at Brooklyn, and I was unable to go there to find out.

The track is light, as I have previously mentioned, but they are welding together the fish-plates and the rails so as to obtain an electrically-perfect return circuit. I saw the car and apparatus used for this welding process; but I could not see it in operation, for one essential part of the plant was being repaired. I saw the electric snow ploughs used to keep the tracks clear in wintry weather. The system of railway working in Boston has given such satisfaction to the public that the traffic returns have improved 30 per cent., owing to the change from horses to electricity. The service is so much quicker, cleaner, and better performed. A railway car in full service is said to run an average distance of 250 miles a day, and its mean speed is 15 miles an hour.

There is an important question under discussion in the United States of America—whether it is better to pursue the present practice of using two motors, one on each wheel axle, or to use only one motor connected electrically and flexibly with the wheels by bevelled gearing. This is the plan advocated and practically carried out by Mr. Sperry. The weight is thus placed in the middle. The horizontal pull is said to be greater. The starting torque is smaller. It is more easily controlled. There is no slip, and the velocity of all parts is uniform. It will climb a stiffer grade. One 35-H.P. motor replaces two 30-H.P. single-reduction Thomson-Houston or Westinghouse motors with economy of energy. The system is working in Pittsburg, where it was adopted after a very severe trial with a Westinghouse car, and it is about to be used on 22nd Street in Chicago. It has this disadvantage—that if the motor fails there is not a second one available to take the car home. The problem is an interesting one, and its solution will be watched with great interest, for it has an important bearing on the economies of our English roads.

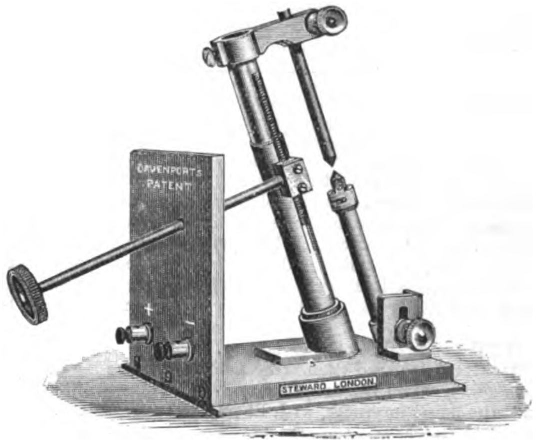
The feeling is pretty prevalent in the States that the conductors must eventually go underground. Experiments in this direction are being made in several directions, notably in Washington and Chicago. The trolley with its guard wires is really an abomination, and the disturbances created by insufficient return accommodation are annoying the telegraph and telephone interests, and alarming the gas and water companies. The future working must be metallic circuits and underground conduits. It is so done in Buda-Pesth, and it has been partially done in Blackpool and in Rome. Other experiments are contemplated in England. No one can doubt that the future of electric railways is very bright. The South London Railway and the Mersey Dock Elevated Railways are examples of great successes in England, but it is in the States, where this form of locomotion has become a necessity, that we are sure to see a speedy and practical solution of the problem.

CONCLUSION.

I have by no means exhausted the notes made during my trip, but I have said enough. Interviewing is a feature of American journalism that, thank goodness, has not taken root here. I was surprised to read of interviews with myself, extending to two or three columns, that resulted from the passage of a few compliments; but I was more surprised to find that statements supposed to have been made by me to an interviewer were taken *au sérieux*. One irate functionary compared an official statement of our Postmaster-General with a mythical statement made by me, and triumphantly pointed out such a glaring contradiction as a complete refutation of my fallacies. I even read that I had stated that we electricians in England had *nothing* to learn from America. I have no recollection of ever having made any remark which could by any shorthand blundering have been construed into such an absurdity; but if I had done so it would more likely have been one where "nothing" was a telegraphic error for "everything." I cannot too gratefully speak of the attention and kindness I received from everyone, and I certainly feel that I have personally profited from my visit very much indeed. A visit to the United States is something like charging an accumulator. It stores the visitor with energy. When I am discharged, and my adverse criticisms have been forgotten, I shall probably cross the Atlantic again.

THE DAVENPORT ARC LAMP FOR OPTICAL LANTERNS.

The accompanying illustration shows a remarkably simple form of arc lamp which has recently been designed by Mr. G. Davenport for use in the optical lantern, and for projection purposes generally.



The lamp consists of two carbon holders, so arranged that, while the lower carbon is automatically maintained in the proper position for burning by a spring within the lower carbon tube, the upper carbon is fed forward, from time, to time as the carbon is consumed, by a rod at the back of the lamp attached to a rack-and-pinion arrangement. It will burn about five minutes without attention. The tube containing the lower carbon is fastened by a thumbscrew to a fixed upright plate, having a slot cut in it so that the height of the tube may be varied and other adjustments made. The two carbons are set at an angle so that the full benefit of the arc is obtained directly in front.

The lamp is made of such size and shape that it will fit any ordinary lantern without alteration, thus allowing of the limelight or other luminant being used when the electric current is not available. The rod carrying the pinion for feeding the upper carbon projects at the back of the lantern, and the only attention necessary in using the lamp is to turn this rod from time to time in a similar manner to that required when turning the lime for the limelight.

The lamp works with from six to eight amperes, and requires an E.M.F. of not less than 60 volts. Carbons 8 m.m. in diameter

should be employed, and the lower carbon should be adjusted so that its point is slightly in front of the point of the upper carbon, and the upper carbon, when burning, should be kept at such a distance that the point of the lower carbon is nearly clear of the crater formed on the upper carbon by the arc. It is found that the normal length of carbon fitted to the lamp lasts two hours, with a little carbon to spare.

The source of light being of small area enables splendid definition to be obtained. The risk of damage to slides from the heat of the arc light depends principally on the amount of current consumed in the arc. With a lamp giving a light two or three times greater than that given by the best mixed jet, the heat is not sufficient to injure any ordinary gelatine slide, and the risk from this source is much less in proportion to the light obtained than with any other form of artificial light.

The Davenport lamp is made by Mr. J. H. Steward.

LEGAL INTELLIGENCE.

Gold Trust and Investment Company (Limited) v. Electric Tramcar (Limited).

This was a motion in a debenture-holder's action to commit Alfred James Jarman, of 71, St. John's-hill, Clapham Junction, and Watson Smith, of 63 and 64, New Broad-street, to prison for contempt of Court in interfering with the Receiver of the Court by having taken away from a certain shed accumulators and other property of the defendant Company, and was heard in the Chancery Division, on Friday, before Mr. Justice North. It appeared that Jarman was a person who had been employed by the Receiver, and had a key of the shed. Watson Smith was manager of a company called the Elieson Accumulator Syndicate. He had contracted to buy from the Receiver certain tramcars, accumulators, and plant for £250, and patent rights for £10, to be paid on delivery. He purported to sell the same chattels to the Elieson Accumulator Syndicate for £2,000, partly to be paid for in debentures. That Company immediately contracted to sell the same property to a trustee for a new company for £15,000. The accumulators and some other goods were removed by Watson Smith, with the aid of Jarman, without paying anything or leave from the Receiver.

Mr. J. W. CLARK, for Jarman, pleaded that the conduct of his client was *bonâ fide*, though mistaken.—Mr. Watson Smith appeared in person.

Mr. JUSTICE NORTH made an order for the committal of both Jarman and Watson Smith. In the course of his judgment he observed on the difference of amount between the prices named in the three contracts. He could not say whether the price in one case was too high, or in another too low. That he had nothing to do with. Commenting on the evidence, he said he could not see anything *bonâ fide* in the conduct of the respondents; on the contrary, he might give it a very different name. As an order for committal was pressed for, he must make it.

Hammond v. Brighton and Hove Electric Light Company (Limited).

This was a debenture holder's action, which came before Mr. Justice North on Saturday, upon agreed minutes.

Mr. EVE, who appeared for the plaintiff, stated that debentures were issued to the amount of £15,000, each of the value of £100, bearing interest at the rate of 6 per cent. The principal moneys were repayable on January 1, 1895, or earlier if default was made in payment of the interest. The Company had made default in payment of the half-year's interest due in January last, and a receiver and manager had been appointed.

Mr. CHITTY appeared for the Company.

His LORDSHIP declared that the holders of the Debentures were entitled to a charge upon the property and undertaking of the Company, and directed the usual inquiries, with liberty to apply, as to a sale.

Tibbits v "The Morning."

This case, which was similar to others in which the plaintiff (well known in recent "electropathic" belt actions) has appeared, was heard on Friday and Saturday before Mr. Justice Lawrance and a common jury, and resulted in a verdict for the defendants. It was an action for libel, in which the plaintiff claimed heavy damages.

Edison-Bell Phonograph Corporation (Limited) v. Smith and another.

In this action, the hearing of which was resumed on Saturday last, Mr. Justice Wright, on hearing the arguments of council upon both sides, gave judgment for the plaintiffs with costs, and granted a certificate of the validity of the patent, and an injunction against the defendants. His reasons for this judgment, and the summing up the whole case, was deferred.

Paper as an Insulator.—Prof. Elihu Thomson is making use of an insulator consisting of sheets of paper impregnated with a mixture of kaolin and silicate of soda.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *January* 27, 1894.

The Rowland Suit.—The decision of the Federal Court, awarding Prof. Rowland $9,000 in his suit against the Cataract Construction Company for services rendered in connection with the Niagara electric plant, is much less than the amount claimed—$30,000—but as Prof. Rowland originally only valued his services at $10,000, in a bill rendered, the verdict is really a favourable one to him. A feature of the case was the evidence produced showing a most bitter feeling toward Prof. Forbes on the part of Prof. Rowland, which was further illustrated by the testimony of Prof. Rowland in the witness box. The verdict merely recognises the value of Prof. Rowland's services aside from any question of priority, and in fact, none of the testimony established that he had originated a single feature of the Niagara plans; on the contrary, the testimony of one of the principal officers of the Construction Company, of Prof. Forbes, and documentary evidence offered were distinctly against this claim, and moreover decidedly favourable toward Prof. Forbes.

An Edison Lamp-Patent Decision.—A Judge of a Federal Circuit, on January 23rd, dissolved an injunction against a lamp manufacturer at Cleveland, O., who had been and declared an infringer of the Edison lamp, on the ground that the American Edison lamp patent had expired with the English patent, on November 10, 1893. It was claimed that the endorsement of that date by the Edison attorney on the American patents was analogous to an election of remedies, and accordingly cannot now be shifted, which view was sustained by the Court. All other Courts have heretofore held that the date of sealing the English patent is the one to apply in determining the effect of the expiration of a foreign patent on an American one, and that the mistake of the Edison attorney in endorsing the wrong date had no effect in law.

The $50,000 Electric Traction Prize.—It is said that more than 200 different street railway conduit systems have been submitted to the Metropolitan Traction Company of New York in competition for the $50,000 prize offered by it. As the time expires in March, however, and a successful system must demonstrate the required qualities under actual working conditions, it does not seem that any inventor will be able to even prepare to compete under the conditions in this limited time.

CORRESPONDENCE.

DOUBLE-ACTING GAS ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of December 22nd an article appeared upon the driving of alternators by gas engines by Mr. J. Emerson Dowson, in which reference is made to double-acting gas engines. The author's expression of opinion is so severely unfavourable to the double-acting gas engine that, unless challenged, it may do serious injury to the reputation of this class of gas engine, and especially so with some readers, who are apt to accept for fact what they see in print, regardless of whether the author knows anything about his subject or not. As Works Manager for Messrs. Dick, Kerr and Co., of Kilmarnock, who are the only makers of double-acting gas engines, and who are also makers of single-acting gas engines, I would ask you to permit me to say a few words in endeavouring to show that the double-acting gas engine is too good an engine to be "damned with faint praise" by being called merely "ingenious," and then with a waive of the hand to be consigned to oblivion in the words: "We need only consider the well-known single-acting engines," &c.

Mr. Dowson says:—"With the double-acting engine, however, more oil and more water must be used to prevent the over-heating of the pistons, and there are twice the number of gas, air and exhaust valves, as well as twice the number of ignition tubes to be kept in order, compared with those of single-acting engines."

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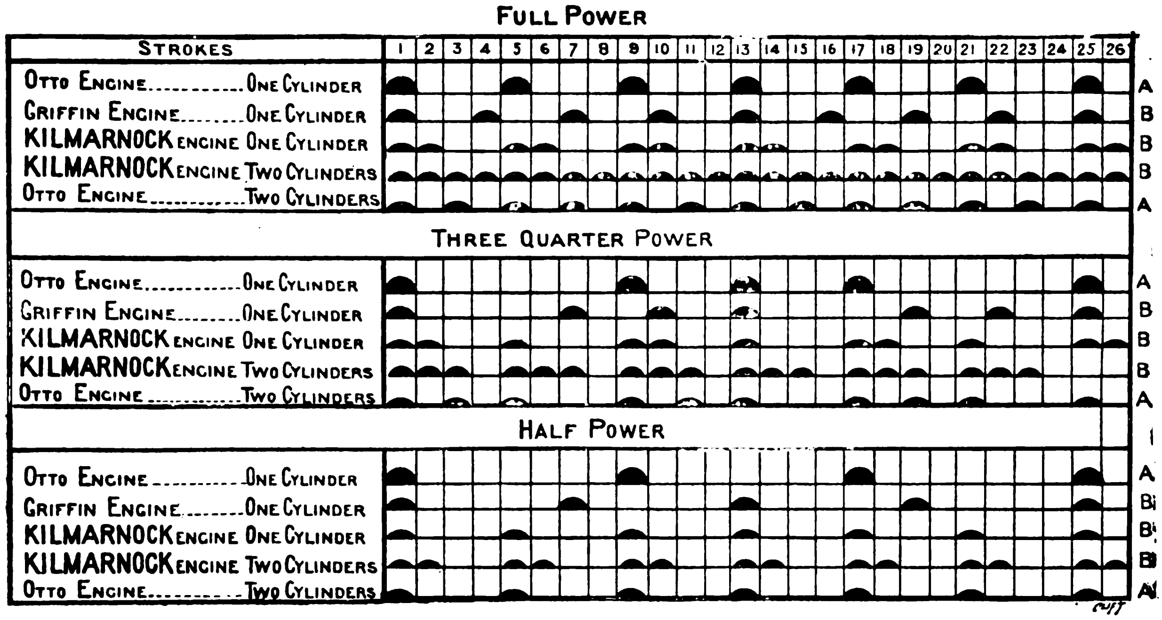
It is true that in double-acting engines two admission valves, two exhaust valves, and two ignition valves are required, but only one gas valve. The works of Messrs. Dick, Kerr and Co., have during the last seven years turned out hundreds of double-acting gas engines, and hitherto only three or four valves have required renewal, but not so with cams, and the valves instanced have been damaged through accident or neglect. This being the case, and the valves in question for equal power engines smaller than in single-acting engines, the greater number of valves cannot be of serious moment.

Mr. Dowson states that more oil is used; this statement requires proof. My experience with both classes of engines shows that there is little or no difference in this respect, and as the circulation water is used over and over again, I quite fail to see the loss from this source. The gas engine originally made by Messrs. Dick, Kerr and Co., was known by the name of the "Griffin Gas Engine." This was a six-stroke cycle engine having a scavenging stroke. This engine gave very fair results, but was found to be not quite so economical in working as the Otto Cycle Gas Engine, and hence, acting upon the writer's suggestion, a double-acting Otto Cycle Gas Engine was constructed, the results being of an extremely satisfactory nature. The manufacture of these engines was at once commenced, and the engines so constructed are behaving area only of the single-acting engines, less trouble is likely to arise from this source, and engines of larger sizes are thus possible on this system.

Our double-acting gas engines when driven with carbon monoxide, frequently known as "Dowson Gas," can be started in a very simple manner from the small boiler which supplies steam to the generator, and as larged-sized gas engines and engines for electric lighting are now being made a speciality by Messrs. Dick, Kerr and Co., this mode of starting is especially convenient. A steam pipe is led to the back end of the cylinder, and the largest gas engine can be started at a moment's notice as readily and easily as a steam engine. For electric lighting, where extra steadiness is required, and also in cases where higher powers are asked, the practice of the principal firm of gas-engine makers is to apply two single-acting gas engines having the connecting rods coupled to the same crank. This device answers the purpose of, and gives the same cyclical result, as one of our double-acting gas engines; but it entails two pistons and two connecting rods, and these would surely use more oil than one piston, &c., and would have more parts and would be less under control than one of our double-acting gas engines, and yet Mr. Dowson says, "We need only consider the single-acting engines." We are now constructing gas engines with two

COMPARATIVE CYCLES OF GAS ENGINES



admirably, and leave nothing to be desired in their steadiness of working and economy and in the fact that they are especially suitable for large powers.

An engineer who would advise that a large Corliss valve steam engine should be made single acting because it would require valves at one end of the cylinder only, and would save complication, oil, &c., would be regarded with curiosity, to say the least of it, and this is practically what Mr. Dowson says. I maintain, however, that if a steam engine should be made double-acting there is the same necessity in a gas engine, even in a greater degree, for the following reason, amongst others:

The advantages of double-acting gas engines over the single are, first, greater steadiness, as illustrated by the cycle diagram annexed, reduced violence of explosion impulses, these being only half the force, the shorter intervals between the explosions, lighter flywheels, reduced weight, crank shaft, &c., and less costly foundations, and especially in the greater ease of starting, and on light loads giving half-power cut-outs with, therefore, greater steadiness than with single-acting gas engines.

It is well known, in dealing with large powers, that heat is more difficult to control in large cylinders than in small ones, and more trouble exists from the excessive heating and expansion of the piston, and it is obvious that in engines of equal power, the piston of the double-acting engines being half the cylinders, each being double-acting and having nearly four times the number of parts of a single-acting engine. We have now under construction at Kilmarnock four such gas engines, each 100 H.P. These engines will have two double-acting cylinders and have two impulses to each revolution, or 320 impulses per minute, and this type of engine has been adopted by the Belfast Corporation, under the advice of Prof. Kennedy, for the central electric lighting station at Belfast.

Apologising for trespassing to so great an extent upon your space.—Yours, &c., J. W. HARTLEY,
Britannia Engineering Works, Kilmarnock.

Kilmarnock, January 31, 1894.

ALTERNATING v. CONTINUOUS CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The opening remarks of this week's leader, which says—"The rivalry between alternate currents and continuous will not cease for many a year: and it is commonly supposed that it will only be diminished when experience has proved that, other things being equal, districts exceeding a certain size should take advantage of the economies of the former, while smaller areas may enjoy the conveniences of the latter"—has an amusing but instructive confirmation in in your advertisement pages. On page 25, the Brush

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Company, *the leading advocates of the alternating high-tension system* (in italics please) advertise a representative continuous-current bar armature machine, which forms one of a series I have designed for that Company, and which is similar to two machines of 100 and 144 kilowatts output just being supplied to the Lancaster Corporation; and on the other side, page 26, there is an illustration of an alternator designed by Mr. Brunton for Messrs. Crompton and Co., who have for years so persistently advocated low-tension continuous currents, but who are now, apparently, making strenuous endeavours—*vide* Newport tenders—to get a foothold in alternate-current work.

Who can wonder that some of the younger members of the profession will begin to doubt some of the cocksure statements of much-respected elders, and ask in a slang, but expressive, phrase, "Where are we now?"—Yours, &c.,

ERNEST SCOTT, A.I.E.E.

Falcon Works, Loughborough, Leicestershire, February 2, 1894.

MINIMISING HEAT LOSSES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The method of minimising loss of heat from electrically-heated vessels, referred to in your "Notes," as proposed by Mr. Fessenden, is not new, as you remark. I have experimented with this method and employed it for some time. I have shown two electrical ovens at the Cookery Exhibition at the Portman Rooms in the month of November last. One of these ovens was made of two jackets of bright tin with air space between them of about half-an-inch, the other being made of bright brass with an inner and outer jacket kept as bright as possible.

I have, however, found that in practical use difficulties are encountered which negative to a large extent the favourable results obtained by laboratory experiments. There may be uses for electrically-heated chambers in which the inner surface can be kept comparatively bright, but in practical cooking this cannot be obtained, and very soon after the operation of cooking begins the very great efficiency of the reflecting bright surface is lost. Another difficulty is, that it is not always possible to make an inner and outer jacket in such a manner that they do not touch and offer heat conducting surfaces between themselves. They may touch between themselves at the bottom, but to obtain a good efficiency it is most necessary that the top half should constitute an uninterrupted latent air chamber. There is no doubt that in electrically-heated ovens bright and smooth surfaces will have to be used whenever possible, as the loss by radiation from black surfaces, such as are now used with ordinary gas ovens, is so great as to make the oven practically useless owing to the large current required to maintain the heat.

Out of the great many experiments I have made upon this subject I will select the following:—

Oven, outside bright polished brass, and inside enamel. Time. 10min.; power, 950 watts. Result: Temperature raised from 60 to 330°F.

Same oven, outside blackened, and inside ordinary sheet iron. Time, 10min.; power, 970 watts. Result, temperature raised from 59 to 165°F.—Yours, &c., G. BINSWANGER.

69 and 71, Queen Victoria-street, London, E.C., February 6, 1894.

MESSRS. NALDER BROS. AND CO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Owing to the numerous inquiries we have had recently as to whether we have changed the constitution and address of our firm, we feel it incumbent on us to state that there has been no change whatever, and that the partners, F. H. Nalder, H. Nalder, C. W. S. Crawley, and A. Soames, who have conducted the business during the last six years, still carry it on as Nalder Bros. and Co., and that our sole place of business is at 16, Red Lion-street, Clerkenwell, London, E.C., as heretofore.—Yours, &c., NALDER BROS. AND CO.

London, E.C., February 6, 1894.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

Our readers are reminded that the 1894 Edition of "THE ELECTRICIAN" Electrical Trades' Directory and Handbook is NOW READY. This valuable book contains 1,000 closely-printed pages, and several new and useful features have been added. The price of the Directory and Handbook is 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

Copies are being despatched in the order of subscription, and the Publisher hopes to be able to forward by Tuesday next all the books ordered.

"ELECTROMAGNETIC THEORY," by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application to the Publisher.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book, by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.) A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

TENDERS INVITED.—The Northern Co-operative Company invite tenders for supplying and fitting up electric wiring and fittings at their central stores at Aberdeen. Mr. J. Ferries, 54, Loch-street, Aberdeen, is secretary, and tenders must be in by the 20th inst.

——— The Guardians of Dewsbury Union invite tenders for lighting the workhouse and premises by electricity. Tenders must be sent in to Mr. J. Peace, Clerk to the Guardians, by Thursday, the 15th inst.

——— The South Indian Railway Company (Limited) requires tenders for the supply of general stores, including telegraph stores and sundries. Particulars may be obtained at the Company's offices, 55, Gracechurch-street, E.C., where tenders must be sent not later than noon on Tuesday next.

TENDERS ACCEPTED.—The Lord Provost's Committee of the Edinburgh Town Council have accepted the following estimates in connection with the electric lighting station in Torphichen-street, the tenders in all amounting to £24,300:—

George Sinclair, Leith—boilers, &c.	£6,024
Siemens Brothers and Co. (Limited), London and Woolwich—engines, dynamos, pipes, pumps, &c.	15,098
Siemens Brothers and Co. (Limited)—switchboard connections, &c.	1,760
Crompton-Howell Electrical Storage Company (Limited), London and Llanelly—storage batteries	1,400

——— The Halifax Corporation have accepted various tenders in connection with their new central lighting station in Foundry-street, at a total cost of between £8,000 and £9,000.

——— The Highways Committee of the Sunderland Town Council have accepted tenders for the erection of buildings required at the electric lighting station, chimney shaft, and iron roofing, which were estimated to cost about £3,015. The lowest tender received was for £3,167, and has been accepted. The tender of Messrs. J. Abbott and Co., of Gateshead, has been accepted for the iron roofing at £235.

——— The Electric Lighting Committee of the Belfast Corporation have accepted the following tenders:—For tandem and single engines (to work with Siemens' dynamos), Messrs. Dick, Kerr and Co. (Limited); switchboard, Messrs. J. H. Holmes and Co.; batteries, Electrical Power Storage Company (Limited); road work, Messrs. Scott and Seller; cast iron work, Messrs. Maclaren and Co.; insulators, Messrs. Doulton and Co.; vulcanised bitumen, the Callender Company; leads, the British Insulated Wire Company (Limited); copper strip, Messrs. Curtis and Sons—the whole of the tenders amounting to £12,984.

——— The Coleraine Guardians have accepted the tender of Mr. J. McCandless for the supplying and fitting up of thirteen electric bells and indicators at the Workhouse Infirmary for £7. 9s. 6d.

APPOINTMENT VACANT.—The Blackpool Corporation require for their tramways a resident working electrical engineer. Particulars of the appointment will be found in our advertisement columns, and applications must be sent in before the 19th inst.

——— The Corporation of Edinburgh require a resident engineer for their central electric light station. Candidates must have had a thorough training both as mechanical and electrical engineers, and have had practical experience in central station working. Applications must reach Mr. William Skinner, the town clerk, on or before the 24th inst. Further particulars appear in our advertisement columns.

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LIQUIDATION.—At meetings held on December 18th and January 15th, it was resolved by the shareholders of Easton and Anderson (Limited), to voluntarily wind up the Company, and to reconstruct under the title of Easton, Anderson and Goolden (Limited), Mr. T. P. Wilson, of 3, Whitehall-place, S.W., being appointed liquidator. Particulars of the formation of the new Company appeared in our last issue.

BANKRUPTCY DIVIDEND.—In the matter of Frederick Silvester, trading as F. Silvester and Co., at Newcastle-under-Lyme, a first and final dividend of 4s. 6½d. in the £1 has been declared by Mr. C. E. Bullock, the trustee, of 15, Albion-street, Hanley.

ENGLISH-MADE CARBONS.—In reference to the question of carbon rods and plates being made in England, the Atlas Carbon Manufacturing Company (Limited) desire us to notify that they have for some years made both lighting rods and battery plates at their London works.

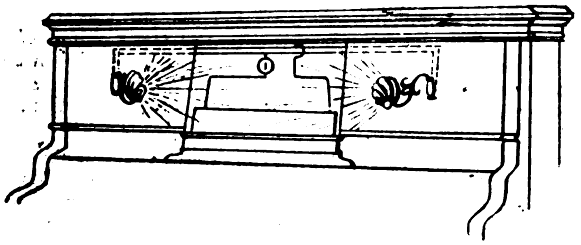
MESSRS. NALDER BROS. AND CO.—We have received a copy of the latest catalogue issued by this well-known firm of electrical and scientific instrument makers. The list contains illustrations of a number of new instruments and apparatus, and we may specially mention that the firm are now supplying the Ewing magnetic curve-tracer in a convenient form for testing purposes, besides a number of other instruments for similar work. New apparatus for central stations and electrical engineering work are also shown, in addition to the instruments, &c., used in teaching and other laboratories.

ELECTRIC FIRE ALARMS.—An advertisement supplement issued with our current number gives illustrated particulars of the system of fire alarms in use by the Fire Brigade Department of the London County Council. About 600 of these posts are erected in the metropolis, and we learn that considerable orders have been dealt with by the Single Wire Multiple Telephone Signal Company, of 50, Old Broad-street, London, E.C., who own the patents.

GAS LIGHT AND COKE COMPANY.—This Company is straining every nerve to make up for any possible diminution of receipts owing to the steady increase in the numbers of those using the electric light in the City of London district. The Company's latest departure is the issue of a budget of pamphlets setting out the advantages of gas as a cooking and heating agent, and we have to acknowledge the receipt of a variety of pamphlets and circulars showing the Company's charges for rentals for stoves and for domestic heating and cooking apparatus, a departure which manufacturers of electric cooking and heating plant and apparatus might well follow. The average city man requires certain light and quickly-cooked food during business hours, and as soon as he can obtain electric current is likely to become a customer for the simple and easily-managed apparatus, which certain electrical firms are placing before the public, but it is essential that he should know what he can obtain, and where.

GAS ENGINES.—A patent duplex high-speed gas engine will be on show running next week in the show rooms of the Indestructible Gas Ignition Tube Company (Limited), 100c, Queen Victoria-street, E.C.

ELECTRIC LIGHT FOR THE PIANO.—At Anderton's Hotel, Fleet-street, London, on Monday last, Messrs. A. Allison and Co., of Apollo Works, Leighton-road, London, N.W., pianoforte builders, had on view one of their most modern instruments effectively lighted by electricity. The sketch herewith shows the position of



the lamp, and it will be seen that under the music board a space is provided sufficient to contain a portable battery, a switch, and the necessary electrical connections for lighting two incandescent lamps. This is effected by making the music board slope at a more pronounced angle than usual, but does not otherwise interfere with the usual arrangements. The whole of the front can be lifted out, including the battery and lamps, leaving the interior free for tuning as usual. The arrangement is ingenious, and is the invention of Mr. Allan Fraser. A lithanode battery is used, which, when in position, is securely fastened with lock and key, and there is no communication between the electrical apparatus and the interior of the instrument. The battery can be easily lifted out for re-charging.

ALLEGED THEFT OF DESIGNS.—Henry H. P. von Weber, of Moore Park-road, Fulham, was charged at Westminster on Monday with stealing eleven designs of electric light fittings (valued at £8), the property of Mr. H. Foote, of Messrs. Statter and Co., Westminster. It appears that the Company advertised for a draughtsman, and that amongst the replies was one from the prisoner (who had been in the service of the firm), submitting designs which were marked with the firm's stamp, and were the firm's property. Upon presenting himself, in answer to his application, he was given in charge of the police. Evidence was adduced which clearly proved that the designs were stolen, and the prosecutors complained of the difficulty they had in preventing their designs passing into the hands of pirating firms. Mr. Foote explained that he had promised the prisoner's father not to press the charge against his son, and this being the case, Mr. de Rutzen, the magistrate, allowed the prisoner to be discharged, cautioning him against similar conduct in future, and pointed out that it was entirely owing to Mr. Foote's generosity that he obtained his discharge.

ALLEGED THEFT.—Two men, named Bonette and Denny, were charged at West Ham, on Wednesday, with stealing 420 yards of telegraph wire, the property of the Postmaster-General. The wires connected the West Ham Fire Brigade with various street fire-alarms and factories in Stratford, and during the past month the connections have been cut on several occasions, and lengths of wire stolen. On Monday night the bells in the Stratford Fire Station began ringing, and as the connection was found broken it was concluded that the ringing was caused by the end of a wire being in contact with earth. Communication was made with the police-station, and at once a large number of police officers were sent out to scour the neighbourhood where the wires were placed. Constables went on to the sewer embankment, on the High-street, Stratford, and met the prisoners carrying the roll of wire.—A remand was granted.

"ENGINEERING MAGAZINE."—The February number of this magazine contains the usual amount of interesting and instructive reading. The contents include "How the Ancients Moved Heavy Masses," by W. F. Durfee; "Labour's Delusion Regarding Capital," by Alfred H. Peters; "Industrial Conditions in Mexico," by John Birkinbine; "Small Electric Light Stations," by J. E. Talbot; "Electricity in Suburban Development, from the Business Man's Point of View," by Erastus Wiman; "The Joplin Zinc-Mining District," by Hamilton S. Wicks, &c. Most of the articles are illustrated in the manner which has made this magazine so universally popular. Subscriptions for the European edition, 12s. 6d. per annum, should be sent to Mr. George Tucker, Salisbury-court, Fleet-street, E.C.; single copies are 1s. each, or 1s. 3d., post free.

TELEPHONE SUBSCRIBERS.—The National Telephone Company have just issued to their subscribers a supplementary list, dated January, 1894, and consisting of 55 pages of additions and corrections to the latest previously-issued list.

MESSRS. FARADAY AND SON'S CANDLE FITTING.—We omitted to mention in our notice of this fitting last week that the arrangement is patented.

ANNUAL DINNER.—The third annual gathering of the staff of the New Telephone Company (Limited), Manchester, took place on Friday evening last, at which a party of upwards of eighty ladies and gentlemen participated.

ABERDEEN.—The Watching and Lighting Committee of the Town Council have suggested, in connection with the public lighting, and as an experiment, that iron brackets should be attached to two or three of the electric lighting pillars between Castle-street and Market street, and that incandescent lamps should be placed on these brackets and lighted after the arc lamps are extinguished at midnight. The suggestion has been adopted.

BASINGSTOKE.—Inquiries were made at the last meeting of the Urban Sanitary Authority as to the steps being taken to introduce the electric light into the district. The Chairman of the Board stated that little or no progress had been made in the matter, as it was advisable to wait a further development of electric-lighting systems before proceeding. Several members of the Board are about to visit Fareham to inspect the lighting of that town.

BEDFORD.—In reference to the proposed transfer of the Bedford Provisional Order to the Bedford Electric Light Company (Limited), which the Board of Trade has disapproved, it appears that the Local Authority made fourteen objections to the transfer.

BIRKENHEAD.—The sub-committee recently appointed to advise the Finance Committee as to the steps to be taken in regard to the carrying out of the provisions of the Birkenhead Provisional Order, 1890, have sent in their report. They recommend an electrical engineer should be appointed to advise the Corporation as to the details of the system of lighting to be introduced, and have advised the appointment of Mr. J. N. Shoolbred, of London. The Finance Committee have confirmed this appointment, and the sub-committee are considering, with Mr. Shoolbred, the question of site, plant, &c.

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CHELMSFORD.—A special meeting of the Town Council was held on Tuesday last to discuss portions of the Provisional Electric Lighting Order applied for by Messrs. Crompton and Co., and the Council accepted clauses giving them power to purchase by arbitration at the end of 21 or 31 years. It was necessary before agreeing to the above clauses to rescind a resolution previously arrived at by the Council.

CLUB LIGHTING.—The new Constitutional Club at Leicester is to be partly lighted by electricity, and Messrs. Matts and Biggs are fixing combined gas and electric light fittings throughout the building.

——— The Nimrod Club, devoted to the special interests of hunting men, has recently taken the premises lately occupied by the Salisbury Club in St. James's-square, London, the premises having been renovated and redecorated, and the new fittings and apartments of which have been brought quite up to date. The rooms have been handsomely fitted throughout for the electric light, and this particularly refers to the billiard-room, which is one of the finest in London. The Nimrod Club is having extensive new club premises built upon the site of Cleveland House, which will be completed in about two years, and which is to be fitted throughout for the electric light.

COLCHESTER.—Mr. W. H. Massey has advised the Lighting Committee of the Town Council that, as the electric lighting works under the Colchester Provisional Order would probably be carried on in conjunction with other undertakings of the Corporation, and as money could be borrowed by the Corporation at a low rate of interest, the Council will be able to supply electricity and make the undertaking a remunerative one. Mr. Massey has been instructed to prepare a further report.

COVENTRY.—Messrs. G. and I. Steane have been appointed architects by the City Council for their electric lighting station, and tenders for the building are to be invited forthwith.

DOVER.—The Town Council recently appointed an expert to report to them upon the electric lighting arrangements, and Mr. W. Slingo's report was before the last meeting. Mr. Slingo points out several matters that require the attention of the Corporation officials. A copy of the report has been sent to the Board of Trade. It is probable that the Electric Lighting Committee of the Town Council will be reappointed.

——— The staff of the local gas company have recently held a concert, at which the manager pointed out that now the company were in active competition with the electric lighting company, it was necessary that unity should prevail among the Directors and the employes.

DUBLIN.—The Corporation's gas lighting arrangements cause that body considerable trouble, and a lengthy discussion took place at the last meeting, which ultimately led to a resolution being proposed for the amalgamation of the Gas and Electric Lighting Committees into one body. It is proposed that the Committee should be formed of the members now constituting the Electric Light Committee and one member from each ward not now represented on that body, the Committee to have all the duties and powers of the Paving and Lighting Committee, the Electric Light Committee, and the Special Gas Committee. The final decision will probably be come to at the next meeting of the Corporation.

DUNDEE.—A deputation of the Glasgow Town Council, including Mr. P. Burt (Chairman of the Lighting Committee) and Mr. Arnot (the electrical engineer), visited Dundee last week to inspect the condensing plant which has recently been supplied by Messrs. Whyte and Cooper to the electric lighting station, the visitors being highly pleased with the results obtained. It is announced that the Dundee Commissioners are sanguine that the revenue from electric lighting will more than fulfil their expectations, and the whole scheme is voted a great success.

HOWTH.—Application is about to be made, under the Irish Tramways Act, for power to lay an electric railway from Dublin to the top of the Hill of Howth. The proposed line is to start from the terminus of the Dublin tramways at Dollymount, and is to proceed along the present level road by the seashore. Electricity is to be used as the motive power throughout the line, and when this is completed it is suggested that the Dublin Tramways Company should obtain powers to run electric cars on their line, from Nelson's Pillar to Dollymount. The engineer to the scheme is Mr. F. G. Fraser, C.E.

KENSINGTON (LONDON).—At their last meeting the Vestry received a lengthy report on the electric lighting question from Mr. Philip Monson, and after considerable discussion referred the report to the Select Electric Lighting Committee for digestion.

LEICESTER.—It will be remembered that considerable discussion has arisen at the Corporation meetings concerning the tenders for the supply and erection of engines for the town electric lighting scheme, and at a meeting last week Mr. Alderman Lennard moved that (in conformity with the report received from the engineer and manager of the Corporation Gas Department, Mr. Alfred Colson, M.I.C.E.) Messrs. Hick, Hargreaves and Co.'s tender for the sum of £4,695 be accepted. He said that complaint had been made that the committee who had the matter in hand had so drafted the specification for the engines that little originality was left to contracting engineers in designs for the work; but he protested that this was not the case, and that, although several firms had written declining to compete owing to the severity of the conditions of the specification, this was chiefly owing to the fact that these firms had little or no experience in the supply of engines for electric lighting work. After going carefully through the tenders sent in, the Corporation Engineer could only recommend two designs, namely, those of Messrs. Musgrove and Co. and Messrs. Hick, Hargreaves and Co. The former tender was £1,000 in excess of the latter, hence the proposal to accept the latter tender. The tender of the local firm of engineers, Messrs. Jessop and Co., regarding which so much feeling had been shown by the members, was not recommended by the engineer, although he (Alderman Lennard), as Chairman of the Committee, was struck with the excellence of design of the engines tendered for by that firm. It appeared, further, that Messrs. Hick, Hargreaves and Co. provided 10 H.P. in excess of that provided by Messrs. Jessop and Co. Alderman Lennard entered into an exhaustive justification of the action taken by the Committee. An amendment was moved that Messrs. Jessop's tender be accepted, but ultimately, after a long debate, the Committee's recommendation, that the tender of Messrs. Hick, Hargreaves and Co. be accepted, was carried by 36 to 15.

MANCHESTER.—At the last meeting of the City Council the Parliamentary sub-committee's report was presented, dealing chiefly with the subject of arrangements to be made with the National Telephone Company, and to decide whether the wires were to be allowed to be continued overhead. The sub-committee ultimately decided to recommend that they be authorised to enter into direct communication with the National Company in regard to the laying down of underground wires within the city, and to report subsequently to the Council.

MONMOUTH.—At the monthly meeting of the Corporation on Monday correspondence was read from the Local Board, in which the latter body declined to grant borrowing powers for electric lighting until a Provisional Order has been obtained; and the Board further question the practicability of using the water from the River Wye as motive power. It was ultimately decided to engage Messrs. Bramwell and Harris to examine and report on the practicability or otherwise of the turbines for the proposed lighting, and upon receipt of their report to again approach the Local Government Board on the subject.

MUSEUM LIGHTING.—The annual inspection of the Kelvin Grove Museum and the Glasgow Corporation Galleries of Art were made last week by the sub-committee of the Town Council appointed for that purpose. Throughout the handsome buildings the electric light has been installed to the satisfaction of the Committee and of everyone concerned. The apparatus includes 50 Crompton arcs.

RUTHIN.—The Town Clerk has been directed to call a meeting of the Electric Lighting Committee, and to prepare and present a report to that body on the subject of the electric lighting of the district.

SCARBOROUGH.—The Corporation have decided to light the Town Hall by electricity.

STAFFORD.—The Local Government Board have sanctioned the borrowing by the Town Council of £20,000 for Electric Lighting purposes. Offers have been made to the Gas Committee for the purchase of certain lands for the use of the Electric Lighting Committee, which body have reported to the Council on the subject of obtaining tenders for buildings and machinery. The Committee's report has been adopted.

STRAND (LONDON) BOARD OF WORKS.—A remarkable report has been presented by Mr. A. Ventris, surveyor, on the public lighting of this important district. He states that he has made a careful survey of the streets and courts of the neighbourhood, and is of opinion that the lighting power of the public lamps compares unfavourably with those of the surrounding districts; but he is unable to recommend any extensive alteration, and suggests that the lighting of the existing lamps should be increased. He is unable to recommend the purchase of new type lanterns, owing to the expense, as the gas companies are unwilling to let, except on the hire-purchase system, unless for a contract of seven years. He is further credited with the opinion that the present experience of electric lighting for narrow streets—its cost, and, in his judgment, its comparative failure for outdoor lighting, renders the electric light unsuitable for the area over which he is the accredited representative of the Strand Board of Works. After the reading of the report the question of lighting the district was remitted to the Lighting Committee for further consideration.

SWANSEA.—An extensive range of buildings has just been erected by Mr. J. S. Brown at Swansea, and the lighting is

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throughout by electricity, which consists of nearly 120 incandescents of various candle-power, and eight 2,000-c.p. Waterhouse arcs, as well as two 6,000-c.p. arcs for lighting the glass roof and showroom floors. Rising above the roof is a handsome tower, fitted with a search-light projector. The plant includes a Stockport gas engine driven by an Elwell-Parker dynamo.

THEATRE LIGHTING.—The Prince of Wales' Theatre, at Grimsby, is being lighted throughout by electricity, the installation consisting of about 300 16-c.p. lights, in addition to two powerful arc lamps for exterior lighting. Included in the plant is a 14-H.P. Tangye gas engine.

BOOKS RECEIVED.

"Lockwood's Builders' and Contractors' Price Book for 1894." By Francis T. W. Miller. Price 4s. (London: Crosby, Lockwood and Son.)

"Electricity in the Service of Man." By R. Wormell, D.S.C. (From the German of Dr. A. R. Von Urbanitzky.) Revised and enlarged by R. Mullineux Walmsley, D.Sc. (London: Cassell and Co.).

"Induction Coils and Coil-making." By F. C. Allsop. (London: E. and F. N. Spon, 125, Strand).

Transactions of the Royal Society of Edinburgh. Vol. XXXVII. Parts I. and II. (Published by Robert Grant and Son, 107, Princes-street, Edinburgh.)

Proceedings of the Royal Society of Edinburgh. Vol. XX.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by* MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.

APPLICATIONS FOR PATENTS.

NOTE.—***The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.***

January 2, 1893.

135. M. J. PUPIN. London. Improvements relating to the transmission of electric currents and to conductors therefor.*
139. R. CALLENDER. London. Improvements in telephone exchange systems.*
140. R. CALLENDER. London. Improvements in telephone exchange systems.*

January 3, 1894.

191. N. S. KEITH. London. Improvements in dynamos.
192. N. S. KEITH. London. Improvements in electric drills or reciprocating motors, and in dynamos for working the same.

January 4, 1894.

207. S. Z. DE FERRANTI. London. Improvements in electrical transformers and apparatus connected therewith.
249. F. KING. London. Improvements in electric switching apparatus, more especially intended for use on electrically-propelled vehicles carrying both the source of electricity and the motors.

January 5, 1894.

267. W. V. HUNT and W. HUNT. London. An improved electric bell indicator.
294. W. P. THOMPSON. Liverpool. Improvements in type-printing telegraphic apparatus. (J. Kustermann, Germany.)

January 6, 1894.

334. P. H. JAUNCEY. Birmingham. Improvements in fastenings for electric light shades or globes.

January 8, 1894.

382. H. C. L. HOLDEN. Belvedere. Improvements in secondary batteries.
433. C. P. ELIESON. London. An improved electric switch.
439. H. H. LAKE. London. Improvements in girder clamps and hangers for supporting pipes, electric conductors, and the like. (C. MacTaggartt and F. McKernan. United States.)

January 9, 1894.

444. C. S. NORTHCOTE and J. B. VERITY. Birmingham. Improvements in electric light fittings.
454. W. EALDRED, Sheffield. Improvements in the generation and distribution of the electric current.
484. J. COSTIGAN, London. Improvements in electrical alarum clocks.
489. E. HERBERT, London. Improvements in electrical clocks.
494. W. P. THOMPSON, Liverpool. Improvements in forges or furnaces for heating or working metals electrically. (C. L. Coffin, United States).*
495. W. P. THOMPSON, Liverpool. Improvements in transformers or converters for electric currents. (C. L. Coffin, United States.)*
496. W. P. THOMPSON, Liverpool. Improvements in apparatus for heating or welding metals electrically. (C. L. Coffin, United States.)*
513. G. J. PHILPOTT and R. HAMMOND. London. Improvements in or relating to apparatus for the production and distribution of electricity.
524. R. W. P. ROBERTSON. London. Automatic switch for accumulator charging.

January 10, 1894.

526. E. L. LEVETUS. Birmingham. Improvements in electric brushes.
546. A. MUIRHEAD and G. W. GREEN. London. Improvements in electric telephony.
548. W. P. THOMPSON. Liverpool. Improvements in or appertaining to working quadruplex and duplex telegraph signal-receiving instruments. (W. F. Melhuish, India.)

January 11, 1894.

646. W. WALKER, jun., T. R. WILKINS, and J. LONES. London. Improvements in primary voltaic batteries.
653. J. W. T. CADETT. London. Improved means for arranging and intensifying the magnetic fields of dynamo-electric machinery.
654. G. C. FRICKER. London. Improvements in electrically illuminated advertising signs.
666. J. B. C. EVANS. London. Improvements in holders for incandescent lamps.
670. A. PHILIP. Richmond. Improvements in the manufacture of electrodes and use of the same.

January 12, 1894.

689. A. W. STEWART. Dalmuir. Improvements in the application of incandescent lamps for use as night lights.
690. R. S. HAMPSON. Manchester. Improvements in electric apparatus for signalling on railways.
722. G. L. ADDENBROOKE. London. Improved electrical marine engine Governor. (R. Macdonald, Australia.)
764. G. H. NISBETT. London. Improvements in jointing and connecting electric cables.

January 13, 1894.

791. J. J. WILSON. Croydon. A combination door belt and electric switch.
835. J. HARGREAVES and T. BIRD. London. Improvements in the construction of electrolytic apparatus and in the application thereof in oxidising, chlorinating, and analogous processes.
836. J. HARGREAVES and T. BIRD. London. Improved means for obtaining metallic bases and their compounds by electrolysis.

15th January, 1894.

854. T. ELCOATE. Stockton-on-Tees. Electrical Tramways.
863. W. McGEOCH, Junr., A. J. McGEOCH, and F. G. HOWARD. Glasgow. Improvement in incandescent electric lamp-holders, ceiling-roses, and other electric fittings.
908. W. L. WILLIAMS, W. T. GOLDEN, and H. W. RAVENSHAW. London. Improvements in apparatus for heating cylinders and parts of hydraulic machinery by the aid of electricity.
916. H. T. HARRISON. London. Improvements in electrical measuring instruments.

January 16, 1894.

923. B. DEAKIN. London. Improvements in high and tow-tension electric fuses.
993. P. J. C. CARRON. London. Improvements in brushes for dynamo-electric machines.
1,003. H. H. LAKE. London. Improvements in electric railways. (E. H. Johnson and R. Lundell. United States.)*

January 18, 1894.

1,087. B. H. THWAITE and G. CAWLEY. London. Improvements in methods of electric haulage.
1,110. E. J. B. LOWDON. Dundee. Improvements in automatic electric governors for prime or other motive power engines.
1,113. W. L. SPENCE. Manchester. Improvements in or in connection with dynamo-electric machinery.
1,115. A. ESSINGER and T. HARDEN. London. Improvements in safety devices for electrical circuits.

January 19, 1894.

1,164. H. PENN and L. LOWNDES. London. Improvements in armatures of dynamos and electric motors.
1,169. G. H. NISBETT. London. Improvements in electric arc lamps.
1,199. H. G. FARRELL. Sheffield. New or improved device for operating the the buttons or switches of electric bells.

January 20, 1894.

1,268. E. J. HOWELL. Birmingham. Apparatus for actuating electric switches, gas and water cocks, or the like.
1,306. E. O'BRIEN and THE ELECTRICAL INSTALLATION COMPANY (LIMITED). London. Improvements in electric heaters.
1,307. H. H. COOPER and THE ELECTRICAL INSTALLATION COMPANY (LIMITED). London. Improvements in electric switches.
1,308. H. E. WALTER. London. Improvements relating to electro-magnetic railway brakes and to brake couplings for railway trains.

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January 22, 1894.

1,320. C. C. CONNOR. Belfast. Improved electrical insulated fitting.

1,356. E. ANDREOLI. London. Improvements in electrolysis.

1,375. C. LANGDON-DAVIES. London. Improvements in rapid telegraphic transmission.

January 23, 1894.

1,417. G. H. WHITTINGHAM. London. Automatic device for removing resistance in starting electric motors and replacing same.*

1,433. W. F. KING. Glasgow. Apparatus for advertising by means of electric lamps.

1,440. J. PEEL. London. Improved electric battery.

1,461. H. M. EDWARDES. London. A detachable ear-piece or device for use in connection with the phonograph.

1,473. H. H. LAKE. London. Improvements in dynamo-electric machines. (G. F. Dieckmann, United States.)*

1,478. J. L. YOUNG. London. Improvements in connection with phonographs, grammaphones, graphaphones, and similar sound-recording and reproducing instruments.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d. each.

1893.

238. SULLIVAN. Galvanometer.

660. PICKARD and THAME. Battery elements.

3,101. JEFFERSON. Insulating armatures of dynamo-electric machines.

3,831. KINGSBURY (Western Electric Company). Telephone exchange systems.

4,390. CANNEVEL. Electric arc lamps.

4,772. MARSH. Metal arms for supporting telegraph insulators, &c.

22,253. BRADRICK and KARR. Railway electric signals.

COMPANIES' MEETINGS AND REPORTS.

Cuba Submarine Telegraph Company (Limited).

The following is the report of the Directors of this Company for the half-year ended December 31st last, to be presented at the forty-fifth ordinary general meeting of shareholders, to be held at 58, Old Broad-street, E.C., on Wednesday next, the 14th inst., at 12 o'clock :—

From the accounts accompanying the report it will be seen that the gross receipts (including the balance brought from last account) amount to £23,229. 1s. 6d., and the gross expenditure to £5,069. 16s. 6d., leaving a sum of £18,159. 5s. to the credit of revenue account. Of this the sum of £1,500 has been set aside as a further reserve against any loss from the deposits with banks, and £5,000 added to the reserve fund, making that fund £105,000. The dividend on the Preference shares will absorb £3,000, and leave £8,659. 5s., out of which the Directors recommend the payment of a dividend on the Ordinary shares at the rate of 8 per cent. per annum, free of income-tax, the balance, £2,259. 5s., being carried forward to the current half-year, against £2,002. 7s. 6d. at the end of the previous half-year.

The cables have continued in good order throughout the half-year, with the exception of a part of the original cable laid in 1870, between Batabano and Cienfuegos, which gave out at the end of last month ; the other portion of the same cable, between Cienfuegos and Santiago, was abandoned 13 years ago. In consequence of the decayed state of the sheathing, its effectual repair, without renewing the greater part of it, is impracticable, and it has therefore been decided not to spend any more money upon it, but to put down a new cable, the cost of which will be charged to the reserve fund.

The position of the Company's suit against the Spanish Government at Madrid remains the same as at the date of the last report.

Kensington and Knightsbridge Electric Lighting Company (Limited).

The following report is issued by the Directors of this Company, to be presented at the seventh ordinary general meeting to be held at Great George-street, Westminster, S.W., on Thursday next, the 15th inst., at 5 p.m. :—

The district of the parish of St. Mary Abbotts, Kensington, arranged to be purchased from the Chelsea Electricity Supply Company (Limited), was transferred to this Company in June last, the necessary statutory powers having been obtained. As far as can be judged from the experience of one half-year, there is every reason to anticipate a satisfactory result from this addition to the Company's area.

The mains, which extended to a length of 13 miles on December 31, 1892, have been increased during the year 1893 to 16¼ miles—of which increase two miles are due to the new district and 1¼ to extensions of the Company's original system.

During the year the number of houses and shops connected with the system has increased from 550 on December 31, 1892, to 734 on December 31, 1893 ; while the number of lamps calculated on the usual basis of eight candle-power has increased from 47,441 to 64,529. Out of the total increase the new district represents 83 houses and shops, and 5,262 lamps. Thus the increase on the Company's original district is 101 houses and shops, and 11,826 lamps.

After paying the dividends on the Six per Cent. First Preference shares to June 30, 1893, on the Five per Cent. Second Preference shares to September 30, 1893, and an interim dividend at the rate of 4 per cent. per annum on the Ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1893 is £4,788. 7s. 9d. Of the above sum £1,456. 4s. 7d. has been appropriated for the payment of the First Preference dividend to the end of the year, and £88 has to be set aside to meet the portion of the dividend on the Second Preference shares to the same date, leaving £3,244. 3s. 2d., out of which it is proposed to pay a further dividend on the Ordinary shares, at the rate of 6 per cent. for the past half-year, making a total dividend for the year of 5 per cent. This will leave a balance of £1,059. 15s. 8d. No provision has been made in the accounts for Directors' remuneration.

In accordance with the Articles of Association, Mr. R. W. Wallace and Mr. A. S. Bolton retire from the Directorship, and, being eligible, offer themselves for re-election. The auditors, Messrs. Lovelock, H. W. Whittle and Dickinson offer themselves for re election.

Newcastle and District Electric Lighting Company (Limited).

The following is the Directors' report, to be presented at the seventh ordinary general meeting, to be held at 57, Westgate-road, Newcastle-upon-Tyne, on Monday next, the 12th inst., at 2:30 p.m. :—

The Directors have pleasure in again reporting that the supply of current continues to give satisfaction to the Company's consumers. The installations connected to the Company's mains during the year are equal to 4,000 10-c.p. lamps, bringing the total up to about 18,500, and 388,422 units of electrical energy have been supplied, as against 290,469 units supplied in 1892. During the past year 3,308 yards of main and branch piping have been laid, together with 6,579 yards of main and branch cable. After some difficulty in carrying through the drift to the river, the condensing plant, referred to in last year's report, is now in operation, and although it has been working only about three months, a considerable saving has been effected in the consumption of fuel and water.

The gross earnings during the year amount to £2,949. 12s. 3d., and after paying interest and making provision for reserve fund and depreciation, and writing off £100 from formation expenses, the Directors are able to recommend a dividend at the rate of 3 per cent. for the half-year ending December 31st (less income-tax), which, together with the interim dividend paid in July last, makes the dividend 5½ per cent. for the year.

Mr. John D. Milburn and the Hon. C. A. Parsons retire by rotation, but are eligible, and offer themselves for re-election as Directors. The auditors, Messrs. Strachan and Co., also offer themselves for re-election.

India Rubber, Gutta Percha, and Telegraph Works Company (Limited).

The following is the Directors' report for the year ended December 31, 1893, to be presented at the thirtieth ordinary general meeting, to be held at the Cannon-street Hotel, E.C., on Thursday next, the 15th inst., at 12 o'clock :—

The accounts show the net profit for the past year to be £94,607. 4s. 2d. Adding £46,844. 17s. 5d. brought forward, and deducting £25,000 interim dividend paid in July, there remains a disposable balance of £116,452. 1s. 7d. The Directors have added £50,000 of this balance to the reserve fund, and recommend the distribution of a dividend of 10s. and a bonus of 5s. a share, free of income-tax, amounting to £37,500, making, with the interim dividend, a total payment for the year of 12½ per cent., and leaving £28,952. 1s. 7d. to be carried forward.

The Company's general business continues to increase. The cable for the Central and South American Telegraph Company mentioned in the last report was duly laid, and a few other cable manufacturing and repairing contracts were carried out during the year. The efficiency of the Silvertown and Persan factories is maintained.

Mr. Scott and Mr. Henderson, the Directors retiring by rotation, offer themselves for re-election.

Newcastle-upon-Tyne Electric Supply (Limited).

The sixth general meeting of this Company was held last week, at the Station Hotel, Newcastle. The Directors' report and balance-sheet having been adopted, a dividend at the rate of 4 per cent. per annum for the half-year ended December 31st last was declared, which, together with the interim dividend paid in July last, makes 4 per cent. for the year.

Sunbeam Lamp Company (Limited).

The annual meeting of this Company was held last week at the offices, Park-road, Gateshead, when an encouraging report of the work done by the firm was presented by the Secretary (Mr. T. J. Grainger), which stated that since the Company resumed operations in November last the factory had been kept busily employed.

On the motion of Dr. J. T. MERTZ, seconded by Miss RICHARDSON, Capt. H. Chapman (Messrs. Clarke, Chapman and Co., Limited) was re-elected Director of the Company.

At the conclusion of the meeting the shareholders and members of the Press made an inspection of the works, under the guidance of the Managing Director, Mr. J. W. Edmundson, and Mr. Grainger.

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NEW COMPANIES, STATUTORY RETURNS, &c

In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in "The Electrician" Electrical Trades' Directory and Handbook, 1894, pages 274-300, &c., &c.]

BRONZE STEEL SYNDICATE (LIMITED).—This Company has been registered with a capital of £6,000 in £1 shares, to carry on business as metallic alloy manufacturers, metal merchants and brokers, steel, iron, bronze and copper manufacturers, &c.

LAS CABESSES MANGANESE MINES (LIMITED).—This Company was registered on February 3rd, with a capital of £250,000 in £10 shares, to acquire the manganese mines and undertaking known as "Las Cabesses," situate in the Department of Ariege, France, now belonging to Charles Simon, who receives 24,000 fully-paid shares as the purchase consideration. The first Directors include John C. Swan, electrical engineer, of Bromley, Kent.

MOSLEY AND CO. (LIMITED).—This Company was registered on February 1st, with a capital of £11,000 in £1 shares, to acquire any patents, licences, concessions, &c., for depositing zinc by electricity or otherwise, upon steel, iron, or any other metal, and to acquire any patents connected with processes for depositing one metal upon another by means of electricity. The subscribers (with one share each) are:—William Thorpe, T. Hainsworth, T. Coombs, W. H. Stocks, J. Day, T. Naylor, and H. B. Farr, all of Leeds.

ELECTRO-PROTECTOR SYNDICATE (LIMITED).—This Company has lately entered into an agreement with Robert Jewell, of 11, Queen Victoria-street, London, E.C., for the acquisition of certain letters patent (particulars of which do not transpire) for £7,000, payable by the allotment, as fully paid, of 7,000 shares, Nos. 3,001 to 10,000 inclusive.

EUROPE AND AZORES TELEGRAPH COMPANY (LIMITED).—The statutory return of this Company, made up to December 28, 1893, was filed on the following day, when 16,700 shares of £10 each out of a capital of £200,000 were taken up. Of these, 5,568 have been issued as fully paid to the Telegraph Construction and Maintenance Company, the contractors for the cable, and a call of £5. 10s. per share has been made on the remaining 11,132 shares, resulting in a total payment of £61,226. The Eastern Telegraph Company hold 5,216 shares, and the Brazilian Submarine Telegraph Company a like number.

EUROPEAN SIMS-EDISON ELECTRICAL TORPEDO COMPANY (LIMITED). The second annual return of this Company, made up to January 14th, has been filed. The nominal capital is £201,000, divided into 10,000 Ordinary shares, of £20 each, and 1,000 Founders' shares, of £1 each. 7,880 Ordinary and 1,000 Founders' shares have been taken up, and 7,350 Ordinary shares have been issued as fully paid. Upon the remaining 530 Ordinary and the Founders' shares the full amount has been called, resulting in the payment of £10,458, leaving £1,142 in arrears.

GENERAL ELECTRIC COMPANY (LIMITED).—The annual return of this Company, made up to January 5th, has been filed. The nominal capital is £60,000, divided into 7,000 First Preference, 1,000 Second Preference, and 4,000 Ordinary shares, all of £5 each. 6,325 First Preference, and all the Second Preference and Ordinary shares have been taken up, the two latter classes being issued as fully paid. The full amounts have been called, and £31. 6s. paid on the First Preference shares. By special resolution passed December 22, 1893, and confirmed on January 8, 1894, the nominal capital was increased to £85,000 by the creation of 5,000 Third Preference shares of £5 each, and certain alterations were made in the Articles of Association.

GENERAL ELECTRIC POWER AND TRACTION COMPANY (LIMITED).—The annual return of this Company, made up to December 26, 1893, has been filed. The nominal capital is £350,000, divided into 25,000 Ordinary and 10,000 Preference shares of £10 each. 23,592 Ordinary and 10,000 Preference shares have been taken up, and 21,734 Ordinary issued as fully paid. Upon the remaining Ordinary shares the full amount has been called, and upon the Preference shares a call of £9 per share has been made. The calls paid amount to £107,985, leaving £595 unpaid.

HOVE ELECTRIC LIGHTING COMPANY (LIMITED).—The first annual return of this Company, made up to December 26, 1893, was recently filed. The nominal capital is £40,000, in £5 shares, of which 3,396 have been taken up. Upon 3,350 of these the full amount has been called, and upon the remaining 46 shares a call of £2 per share has been made. The calls paid (including a sum of £33 paid in advance of calls) amounts to £16,850, leaving £25 in arrears.

HOLLOWAY ELECTRICITY SUPPLY COMPANY (LIMITED).—When the first annual return was made up (filed on December 12, 1893), only the seven subscribers' shares were taken up out of a capital of £2,000 in £10 shares, and nothing paid thereon.

INCANDESCENT ELECTRIC LAMP COMPANY (LIMITED).—The statutory return of this Company, made up to December 4th, was recently filed. The nominal capital is £25,000, divided into 2,000 Ordinary and 5C0 Deferred shares of £10 each. 1,200 shares have been taken up, and a call of £2. 10s. per share made, resulting in the payment of £2,850, and leaving £150 in arrears.

ISLE OF WIGHT ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return of this Company made up to September 27, 1893, was recently filed, and shows that seven shares have been taken up out of a nominal capital of £1,000, in £1 shares, no calls having been made.

ITALIAN ELECTRICAL LIGHT AND POWER COMPANY (LIMITED).—The second annual return of this Company, made up to December 22nd, has been filed on December 29th. The nominal capital is £60,000, in £4 shares, of which 307 have been taken up. Of these 300 were issued as paid to Girolamo Taddei, of 83, Via Arenula, Roma, and no calls have as tey been made on the signatories' shares.

CITY NOTES, &c.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY (LIMITED).—The report of the Directors of this Company is issued, and, after dealing with the Company's financial position, the Directors proceed: "We have also concluded our investigations with reference to electricity as a motive power, and we, with confidence, recommend the shareholders to approve the adoption of the overhead system of electric traction on the existing line from Old Market-street to St. George, as well as the proposed extension to Kingswood. The latter district is not only a very populous one, but an important manufacturing centre, and has, up to the present, suffered from want of means of communication with Bristol. We recommend the shareholders to carry out this extension (the Parliamentary powers for which we already possess) if the necessary authority is obtained for the use of electric motive power." The population to be served by this line is nearly 60,000, and the Directors anticipate the hearty co-operation of the Local Boards of the district, as well as the Bristol Corporation. The Company will shortly invite further capital, consisting of 5,000 new shares of £10 each.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended February 4th, were £951, as against £956 for the corresponding period of last year, being a decrease of £5. The total receipts for the half-year amount to £4,790, as against £4,910 for the corresponding period of 1893, a decrease of £120.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of January are £3,900, as compared with £3,876 in the corresponding month of last year.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of January amounted to £1,909, as against £1,901 for the corresponding period of 1893.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the month of January, 1894, amounted to £64,851, as against £60,516 in the corresponding period of last year, or an increase of £4,335.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of January amounted to £39,677 as against £43,040 for the corresponding period of 1893.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company for January, 1894, amounted to £21,000. In the corresponding month of 1893 and 1892 they were £20,800 and £20,000 respectively.

HOBART ELECTRIC TRAMWAY COMPANY (LIMITED).—The traffic receipts for the month of December, 1893, were £1,488, and for January, 1894, amounted to £1,682.

MILDE TELEPHONES AND ELECTRIC SUPPLY COMPANY (LIMITED).—As announced in our last issue, a Company has been formed under the above title to trade in the telephones and general electrical apparatus manufactured by Messrs. Ch. Mildé Fils et Cie, Paris. The Company has a capital of £20,000, in Preferred and Deferred shares of £1 each. The offices of the Company are at 60, Watling-street, London, E.C., where prospectuses and forms of application can be obtained.

NEW ELECTRICAL RAILWAY.—For a number of years it has been the ambition of the Directors and shareholders of the London and South-Western Railway Company to bring the present terminus of the line, Waterloo Station, into closer touch with the City. The subject has been discussed times out of number, as the chairman, Mr. Wyndham S. Portal, stated at the meeting of the Company on Wednesday last, but has had to be abandoned as an unprofitable enterprise on which the Company could not afford to embark. The estimated cost of constructing an ordinary railway between the two points, was between three and four millions sterling, and the Directors could not seriously entertain a proposal involving such a larger capital expenditure without seeing their way to get a commensurate increase of traffic. Happily, however, science, and particularly that branch of it which comes under the qualification, electric, has been steadily advancing, and has been invoked to obviate the difficulties which passengers by the London and South-Western Railway have hitherto experienced in getting to and from the City. As our readers are aware, it is now proposed to construct an electric railway from Waterloo Station to a point near the Mansion House, and at the meeting referred to a special resolution was unanimously adopted, empowering the board to proceed at once with the carrying out of the undertaking which, it is calculated, will cost between £500,000 and £600,000. Tenders are to be at once invited. The line, which will be constructed in the course of two or three years, will prove a great boon to residents on the London and South-Western Company's system, and will doubtless prove a source of remunerative traffic to the Company itself.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to allow 6,832 shares in W. T. Henley's Telegraph Works (Limited) to be quoted in the Official List.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED). Subject to audit of the accounts, the Directors propose paying a dividend of 15 per cent. (£1. 16s. per share), in addition to the 5 per cent. already paid, making 20 per cent. for the year 1893.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LIMITED).—A dividend at the rate of 5 per cent. per annum for the half-year has been declared.

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WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the week ending February 2nd (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,207.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the two weeks ended January 21st were £2,649, as compared with £3,074 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Divid.	Name	Previous Week's Price, Jan. 31		Price Wednesday, Feb. 7		Rate per Cent. Yielded (£ s. d.)	Dividend Due	Business Done During Week Ending Feb. 7: Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	13/6	Anglo-American xd	42	44	42	44	6 5 0	Jan., Apr., July, Oct.	..	..
£2,932,680	Stock	27/0	Do. Preferred xd	78½	79½	79½	80½	6 18 4	" "	80	79
£2,932,680	Stock	5/0	Do. Deferred	7½	7¾	7½	7¾	..	" ..	7 7/16	..
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	100	103	100	103	3 17 8	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	11¼	11¾	11¼	12	5 10 8	Mar., June, Oct., Dec.	11⅜	11⅛
£18,700	£100	5%	Do. 5 per Cent. Bonds xd	99	102	99	102	4 18 0	January and July	..	–
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	–	–
10,000,000	$100	7%	Commercial Cable Capital Stock	130	140	135	145	4 16 7	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11½	12½	11½	12½	6 8 0	February and August	–	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	..	..
60,710	20	8/0	Direct United States Cable, 1877	9¼	10	10	10½	6 10 0	Jan., Apr., July, Oct.	10	9¾
400,000	10	2/6	Eastern	14⅞	15⅛	14⅞	15⅛	4 5 11	" "	15⅛	14⅞
70,000	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16¼	3 13 10	" "	16½	15¾
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	116¾	115⅝
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899 xd	108	111	106	109	4 11 9	February & August	107¼	..
250,000	10	2/6	Eastern Extension	15½	15¾	15½	15¾	4 8 11	Jan., Apr., July, Oct.	15¾	15 1/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock xd	113	116	113	116	3 9 0	February & August	–	..
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	101	104	101	104	4 16 2	January and July	–	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	101	104	101	104	4 16 2	" "	–	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.) xd	103	106	102	105	3 16 2	February & August	..	–
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	106%	109%	106%	109%	3 13 5	May and November	..	..
180,227	10	1/3	Globe Telegraph and Trust	8⅝	8⅞	8⅜	8⅝	5 4 4	Jan., Apr., July, Oct.	8¾	8 9/16
180,042	10	6%	Do. 6 per Cent. Preference	15¼	15¾	15½	15¾	3 18 1	" "	15 7/16	15 3/16
150,000	10	5/0	Great Northern	20½	20¾	21¼	21¾	3 18 4	Jan., April, and July	21½	20¾
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	..	..
17,000	25	12/6	Indo-European	41	44	41	44	5 13 8	May and November	43	42
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	3 6 8	" "	..	–
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	106	109	5 10 1	March & September	–	–
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red 1942	101	104	101	104	3 16 11	..	..	..
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	..	..
3,381	£100 Cert.	25/0	Submarine Cables Trust 6 per Cent.*	114	119	113	118	5 1 8	" "	–	..
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July	..	..
£249,900	100	5%	Do. 5 per Cent. Debentures	100	103	100	103	4 17 1	March & September	..	..
30,000	10	2/0	West Coast of America	2	2½	2	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	97	101	97	101	7 18 5	June and December	..	..
88,821	10	1/0	West India and Panama	1	1¼	1	1¼	..	..	1⅛	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	9½	10	9½	10	6 0 0	May and November	9⅝	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 7	June and December	107½	..
64,242	15	4/6	Western and Brazilian	5¾	6½	6½	7	..	May and November	..	..
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5½	5¾	5½	6	..	..	..	–
33,129	7½	4/6	Do. 5 per Cent. Deferred	1½	1¾	1¾	2½	..	..	2	1½
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910 xd	104	107	102	105	5 14 3	February & August	..	..
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910 xd	104	107	102	105	5 14 3	" "	104½	103½
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	105	102	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	–	–	–
224,800	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
220,000	£1	4·76d.	Oriental Telephone and Electric (11s. paid)	½	⅜	½	⅜	5 6 5	Yearly	..	–
484,597	5	2/6	National	4⅜	4⅞	4¾	5	5 2 7	June and December	4 15/16	4¾
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½	15½	14½	15½	3 17 5	" "	15	..
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	14	15	14	15	4 0 0	" "	14⅝	14½
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¼	5½	5¼	5½	4 10 11	..	5 7/16	5⅜
925,017	£100	4½%	Do. Deb. Stk. 4½%	112	114	112	114	3 18 11	January and July	113½	113
58,000	5	1/0	United River Plate	1½	2	1½	2	–	" "	–	–
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	–	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11¼	11¾	11	11½	–	..	11¼	..
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	13	13½	12¾	13½	..	–	13½	13 1/16
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	–	–
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	–	–	–
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	–	–
8,322	£5	..	House to House Electric	..		..		–	–	–	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		–	–	–	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	–	–
30,000	£5	1/9	Liverpool Electric Supply (£3 10s. paid)	4⅜	4¾	5½	5⅝	..	–	–	–
15,000	£5	2/6	Do. (fully paid)	6⅛	6⅝	6⅛	6⅝	..	–	..	–
111,000	5	..	London Electric Supply	½	¾	¼	¾	–	..	..	..
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	8½	8¾	8	8½	2 5 7	..	8½	8 3/16
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	104	108	104	108	4 12 7	June and December	..	..
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	–	–	..	–
19,980	£5	4/6	St. James' and Pall Mall xd	5¼	6	5¾	6½	..	–	..	..
20,000	£5	7%	Do. 7 per Cent. Preference xd	7¾	8¼	7¾	8¼	4 4 10	–	8½	8 1/16
59,900	5	1/6	Westminster Electric Supply (fully paid)	5¼	5¾	5½	6	2 18 4	–	5⅝	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	2/1	Brush Electrical Engineering	2⅝	2⅞	2⅝	2⅞	6 5 4	–	2¾	2⅝
90,000	2	6%	Do. 6 per Cent. Preference Non-Cumulative.	2⅛	2⅜	2⅛	2⅜	5 1 1	–	2⅛	..
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	104	106	104	106	4 4 11	March & September	106	105½
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	3	4	3	4	..	January and July	3½	3 1/16
12,139	5	..	Edison and Swan United	–		–		–	–	–	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		–	–	..	½
120,000	2	..	Electric Construction	½	1	½	¾	..	–	⅝	..
12,845	2	..	Do. 7% Cumulative Pref.	1	1½	1¼	1¾	..	–	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	⅜	⅝	⅜	⅝	..	..	–	–
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	–	–	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	23	24	23	24	5 4 2	February & August	24	23½
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	..	–
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	..	–	–
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	–	–
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/16	5/16	3/16	5/16	..	..	–	..
78,949	5	3/6	Swan United (£3. 10s. paid)	2¼	2¾	2	2½	..	May and November	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	36	38	42	44	4 1 9	March and July	42¾	37
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	103	106	..		..	January and July	..	..
37,514	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		–	–	–	–
41,098	£5	–	Do. Preference (fully paid)	..		..		–	–	–	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	5%	City and South London Railway	28	33	28	33	2 5 5	May and November	..	–
87,500	£10	–	Liverpool Overhead Railway	5	5½	4⅞	5⅛	–	–	–	–

* Ex 25/- Balance Coupo October 15, 1893.

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THE ELECTRICIAN:

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NOTES.

The dividends, ranging from 4 per cent. to 5 per cent., which have within the past week or so been declared by some five of our metropolitan electricity supply companies, are in themselves a satisfactory evidence that the business can be made to pay. The steady 12 per cent. of the Gas Light and Coke Company is not, perhaps, altogether to be envied, but whether so or no, it is not, in the nature of things, likely to be attained by an electricity supply company; the day for colossal monopolies of that particular kind are over, at any rate for the present, and gas and internecine competition, and the necessity of making timely provision for the day of purchase, forbid anything in the shape of extraordinary profits. Indeed, there are already some ominous symptoms that the reduction in the cost of production, which is being brought about by experience and large-scale working, is not keeping pace with the rate-cutting policy which was inaugurated last year, and is no doubt destined to continue. There is not much cause to quarrel with the comparatively small sums hitherto generally set aside for depreciation, since the very circumstances of the case require that the plant of an electricity supply company should be kept in perfect repair; but the business will not be in a wholly sound state until, in addition to the payment of a 5 per cent. or 6 per cent. dividend, substantial preparation is made against the day of municipal wrecking—we mean reckoning.

Merely by the way, and not with any desire to make "odorous comparisons," it may be interesting to note how the electricity supply business prospered abroad during 1893. In New York, according to the Report of the Directors of the Edison Illuminating Company, the past year was a most prosperous one. The Edison Company has now the equivalent of nearly 400,000 8-c.p. lamps connected to its mains, not to mention 2,500 arcs and motors to the extent of over 5,500 H.P. The net earnings of the concern for 1893 were £121,128, an increase of 27 per cent. over those for 1892. In Paris the Compagnie Continentale Edison reports a profit for 1893 of £101,340, an increase of 21 per cent. over the figure for 1892. In Berlin the Elektricitätswerke, which has a lamp connection of 328,000, has paid an 8½ per cent. dividend, and put £5,200 to the reserve and renewal funds.

It is gratifying to note the steady progress and continued success of the two great electric traction enterprises in this country—the City and South London Railway and the Liverpool Overhead Railway. Of the two the latter has by far the more favourable position, and yields the more satisfactory results. During the past six months the Liverpool line, the numerous stations on which skirt the docks, has carried passengers at the rate of five millions per annum. According to the Report presented at the shareholders' meeting last Tuesday, the gross earnings for the six months were £18,518, and the working expenses for this period £13,732, by which it will be seen that both in efficiency of plant and in carefulness of management a very satisfactory condition of affairs obtains. The number of trains run during the stated period was 46,429, of which 95·35 per cent. were stated to be "on time." Items like this, though some engineers might not admit it, are quite as important to the success of a railway scheme as the question whether the low-pressure cylinders at the generating station ought or ought not to be jacketted. Public confidence is worth a good many pounds of steam, and statistics such as the foregoing confirm us in the belief that electric traction of this class can be made a sound financial success, and can be made to compete without fear, under these or similar conditions, with any existing system of railway traction.

Prof. H. Robinson's Paper read before the Society of Arts on Wednesday last, and printed in abstract in our present issue, gives only a general account of the St. Pancras supply system, and was intentionally written only on broad lines. Little or nothing, unfortunately, was added in the discussion, for the author declined to give information even on such small but interesting details as the air-pressure maintained in the culverts by the ventilating fan. This, and the cost of pumping, &c., for condensing, he promised for a future communication. Mr. A. Siemens made a few remarks, and observed that as the new sub-station was 2,700 yards distant from the station, the three-wire system was easily adapted for a two-mile radius. Mr. Kapp somewhat surprised the audience by speaking of the difference between the coal consumption per unit sold per annum and the consumption estimated from tests of the dynamos at Thames Ditton, as a mystery. The difference was indeed large, since Prof. Robinson's figures work out at about 12lb. per unit. Mr. Kapp gave a few figures about Bristol. There are 11 sub-stations, the supply extends over two miles, and further extension is demanded. Lead-covered iron-armoured cables are used, 12,000 lamps are connected, and the coal works out at 12lb. per unit. The most interesting contribution to the discussion was from Mr. Eccleston

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Gibb, who gave an account of the action of the County Council in connection with loans to municipal authorities. Justice cannot be done to these remarks in a brief abstract, and we hope to give them in a more complete form on another occasion.

The Victoria Embankment lighted by the Metropolitan Board of Works in 1884 under an agreement with the Jablochkoff Company is to be taken in hand shortly by the County Council. The Highways Committee recommended that poles should be set in the middle of the road, a proceeding which Colonel Ford, for some inscrutable reason, thought would be "for the inconvenience of the vast masses of the people who used Waterloo and Westminster Bridges." That £2,000 might be thus saved appealed to several members, but fortunately this proposed disfigurement was abandoned. Posts in the middle of the road are all very well where there is plenty of room, and where, as in Tottenham Court-road and other places, there is no view to spoil. We regret, however, that it has been suggested to place the lamps on alternate sides of the Embankment roadway. This is quite unnecessary. The lighting in 1884, from the lamps on the parapet, was, as far as distribution is concerned, excellent. The traffic in the late afternoon and evening is almost entirely westwards, and, therefore, on the river side. A single sweep, more than a mile and a-quarter long, of close-set six-ampere arcs on the present posts would have a fine effect. Elaborate as is the ornament on the City posts, as disclosed in the illustrations in Gen. Webber's Paper, but hardly noticed in the streets, the general appearance is ugly, and not much more can be said for the posts at Brighton, or for the German ironwork at Oxford. Ten-ampere lamps on high posts at long intervals are cheap, but they would spoil the Embankment, of which, but for such hideous buildings as King's College and Charing Cross Station, all Londoners are particularly proud.

A curious want of proportion exists between the length of the report of the inquest on the lad who was killed at Prescot, through meddling with high pressure wires, a fortnight ago, and the report furnished to the Board of Trade by its electrical adviser on the accidental death of a grey mare at Bournemouth. Twelve honest men with a newspaper knowledge of electric lighting are supposed to be competent for the former case, and if they think fit, to suggest precautions which ought to be adopted. But it must not be supposed that the Electrical Department is so well equipped that, like the Railway Department, an inspector can be sent off at an hour's notice to report upon every accident. So willing is it, however, to serve the public that when the Bournemouth Town Council telegraphed for advice, Major Cardew was on the spot within twenty-two hours of the mishap. The curiously high insulating character of the soil, and "the juxtaposition of masses of thawed and masses of frozen ground," seems to have caused the current to rise from one leak to the surface, to pass along the wet surface, and to descend to the other leak. Such a combination of circumstances must, of course, be very rare. The iron pipes in which the conductors are drawn ought to have been bonded together with a metallic connection. This is the practice at Bournemouth, but it had been neglected in this one instance. A question asked in the House of Commons on Monday shows that there is a natural fear that human life may be endangered by such accidents. This matter may confidently be left with the Board of Trade. It may be remarked that the shoes of a horse make an exceptionally good contact, and this particular one was pre-disposed by a weak heart. On one occasion, at Berlin, a man laid his hand on a horse's back and experienced only a slight shock, while the horse fell stone dead.

When, about three years ago, a scheme was announced for building a locomotive on which a high-speed engine was to drive a three-phase alternator, which was in turn to drive motors, it met with a little ridicule, and the two sets of tests which have been recently made on the Chemin de Fer l'Ouest at Havre have raised a smile, but only where the reasons for this roundabout system have not been understood. The two chief difficulties in obtaining higher speeds than from 70 to 80 miles an hour with ordinary express locomotives are want of balance and want of space. A good rotary engine would get over the first disadvantage, but want of space would become a more serious difficulty than at present if an attempt were made to mount such an engine direct on the axles. The impossibility of avoiding the superfluous vertical action of balance weights on an ordinary single-wheel locomotive is alone sufficient to reduce the adhesion and to allow slip at speeds a little over 80 miles an hour, and a driving wheel 8ft. diameter, running at 60 miles an hour, only makes 210 revolutions per minute. Another drawback to a locomotive as commonly built is that the direct connection between its speed of travel and the speed of the driving wheels actually checks the full output of the engine on a gradient at the time when maximum power is wanted. All these difficulties are reduced, if not avoided, in the Heilmann locomotive, though not without the introduction of others, and it remains to be seen how the balance of advantages works out.

The idea of using a three-phase alternator was soon abandoned, as more or less synchronism was necessary, and this was one of the things to be avoided. The absence of commutators and brushes appears to be the only argument in favour of alternating currents for such a purpose. A compound horizontal steam-engine, with cylinders on opposite sides of the crank shaft is designed to develop 600 H.P. at 300 revolutions per minute. It may be observed that this engine provided with 8ft. driving wheels would travel at about 86 miles an hour at this speed. It is, however, mounted across the locomotive, and drives a dynamo made by Brown, Boveri & Cie., giving over 1,000 amperes at 400 volts; another small engine drives an exciter. The dynamo has six poles and a Gramme-ring armature. There are eight motors, four on each bogie; they have four-pole cast-steel fields boxing in the armatures, each takes 125 amperes at 400 volts, and these eight can, of course, be easily connected in groups of two or more in series. The speed of the test runs has been restricted by the railway company, and, according to the *Temps*, the return

journey from Beuzeville to Havre on Saturday last, including a long up gradient of 1 in 125, was made at 100 kilometres, or 62 miles an hour. The weight of the train on the previous test was a little under 200 tons. We have not heard to what extent vibration has been reduced; that part which is due to the engine should be small, but jumping due to irregularities of the road still remains, and though no doubt it is well to experiment with a high-speed locomotive first, such a machine will be of little use until a suitable line has been laid.

We give to-day, in another column, the conclusion of our abstract of the Paper on "Telegraphic Communication between England and India," recently read by Mr. E. O. Walker before the Indian Section of the Society of Arts. Considering that Mr. Walker was an official in the Indian telegraphs, it is somewhat surprising that so many of his statements should be inaccurate and his deductions misleading. Want of space compels us to refer to a few instances only. He states that the land lines and cables can each transmit fifteen words per minute, and implies that with duplex this carrying capacity is nearly doubled. As a matter of fact the number of paying words which can be sent over the long cables, with duplex working, between here and India is nothing like thirty a minute, being considerably less than half that number. Then he assumes that 4,000 messages could be transmitted between 11 a.m. and midnight without delay, which means that the telegrams would steadily flow into the offices nearly as fast as they could be sent off. Mr. Walker surely knows that telegrams are not so obliging, and come in with a rush at certain hours. The fact is, there must always be a large reserve of carrying power in telegraphy to prevent delay and provide for interruptions. To promise the Companies £1,750,000 a year by carrying out his suggestions is like assuring railway companies that if they only lowered their fares every seat in every train despatched would be occupied between, say, 8 a.m. and 9 p.m., and telling them what their earnings based on such a traffic would be. Mr. Walker says that the cost of the Persian Gulf cables, which belong to the Indian Government, is an important factor in determining the rate to India. Does he assume that cables in the Red Sea and Indian Ocean, which do not belong to the Indian Government, are inexpensive, and, consequently, not important factors in the matter?

The article on Electrical Units which we publish this week is a useful contribution to a subject about which much confusion still exists. Nearly thirty years ago the British Association started the work of arranging a consistent system of electrical units, founded on the fundamental units of length, mass, and time. The ablest electricians at home and abroad have assisted from time to time in this endeavour, and their labours may be said to have ended with the Congress held in Chicago last autumn. The result is one of which every electrician can be proud, and there can be little doubt that weights and measures founded on this international system will be ultimately adopted by civilised nations to replace the arbitrary systems now in use. Nevertheless, this result has not been brought about without the introduction of many confusing considerations, which would certainly have been avoided if each country had adopted a simple arbitrary system of its own. In the first place, it has apparently been necessary to consider three distinct systems of units, called the electromagnetic, the electrostatic, and the "practical." The last system consists of units, each of which is an arbitrary multiple or sub-multiple of those of the former system. The second system is only wanted for theoretical work in electrostatics, and is hardly ever used. Its connection with the first system is never clearly explained in text-books, and its omission altogether from such books would be a positive gain as regards the student.

The system of units established by the British Association is as perfect theoretically as anyone can expect to be adopted; but even from a theoretical point of view it is possible to point out improvements. Mr. Heaviside has done so in these columns, although there can be little hope that his "rational" system of units will ever receive much attention except from theorists. It is, however, from the practical side that most confusion about these electrical units has been caused. The ohm standardised by the original Committee of the British Association, and called the B.A. unit, was found to be wrong by more than one per cent. This error was to a great extent corrected at the first Paris Congress, and so-called "legal ohms" were introduced. These, in turn, were found slightly wrong, and after much confusion about legal ohms, real ohms, Rayleigh ohms, and various other ohms, the true and only ohm, which is to be the British legal ohm, has been discovered by a committee of the Board of Trade, and has been recently christened in America as "International."

The difficult points of theory, alluded to by Mr. R. M. Deeley in our Correspondence columns this week, will probably remain unexplained until more definite information is forthcoming as to the interaction between ether and matter. It is possible for steady states of electric or magnetic force to exist independently of each other, but it is not possible for an electric field, varying with time, to exist without giving rise to a magnetic field, and *vice versâ*. A varying magnetic field gives rise to induced electromotive forces, while a varying electric field induces magnetic forces. This does not imply, of course, that the induced forces, whether electric or magnetic, are of appreciable magnitude, so that an undulatory electrical disturbance, although giving rise to an undulatory magnetic wave, may still remain practically a purely electrical phenomenon. Electrical waves may in this sense be either electric or magnetic, according to the relative importance of the electrical or magnetic undulations. Every wave, however, must be electromagnetic, since both kinds of disturbance must be taking place, and the undulations which comprise light must also be electromagnetic, although it has been made nearly certain by recent experiments that the undulations referred to in the higher parts of the wave theory of light are those which correspond with the electrical disturbances in an electromagnetic wave.

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The General Electric Company of America.—Prof. Elihu Thomson is reported to be contemplating the starting of an electrical manufacturing company of his own.

The Glasgow and West of Scotland Technical College.—The Glasgow University Court, at their meeting on the 8th inst., agreed to recognise the day Lecture and Laboratory Courses delivered by Prof. Jamieson on Electrical Engineering as qualifying *pro-tanto* for Graduation in Science under Section IV. of the Ordinances regulating Degrees in Science in Engineering.

Newport.—At the meeting of the Town Councll on Tuesday last it was finally decided to accept the tender of Messrs. John Fowler and Co. for all the electric lighting plant except engines and cables. The order for the former was given to the Uskside Engineering Company, and for the latter to Messrs. Siemens Bros. and Co., "subject to the cables being made in England."

Thunderstorm at Burnley.—At Burnley a severe thunderstorm was experienced last Monday, and while at its height a tall chimney at Towneley Colliery, belonging to Lord Crawshaw, was struck by lightning. One half of the chimney was completely shattered, and the discharge passed down the pit shaft, which is 300ft. deep, curling up the metals at the bottom. Bricks from the chimney fell in all directions, and two men were injured.

The City of London Electric Lighting Company.—We are glad to receive from the manager and engineer of the Company, in response to the suggestion we made last week, returns of the lamp connections of five dates during the past two years. These, plotted on the diagram published in our last issue, show a most satisfactory progress, resulting in a total at the end of 1893 of 65,341, nearly 1,000 more than the lamp connections of the Kensington and Knightsbridge Company.

Obituary.—The death is announced, within two days of his 90th year, of Mr. John Galloway, one of the founders of a great engineering business at Manchester, and known in commercial circles as "the father of the Manchester iron trade." One of his sons is chairman of Galloways (Limited), the company by which the works of the late Mr. Galloway and his partners is now carried on.——The death is also recorded of Mr. John Hick, J.P., one of the founders of the large engineering firm of Messrs. Hick, Hargreaves and Co., Soho Iron Works, Bolton.

Cable Interruptions and Repairs:

	Date of Interruption.		Date of Repair.
Cayenne-Vizeu	Nov. 25th. 1893.	...	Feb. 14th, 1894.
Saigon-Thuan-An..................	Feb. 1st, 1894.	...	Feb. 14th, 1894.
Cayenne-Paramaribo	Oct. 15th, 1893.	...	—
Bissao-Bolama	Nov. 24th ,,	...	—
Garachico - Santa Cruz de Palma	Dec. 27th ,,	...	—
Constantinople-Odessa.........	Jan. 31st, 1894	...	—
St. Thome-Loanda	Feb. 5th ,,	...	—
Maranham-Ceara	Feb. 12th ,,	...	—

Derby.—While calling our attention to the fact that in *The Electrician*, February 9th, p. 367, his name had been misspelt, Mr. J. E. Stewart informs us of the progress which has been made in the lighting of Derby. Since the opening of the central station at that town, on October 10th last, 2,600 8-c.p. lamps have been connected to the mains, and 37 additional lamps have been placed for street lighting. It is expected that another 2,800 lamps for private consumers will be ready for use shortly, and that another 30 street lamps will be fixed.

The Ventilation of Electrical Conduits.—In a paper recently read before the Glasgow Physical Society, the author (Mr. William Lackie, electrical inspector to the Corporation) gave it as his opinion and experience that no ventilating system was requisite, and stated that although in Glasgow nearly 500 manholes existed, only in six of them had any trace of gas been discovered, and then only owing to damage to the gas-pipes caused by the extensive railway operations being conducted throughout the city.

Exhibition of Meteorological Instruments.—The Council of the Royal Meteorological Society have arranged to hold, at 25, Great George-street, S.W. (by permission of the President and Council of the Institution of Civil Engineers), from April 10th to 20th, an Exhibition of Instruments, Photographs and Drawings relating to the Representation and Measurement of Clouds. The committee will also be glad to show any new meteorological instruments or apparatus invented or first constructed since the Exhibition in 1892, as well as photographs and drawings possessing meteorological interest.

Gas-Retort Carbon for Anodes.—In the preparation of chlorine and caustic soda by electrolysis, one great source of trouble is the difficulty in getting anodes which will not corrode. The Electrolytic Caustic Soda and Chlorine Trust, of Snodland, Kent, have found that, after all, the best material is gas retort carbon. They cut out a part of the carbon and fill in with lead; but this lead is not to dip into the electrolytic solution. This, says the *Gas World*, again illustrates the advisability of attention being paid to getting gas-retort carbon in slabs rather than in lumps, for the purpose of making electrodes.

The Bournemouth Accident.—In the House of Commons, on Monday evening, Mr. Weir asked the President of the Board of Trade whether his attention had been drawn to a serious accident which occurred in a public street in Bournemouth on the afternoon of the 8th inst.; whether the accident was caused by a leakage of high-tension electricity from the electric wires laid under the street; and whether steps would be taken to prevent similar accidents occurring in the streets of London, where so many high-voltage systems were in constant use under the thoroughfares. Mr. Mundella stated in reply that the Board of Trade was considering whether any additional regulations were necessary in order to prevent similar accidents in future.

British North Borneo and Telegraphy.—Speaking at the meeting last week of the British North Borneo Company, Mr. R. B. Martin, M.P., who presided, said that the Eastern Extension Telegraph Company hoped to land their cable at Labuan, which would practically connect North Borneo with Singapore and Europe, by the end of April next. He need not say that this would be a great boon not only to themselves but also to the various companies working in their country. The cable was leaving very shortly, and when once the expedition arrived on the spot it would only take a few weeks to lay. He therefore hoped that long before their annual meeting in June next they would be able to report the establishment of telegraphic communication with their territory.

Electricity Supply in Sweden.—In the 1893 report of the Elektron Lighting Company of Gothenburg it is stated that this Company's station is on the three-wire system. The dynamos are run in pairs, and rope-driven from engine fly-wheel. The larger ones are by Crompton, the smaller of Swedish make. The boilers work with forced draught, the air being blown into the closed ashpit by an ordinary blast fan worked by separate engine. The cables (Callender Bitumen) are all overhead. The lighting embraces 28 1,400-c.p. arcs for the harbour lighting, 51 arcs for shop lighting, and about 5,600 16-c.p. and a few 5, 8, 32, and 50-c.p. glow lamps for shop and private lighting, in addition to which the station supplies current to some 20 motors, ranging from $\frac{1}{4}$ H.P. up to 8 H.P., aggregating about 45 H.P. The service is continual, day and night, all the year round. Most of the current is sold by contract, and the energy actually generated amounted to 457,908 units, the total income for which was £4,544, or 2·38d. per unit sold.

Bradford.—At the last meeting of the Town Council, Alderman Moulson, chairman of the Gas and Electricity Supply Committee, in moving the adoption of the report, said that the electricity works were in fairly good order. During the half-year the sales of electricity came to £5,510, as against £4,548 in 1892; the total outgoings were £4,463 against £3,562 in 1892. The total amount of the capital was £56,679. The total number of lamps connected was 28,400. There would have been in connection with the electricity works a very good profit had it not been for the coal strike, which had made the coal cost about £600 extra. Alderman F. Priestman, at the close of the statement, expressed the opinion that it would be a very great advantage to the Corporation to reduce the price

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of electricity to 2½d. or 3d. for motive power only during the day. He had reason to know that people who were using a considerable amount of current would not go on paying 5d. for it, which was a higher price than they were giving for other motive power. The minutes were adopted.

Official Vocabulary for Code Telegrams.—The Secretary of the General Post Office notifies intending users that the International Bureau at Berne will shortly issue this vocabulary, and points out that the employment of these words will become compulsory for European code telegrams after the expiration of three years from the date of its publication, and that its general adoption for the extra-European messages is desirable. The vocabulary will consist of about 200,000 words drawn from the eight authorised languages. The circular omits, however, to point out that the compulsory use of the words for extra-European telegrams is left for the decision of the next Convention, which is to be held at Buda Pesth in 1896. There is no doubt, however, that the compulsory use of the Authorised Code Vocabulary will then be decided upon. The price per copy of the book will be 10s., and copies will be supplied through the Post Office. Intending subscribers are invited to forward applications to the Secretary of the General Post Office. The circular is dated January 15th, but is still being sent round by the Department.

The Electric Lighting of the Embankment —At the last meeting of the London County Council the Finance Committee recommended that the work of laying the necessary conduits and forming the refuges round the lamp columns in connection with the electric light installation for the Victoria Embankment, &c., be carried out by the Council without the intervention of a contractor. The chief engineer estimated the cost of this preliminary work at £2,100. Mr. Lloyd moved a reference back. The lamp-posts proposed to be put in the middle of the roadway greatly impeded the traffic, as had been shown in Euston-road. Mr. Beresford-Hope seconded. The Embankment was one of the finest thoroughfares in the world, and to put posts in the centre would spoil it utterly from an æsthetic point of view, besides interfering with the traffic. Mr. Bassett-Hopkins hoped the Council would not listen to the arguments of the two previous speakers. To put the posts—which would be handsome columns—on the side paths would add £2,000 to the cost. Mr. Roberts supported Mr. Lloyd's amendment. Was the Council going to spoil the Embankment for the sake of £2,000? The posts which had been put up by the St. Pancras Vestry certainly did not add any adornment to the roadway. Mr. Torr thought it was desirable to keep the traffic in two strings, which would be effected by placing the posts in the middle of the road. After some further discussion the amendment to refer the matter back was carried on a vote.

The Harness Case.—Mr. Richard Furber, of 8, Gray's Inn-square, has forwarded the following letter to Messrs. Lewis and Lewis, Mr. Astor's solicitors, giving Mr. Harness's reasons for discontinuing his action against the *Pall Mall Gazette*:—

"Dear Sirs,—I have been consulted by Mr. C. B. Harness with reference to the pending action for libel brought by him in respect of the articles which appeared in the *Pall Mall Gazette* in the month of October last. You are aware that Mr. Harness has recently, and after he had commenced that action, been prosecuted for a conspiracy to defraud and obtaining money by false pretences, as suggested in the columns of the *Pall Mall Gazette* containing the libels referred to, with the result that after sixteen days' hearing, extending over a period of three months, he has established his innocence of the charges made against him, the magistrate having dismissed them after hearing only a small portion of the evidence for the defence. The costs of his defence during this prolonged investigation have been very heavy, and my client, who is erroneously supposed to have made a considerable fortune out of the business of the Medical Battery Company in which he is interested, and in which all his capital was invested, finds his resources entirely crippled, and is therefore unable to find funds (which must necessarily be very large) to carry on this litigation against your client, who is a millionaire, and to whom money is probably of no object. I feel that he would, under the circumstances, be carrying on the fight on the most unequal terms, and, having vindicated his character in a court of law from the serious allegations made against him in the *Pall Mall Gazette*, as distinguished from the vulgar abuse which accompanied them, he has determined, on my advice, to discontinue the action. I enclose formal notice of discontinuance. This is a course which he takes with the utmost reluctance, yielding only to advice which has been given him on the assumption that your clients will loyally accept the decision of the magistrate, who stated in his judgment that he had been convinced against his inclination that the charges were without foundation."

Northern Society of Electrical Engineers.—At a meeting of the Northern Society of Electrical Engineers in Manchester last week, Mr. John Hesketh, of Blackpool, read a Paper on the Blackpool Central Station, with a view to provoking a discussion on the broad question of central station designs. Mr. Hesketh gave details of the plant, and fully described the method of distribution, which is by means of cables insulated by vulcanised india-rubber. As many as six cables were drawn into 3in. cast-iron pipes, and over 20 miles had so far been laid, the furthest point at which a supply was given being two miles distant from the station. It was not, he said, his intention to go closely into the question of the cost of working the plant at Blackpool. The time had not been long enough for a reliable deduction to be made on this head, and he would, therefore, reserve the question of cost of working for a future communication. The point of discussion he desired to raise by the Paper was, given an area of supply such as Blackpool, with two classes of lighting, what general design of station was best calculated to give satisfaction? The only question likely to be raised was that of general efficiency and reliability, and he strongly inclined to the opinion that reliability was worth the sacrifice of a percentage of efficiency ranging from 5 per cent. upwards. The question of distribution was one having many aspects. The advocates of the simple two-wire system had now many opponents, but with a high-tension network designed to feed each transformer from two directions, and with banked transformers feeding into a similar low-tension network, the variation in voltage, which, after all, was the public's criterion of successful lighting, was reduced to a minimum. The question of mains and their insulation, too, was viewed differently by different engineers. His own opinion was that it was useless to endeavour to lay watertight conduits, and that the endeavour should be to have cables to run as well in water as out of it.

Proposed State Telephones in Norway.—The Norwegian Telephone Committee has, says our Scandinavian correspondent, now ended its labours, and the report recommends some very extensive alterations of the whole telephonic system of the country, based upon exhaustive examinations and calculations. The main points of the report are as follows:—The State takes over the building and working of both local and long-distance telephone lines, and obtains, by degrees, possession of the existing private telephone companies, either by purchase by private contract or by expropriation. Long-distance telephones are to be constructed, having Christiania for their centre, in accordance with a plan already completed. According to this plan some half-dozen long-distance telephone-lines shall be taken in hand; among these are lines to Frederikshald and the frontier, along the coast to Bergen, *viâ* Thelémarken to Bergen, with various branch lines, to Drontheim, and on to Namsos, &c. This plan only refers to that part of the country lying to the south of Namsos. At the same time concessions will be given to private individuals or syndicates for the erection of telephone lines at places where the State either has not built or does not intend to build telephone lines. Private telephone companies are to be allowed to have connection with the State telephones, and the telegraph stations will everywhere be connected with the respective central State telephone stations. Both local and long-distance lines are to be constructed on the twin-wire system; the single-wire telephone companies, which the State may acquire, are to be gradually transformed into double-wire concerns. The following annual charges are recommended:—For Christiania, £5. 10s.; for Bergen and Drommen, £4. 9s.; for Drontheim, Stavanger, &c., £3. 6s. 6d.; for other towns, £2. 15s. 6d. These are all for twin circuits. The charges for conversations on long-distance lines are regulated according to the distance between two neighbouring towns, about 3d.; for distances up to 100 miles, 6⅔d.; for distances over this, 1s. 1d. The length of a conversation to be three minutes. The expenditure is estimated as follows:—Purchase of existing telephone companies south of Namsos, 2,630,000kr.; altering of these to double-wired, 1,840,000kr.; new lines, 2,112,000kr.—6,285,000kr., or, with incidental expenses, 7,000,000kr., or about £350,000. The estimated net profits amount to 320,000kr., or about £16,000, per annum—that is to say, 4·6 per cent. on the capital.

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MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(*Continued from page 381.*)

Thermodynamic Principles.

Notes on Some Physical Effects of Heat.—One of the most palpable of the effects of heat on matter is the tendency of the heated body to communicate its heat to surrounding objects. This effect is called *temperature*. Any body is said to be at a higher temperature than any other body when there can be a direct transfer of heat from the former to the latter without that heat being transformed in its passage into any other form of energy. By this it is meant that while a body can supply heat to one that is hotter by indirect energy transformations, as when a steam engine makes arc lamp carbons hot, it is impossible for heat to flow directly from a colder to a hotter body. When heat cannot be made to pass in either direction between any two bodies, these may be defined to be at the same temperature; and this definition is independent of the system upon which the temperature may be measured. Temperature is measured upon several systems, of which two are used in engineering: (1) the volumetric system, and (2) the thermodynamic system. The volumetric, or ordinary, system is based upon the expansion of bodies when a rise of temperature takes place in them. The thermodynamic system is based upon the work which may be done by heat passing between the two temperatures which are compared. In the Fahrenheit scale of ordinary temperatures two points on the scale are fixed by the melting point of ice and the liquefying point of steam (at standard pressure) respectively. The former is marked 32 degrees and the latter 212 degrees; an interval of 180 degrees occurring between them. These successive degrees of temperature are recorded on the thermometer scale by the expansion of a mass of mercury, contained in a bulb at the base of a sealed and graduated capillary tube. Equal increments in the height of the mercury in the tube are assumed to represent equal increments of temperature. In the air thermometer, of which more will be said presently, the successive degrees of temperature are determined by equal increments in the volume of a portion of air heated in a confined space at constant pressure. It therefore by no means follows that equal increments of temperature, as measured volumetrically by the expansion of an arbitrarily chosen substance such as mercury or air, will be a correct representation of equal increments in the heat-energy state of the heated body. But it will presently be shown that the ordinary scale of temperatures is practically identical with the scale in which equal degrees represent equal increments of heat energy of some perfectly elastic substance.

If we take a rod of some solid substance, such as iron or copper, and raise its temperature, we find that it has increased in length. It has also expanded in the same proportion in every other direction. If we measure this linear expansion of the rod, we find that it is practically proportional to the rise of temperature of the rod as measured on a mercury thermometer; provided always that the rise of temperature is not sufficient to alter the other physical properties of the rod. The volumetric expansion is approximately three times the linear and the surface expansion twice the linear. If, now, instead of causing the rod to expand by heating it, we elongate it by the application of a tensile stress; or if, instead of causing it to contract by cooling, we cause it to become shorter by means of a compressive stress; we shall produce a similar linear change in the rod. The expansive or contractile effect of change of temperature may therefore be measured in terms of an elastic force which would produce the same result. It is popularly supposed that the elastic force of expansion of solids is infinite and irresistible. This is erroneous: for if we raise the temperature of a rod or other shape of solid, at the same time so constraining it that it cannot freely expand, we shall set up within the body compressive stresses of equivalent value as determined by the elasticity of the body. This is an important point, as it affects the behaviour of structures which are so heated as to be unable to freely take the proper shape which their rise of temperature would naturally produce. In the following table (V.) the coefficients of expansion of some important metals, together with the equivalent values of these coefficients, considered as elastic stress in lbs. per square inch section, have been tabulated. The coefficients of expansion give the fractional increase of length per 1° F. rise of temperature:—

Table V.—*Linear Coefficients of Expansion and their Equivalent in Elastic Stresses.*

Metal.	Coefficient of Expansion per 1° Fah.	Equivalent Stress in lb. per sq. in. per 1° Fah. (from Young's modulus)
Steel (rod and boiler plate)	0·00000636	165
Steel (cast)	0·00000636	190
Wrought iron (rod & plate)	0·00000680	197
Cast iron	0·00000617	142
Brass	0·00001042	102
Copper	0·00000960	144
Gun metal	0·00001060	106

As an example we may cite the case of a rod or tube of wrought iron subjected to a rise of temperature of 100° F., the metal being prevented from elongating. A stress of 19,700lb. per square inch would result—a stress far beyond the safe working stress of this material. As a matter of fact, no substance under stress can be perfectly constrained; but, in practice, stresses will arise in proportion to the degree of constraint. Where any detail is liable to undergo very great variations of temperature, this matter becomes one of some importance.

The heat which is supplied to the rod of iron or copper, about which we have been speaking, is expended in two ways:—(1) In raising the temperature of the rod; (2) in expanding it. The former of these is usually called the *sensible heat*, the latter the *latent heat*. Sensible heat is measured as the product of the true specific heat of the substance into its temperature. Latent heat is in reality not heat at all, but potential energy. If we exert mechanical force in elongating a rod of metal, we must necessarily expend energy and do work. Of the total heat put into any body which expands under the process, some at least must be expended in doing this work of expansion—in overcoming the elastic resistances of the material—and this portion is called latent heat. If, to cite another case, instead of taking a rod of metal we supply the heat to a block of ice a few degrees below the melting point, we find that both rise of temperature and expansion occur till 32° F. is reached. Then all the heat which is afterwards supplied becomes latent, the ice melting at a constant temperature. As soon as the ice is all melted the added heat again becomes partially sensible, and the temperature rises until the boiling point is reached. At this last-named point all the added heat again becomes latent, being expanded in turning the water into steam at a constant temperature. Beyond the point where all the water is turned into steam, the addition of heat will cause a rise of temperature, and heat will become latent only if the steam is allowed to expand. Latent heat is, therefore, associated with the physical change of state of any substance, and represents the work done in producing that change.

The term specific heat is given to the number which indicates the amount of heat which is required to produce a rise of temperature of 1 degree in unit mass of any substance, the unit of mass being either the gramme (in the c.g.s. system) or the pound (not the 32lb. of the engineering system). It is evident that this coefficient may be regarded in two ways: first, in relation to the total heat which must be supplied to the unit mass; second, in relation to the fraction of the total heat which alone is employed in raising the temperature of the body. In the first the coefficient is called the *apparent specific heat*, in the second it is called the *true specific heat*. In solids and liquids the difference between the two coefficients is very small and may generally be neglected; but in gases the rate of expansion is so great that a considerable difference may arise.

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The volume of a gas is determined by its mass, its pressure and its temperature. The volume of any given mass of gas has been found by Boyle to vary inversely with the absolute pressure to which it is subjected, when the temperature of the gas is maintained constant. This is known as *Boyle's law.* Since pressure alone will affect the volume of a gas, it will be necessary to notice the variation of pressure in any determination of the effect of a change of temperature on the volume. Charles has found that when the absolute pressure of any mass of gas is kept constant, its coefficient of expansion as referred to the volume of the gas at any standard temperature, is constant and independent of the chemical nature of the gas. Thus, if we take the zero on the Fahrenheit scale as the standard, it was found by Charles that all gases expand 1/460 of their volume at this temperature when raised from any temperature to a temperature 1°F. higher. Conversely, if the gas be cooled it will contract 1/460 of this standard volume for each 1°F. of cooling. So that if any gas could be cooled down to a temperature 460°F. below the ordinary zero, remaining a gas all the while, it would completely lose its volume. The temperature −460°F. is therefore called the absolute zero of temperature on the Fahrenheit scale. Absolute temperature is measured by the number of degrees on any scale reckoned from the absolute zero; and on the Fahrenheit scale is equal to the ordinary Fahrenheit temperature + 460. The law of expansion of gases at constant pressure may therefore be expressed by saying that the volume of any mass of gas at constant pressure is directly proportional to its absolute temperature. This is known as *Charles's law.* Let V be the volume of any portion of gas at any absolute pressure, P, and absolute temperature, T; and let V_1, P_1, and T_1 be the volume, pressure and temperature of this portion of gas under other conditions. Then by Boyle and Charles's laws,—

$$\frac{V \cdot P}{T} = \frac{V_1 \cdot P_1}{T_1} = \text{a constant.} \quad . \quad . \quad . \quad (38)$$

Any substance which would behave according to the foregoing expression for every possible set of conditions would be a perfect gas. No such substance is known in nature. All known gases tend to become liquid at very low temperatures and great pressures; and when they approach the liquid state they pass through a state of vapour, in which the viscous forces within its substance cause the law of its expansion to depart more and more from the above simple expression as the liquefying point is approached. Many gases, however, behave as perfect gases within certain limits of temperature and pressure, where the conditions are far above those which would liquefy the substance, and below those which would decompose it. Air and all gaseous products of combustion follow this law at furnace temperatures.

The passage of heat from a hotter to a colder body is effected in several ways. Of these, the only direct ways in which the heat remains as heat during the transfer are *conduction* and *convection.* In conduction, the heat is passed along by communication of heat between contiguous portions of the conducting body. In convection, it is passed along by the actual transfer of the heated body itself. Besides these direct modes of transfer, heat is frequently passed from a hotter to a colder body by reason of the former setting up ether waves in the space surrounding it, which waves, in their passage from the hot centre outwards through space, are partially intercepted by the cooler body, and their energy partially turned back again into heat in the latter. This most frequent mode of passing heat energy from a hotter to a colder body is called *radiation*, and the energy of the ether waves is called radiant energy.

The number of units of heat conducted through any body varies directly as the continued product of the difference of temperature between the ends of the path along which the heat must flow, the section of the path, the time during which the difference of temperature is maintained, and a constant called the specific conductivity of the material, and it varies inversely as the length of the path along which the heat must flow. Thus, if T_2 is the temperature of the hotter end, and T_1 that of the colder end, while L, S, t and K are the length, section, time, and specific conductivity respectively, the flow of heat by conduction will be—

$$H = \frac{(T_2 - T_1)\, S . t . K}{L} . \quad . \quad . \quad . \quad . \quad (39)$$

Since in furnaces heat usually passes through conductors of plate shape, it will be convenient to measure the section or surface exposed to heat in square feet, the length of the plate or thickness of the plate in inches, and the temperature and time in Fahrenheit degrees and hours respectively. The values of K on this system are given in Table VI.:—

Table VI.—*Specific Thermal Conductivities of Solids, in B.T.U., transmitted per hour through 1 in. thickness and 1 sq. ft. surface, with 1°F. difference of temperature.*

Substance.	K	Substance.	K
Copper (sheet)	555·0	Porcelain	56·0
Phosphor bronze	428·0	Fireclay	49·0
Zinc	421·0	Fire Brick	42·0
Gun metal	417·0	Chalk	40·0
Brass (sheet)	400·0	Oak	23·1
Cast steel	3'0·0	Fir	22·0
Mild steel	300·0	Ash	21·0
Wrought iron	278·0	Sawdust	21·0
Cast iron	220·0	Plaster-of-Paris	15·4
Lead (sheet)	140·0	Powdered brick	14·2
Limestone	130·0	Cement	14·0
Granite	125·0	Sand	12·6
Building stone	120·0	Bran	7·7
Sandstone	100·0	Flannel	3·0
Slate	70·0	Lampblack	0·8
Glass	70·0	Hair felt (wood lagged)	0·72
Stock bricks	63·0	Wood ashes (loose)	0·56
Asbestos	56·0	Eiderdown	0·50

The difference of temperature between the opposite surfaces of the materials tabulated in the above table is supposed to be measured on the surfaces themselves, and not on the contiguous layer of heat-producing or heat-absorbing substance in contact with the conductor. When the temperature difference is measured as between the heating and heated substances on either side of the plate or layer of conductor, then the conductivity of that conductor not only is very much lower per 1°F. than is specified in the table, but the actual value of the conductivity will be found to depend very largely on the nature and state of motion of the heating and heated substances on either side. Inasmuch, however, as it is useful to know the exact conductivity of the materials themselves, independently of the manner of supplying the heat, the above table has been calculated in its present form; the more complicated considerations involved in the nature and state of motion of the heating and heated substances being dealt with in connection with boilers and furnaces.

Convection is determined by conditions which are not capable of mathematical treatment; the quantity of heat conveyed being dependent upon the rapidity of the heated stream of matter, and this upon whether that stream is forcibly propelled or only permitted to flow naturally. In general, the more rapid the circulation the greater will be the passage of heat.

Table VII.—*B.T.U. radiated per hour from 1 sq. ft. of surface at 1° Fah. temperature above surrounding temperature.*

Nature of surface.	Authority.	Radiation in B.T.U. per hour.
Ordinary cast iron (bare)	Tredgold	1·823
„ „ (with black varnish)	„	1·900
„ „ (with white paint)	„	1·780
„ „ (lagged with straw)	Burnat	0·868
„ „ (lagged with felt)	„	1·515
„ „ (lagged with earth and hair)	„	1·568
Copper pipe (bare)	Clément	1·710
„ „ (blackened)	„	1·970
Wrought iron (lagged with spun yarn and felt)	Nichol	1·260

Radiation is determined by the extent of surface exposed by the heated body to surrounding space; and is equal to the product of that surface into the number of degrees of tem-

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perature above the temperature of surrounding objects, and into a constant called the coefficient of emissivity of the surface. This product gives the number of units of heat radiated in unit time. According to Péclet, the quantity of heat radiated from incandescent carbon at ordinary furnace temperatures is about equal to half the total heat of combustion. Table VII. gives the number of thermal units of heat radiated from common surfaces under stated conditions.

The relative radiating powers of some important surfaces are given in Table VIII. :—

Table VIII.—*Comparative Radiating and Absorbing Powers of Different Substances in respect to Non-luminous Radiation.*

Substance.	Relative radiating and absorbing power.	Substance.	Relative radiating and absorbing power.
Lampblack	100·0	Galvanised iron (bright)	20·0
Soot	100·0	Cast iron (polished)	19·0
Pure water	100·0	Zinc (polished)	19·0
Powdered charcoal...	95·0	Steel (polished)	17·0
Ivory	94·0	Tin	15·0
White marble	94·0	Wrought iron (polished)	15·0
Ordinary sheet glass	90·0	Tinned plate (very bright)	12·0
Dull black paint......	90·0	Brass (polished)	11·0
Dull red paint	80·0	Copper (polished) ...	11·0
Plumbago	75·0	Silver (polished)	3·0
Tarred surfaces	70·0		
Lead (tarnished)......	40·0		
Zinc (tarnished)	30·0		

(To be continued.)

ELECTRICAL UNITS.

BY ALBERT CAMPBELL, B.A.

Of the three systems of units commonly employed in electrical science, namely, the Electrostatic, the Electromagnetic, and the Practical, the last-named system naturally is by far the most important for the practical man. The electromagnetic system of units comes next in importance, for the practical system is directly obtained from it, the practical units being merely multiples or submultiples of the electromagnetic ones; and, besides, the electromagnetic units are at present used in practical work in some cases where a practical unit has not been chosen and named.

But the electrostatic units have also their domain, and it is one which may in the future become more important: they are the simplest units to use in calculating the capacities of condensers from their dimensions. In electrostatic measurements, too, they are sometimes the easiest to employ, for instance, in working with a Kelvin Absolute Electrometer; but specimens of this noble instrument are exceedingly rare, although text-book descriptions are so familiar.

The elementary text-books, however, are by no means clear enough on the subject of the Electrostatic Units and their connection with the other systems; indeed, most readers get the idea that magnetic pole, strength of field, reluctance, and such like, can only be measured in the electromagnetic system. The object of this Paper is to show the completeness of each system and to indicate definitely the relationships of corresponding units, in particular of those less familiar ones which are not discussed in the ordinary text-books.

Before proceeding to the consideration of the electrical units, it will be necessary briefly to discuss the question of units in general; accordingly, we shall begin from first principles.

In the first place, the amount of anything means the number of times that a certain portion of a similar thing is contained in it; in other words, the quantity of anything is equal to a number × a unit.

Of these two parts, the abstract numerical part presents no serious difficulty, as the properties of ordinary numbers are sufficiently familiar. The consideration of the second part of the expression, namely, the unit, is much more difficult; for the unit is sometimes a concrete thing with many different properties, and it has to be defined and measured by means of one or other of these properties. To take an instance: A unit of heat may be defined in different ways by reference to various properties of heat. Now, heat has the property of changing the state of a body from solid to liquid, and if we select this property we may take as our unit of heat-quantity the amount of heat which will just melt a unit amount of a standard substance, such as ice at its melting point. If we choose the property of producing change of bulk, we shall have, as unit, the amount of heat necessary to produce a certain change of bulk in a given amount of a standard substance under fixed conditions of temperature, pressure, &c. Again, if the property selected be that of producing rise of temperature, we shall have quite a different unit of heat; and similarly for the other properties of heat.

Having thus defined these different units of heat, it is necessary to find the proportions of one of the units to each of the others, and this has to be done experimentally by measuring the same definite quantity of heat in terms of each unit. This means that we have to find the quantitative relations between the various physical properties or effects of heat.

In actual measurements the things ultimately observed are quantities of space and time, and of matter and energy; for example, if we wish to determine the magnetic moment of a given magnet, we observe a mass, a time of swing, and a deflection which practically means two lengths. This way of measurement quite agrees with the results of modern physical science, which tend to show that in the material universe there are two real things, namely, matter and energy, which have been found as yet to be indestructible by physical processes, and which are limited in their action by relations of space and time. But quantities of energy are ultimately determined by their effects in space and time when associated with quantities of matter; accordingly, our fundamental units are of Length, Mass, and Time. And, in order to have a uniform and reasonable system of measurement throughout the scientific world, the particular units which have been chosen by international consent are the Centimetre,* the Gramme,* and the Second.

From the centimetre we derive our units of area and volume. From the centimetre and second we derive the unit of velocity, which is the time-variation of space; and the unit of acceleration, which is the time-variation of velocity. Next, when we have a body (*i.e.*, matter) in motion energy is showing itself; so from unit mass and unit velocity we derive the unit of energy (or work), namely, the erg. [Thus: Two grammes moving with velocity of 1cm. per second has one erg of kinetic energy.] Force being "a mere space variation" of energy, the unit of force is derived from the erg and the centimetre, and is called the dyne. [On this system of derivation, unit force is that which does unit work when its point of application moves through unit distance in the direction of the force.] If we prefer it, we may derive the force unit directly from the units of mass and acceleration.

Last of these dynamical units may be mentioned the unit of Power; since power is the time-variation of energy, *i.e.*, the rate of doing work, its C.G.S. unit is an erg per second.

Proceeding to the electrical units, let us confine our attention in the first place to the electromagnetic and electrostatic systems. Our fundamental units are, as above, the centimetre, gramme, and second; derived from these, we have the erg and the dyne.

To make the notation consistent let capital letters (*for the occasion only*) be used to denote electromagnetic units and small letters for electrostatic units. We may now proceed to build up our two systems of units, each new unit being derived from units already determined, by means of a defining statement (sometimes called a dimensional equation) connecting the new unit with units already known. These defining statements, or formulæ, embody definition and result of experiment, or mathematical deduction therefrom. To make the matter more clear, let us consider a simple case, viz., to derive the current unit from a time unit and a quantity unit, both supposed to be already known. Here the law is that a uniform current of p units flowing for q units of time transfers $p\,q$ units

* The Editor, and not the Author, is responsible for these spellings, as the Author is very strongly of the opinion that the fully Anglicised spellings, *Centimeter* and *Gram*, should be used; and in this he follows the practice of several of our best writers on chemistry.

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of quantity, ∴ 1 unit of current in 1 unit of time carries 1 unit of quantity; or C in T carries Q.

We may write this shortly thus:—

$$C\,T\,[=]\,Q,$$

and this is the defining statement connecting C with Q and T.

Any other units may be similarly derived as soon as we know the laws and definitions connecting them with their predecessors. In what follows, the defining statements, though not actual equations, will, for shortness, be referred to as formulæ.

Tables I. and II. show the method and order of procedure in each system, the words in the formulæ, as well as the letters (except x, y, v, and π), being taken to denote corresponding units.

Table I.—*Electromagnetic System.*

No.	Formula.	Unit obtained.	
1.	$\frac{M.M.}{(\text{distance})^2}[=]$ force	Magnetic pole,	M
2.	M H [=] force	Magnetic field,	H
3.	$H\,[=]\,\frac{\text{arc}}{(\text{radius})^2}.\,C$	Current,	C
4.	Q [=] C . time	Quantity,	Q
5.	$\frac{Q\,Q}{(\text{distance})^2}[=]\,x\,.$ force	$(x=v^2)$	
6.	M Ω [=] energy	Magneto-motive force,	Ω
7.	4 π F Ω [=] energy	Magnetic flux	F
8.	4 π B Ω area [=] energy	Magnetic induction	B
9.	B [=] μ H	Permeability,	μ
10.	$F\,[=]\,\frac{\Omega}{R}$	Reluctance,	*R*
11.	$2\,L\,C^2$ [=] energy	Co. of induction,	L
12.	Q E [=] energy	Electromotive force,	E
13.	$C\,[=]\,\frac{E}{R}$	Resistance,	R
14.	$K\,[=]\,\frac{Q}{E}$	Capacity,	K

Table II.—*Electrostatic System.*

No.	Formula.	Unit obtained.	
I.	$\frac{q.q}{\text{distance}^2}[=]$ force	Quantity,	q
II.	q [=] c . time	Current,	c
III.	$h\,[=]\,\frac{\text{arc}}{(\text{radius})^2}.\,c$	Magnetic field,	h
IV.	$m\,h$ [=] force	Magnetic pole,	m
V.	$\frac{m\,.\,m}{(\text{distance})^2}[=]\,y\,.$ force	$(y=v^2)$	
VI.	$m\,\omega$ [=] energy	Magneto-motive force,	ω
VII.	$4\,\pi\,f\,\omega$ [=] energy	Magnetic flux,	f
VIII.	$4\,\pi\,b\,\omega$. area [=] energy	Magnetic induction,	b
IX.	$b\,[=]\,\mu'\,h$	Permeability,	μ'
X.	$f\,[=]\,\frac{\omega}{\text{r}}$	Reluctance,	r
XI.	$2\,l\,c^2$ [=] energy	Co. of induction,	l
XII.	$q\,e$ [=] energy	Electromotive force,	e
XIII.	$c\,[=]\,\frac{e}{r}$	Resistance,	r
XIV.	$k\,[=]\,\frac{q}{e}$	Capacity,	k

The above order of deriving the units avoids equations containing differential coefficients, and is probably as simple as any other that can be arranged. It is not necessary to make any remark upon the methods of obtaining the formulæ, except in the case of formulæ (7) and (11). Of these, (7) is derived from (6) by reason of the fact that a unit pole in the electromagnetic system has 4 π unit lines of force proceeding from it. This is a consequence of formula (1). It is *not* the case that in the electrostatic system 4 π unit lines come from unit pole, but it will be found that formula (VII.) is true for all that. Again,

$\frac{1}{2}$ (coefficient of self-induction) × (current)^2 = energy stored; ∴ when unit current C stores unit energy we must have two units of coefficient of self-induction,

i.e., $2\,L\,C^2\,[=]$ energy unit,

which is formula (11).

It will be seen from Tables I. and II. that the two systems differ firstly in the order of deriving the first four units; the electromagnetic proceeding in the order—pole, field, current, quantity; while the electrostatic follows the inverse order, viz., quantity, current, field, pole. The remaining units from magneto-motive force (M.M.F.) onwards may be derived in the same order and from exactly similar formulæ in the two systems.

The second difference lies in the fact that Table I. does not contain a formula $\frac{Q.Q}{(\text{dist})^2}\,[=]$ force unit, nor does Table II. include a formula $\frac{m.m}{(\text{dist})^2}\,[=]$ force unit, for the simple reason that neither of these formulæ is true. Accordingly we find, in formulæ 5 and V., the coefficients x and y, whose values must be found from experiment. It is clear, from formulæ 1—5 and I.—V., that

$$\therefore\ x = \frac{Q}{q} = \frac{m}{M} = \sqrt{y}.$$

Several independent researches (by Maxwell and others) agree in showing that the value of $\frac{Q}{q}$ is approximately $= v$, the velocity of light, *i.e.*, about 3×10^{10} cms. per sec. This result, along with Tables I. and II., gives us immediately the ratio of any electromagnetic, to the corresponding electrostatic, unit. In fact, we have only to compare the corresponding formulæ in Tables I. and II., in the proper order, to get successively the desired ratios as follows:—

$$v = \frac{Q}{q} = \frac{C}{c} = \frac{e}{E} = \sqrt{\frac{r}{R}} = \sqrt{\frac{K}{k}} = \sqrt{\frac{l}{L}}$$
$$= \frac{m}{M} = \frac{H}{h} = \frac{\Omega}{\omega} = \frac{f}{F} = \frac{b}{B} = \sqrt{\frac{\mu'}{\mu}} = \sqrt{\frac{R}{\text{r}}} \quad . \; . \; . \; (15)$$

By the help of these equations we can easily pass from the one system of units into the other. The formulæ in Tables I. and II. also enable us to find the dimensions, with regard to length, mass, and time, of any of the units mentioned (in either system); in other words, the way in which length, mass, and time come in in the measurement of any of the other quantities.

For example, let us investigate the dimensions of permeability in each system. Comparing formulæ (1) and (2) we see that

H × area has same dimensions as M.

Similarly from (6) and (8):

B × area has same dimensions as M.

∴ H and B have same dimensions.

i.e., in the electromagnetic system μ is a mere number.

In the electrostatic system, however, $\mu'[=]\frac{b}{h}$, which has same dimensions as

$$\frac{m}{h \times \text{area}},\ \text{which} = \frac{mh}{h^2 \times \text{area}} = \frac{\text{force}}{h^2 \times \text{area}}.$$

But, from formulæ I., II., and III., h has dimensions $\frac{\sqrt{\text{force}}}{\text{time}}$;

∴ dimensions of (μ' electrostatic) are $[\text{time}]^2 \div [\text{length}]^2$.

If we examine equations (15) it is somewhat surprising that $\frac{H}{h} = \frac{b}{B}$, but careful consideration of formulæ (2), (6), (8) will make the reason clear. It is evident from these formulæ that $4\,\pi$ B × area corresponds with M, while H × length corresponds with Ω. Thus the magnetising force (H) is not to be confounded with the effect (B) which it produces.

Practical System.

To connect either system with the practical system, we have the following:—

1 volt = 10^8 E, and 1 coulomb = 10^{-1} Q;

∴ 1 ampere = 10^{-1} C, 1 farad = 10^{-9} K, 1 henry = 10^9 L,

1 line of flux = F, 1 ampere-turn = 0·4 π Ω.

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These relations, combined with the last set of equations, (15), give Table III., in which will be found the values of the practical units in terms of the units of the other systems. The joule and watt, although not really electrical units, are also included in the table. 1 supply unit $= 3{\cdot}6 \times 10^6$ joules $= 3{\cdot}6 \times 10^{13}$ ergs.

Table III.

Practical.	Electromagnetic.	Electrostatic.
1 coulomb	10^{-1}	3×10^9
1 ampere..................	10^{-1}	3×10^9
1 volt	10^8	$3^{-1} \times 10^{-2}$
1 ohm.......................	10^9	$3^{-2} \times 10^{-11}$
1 farad	10^{-9}	$3^2 \times 10^{11}$
(1 microfarad...........	10^{-15}	$3^2 \times 10^5$)
1 henry	10^9	$3^{-2} \times 10^{-11}$
(1 ampere-turn).........	$4\pi . 10^{-1}$	$4\pi \times 3 \times 10^9$
	1 line of induction	$3^{-1} \times 10^{-10}$
	1 reluctance unit	$3^2 \times 10^{20}$
1 joule.....................	10^7 ergs	10^7 ergs
1 watt......................	10^7 ergs per sec.	10^7 ergs per sec.

In illustration of the foregoing we shall conclude with the following example :—Express a magnetomotive force of 255 ampere turns in electromagnetic and electrostatic units.

Since 1 ampere turn $= 0{\cdot}4\,\pi\,\Omega$,

$$255 \text{ ampere turns} = 255 \times 0{\cdot}4\,\pi\,\Omega,$$
$$= 320{\cdot}4 \text{ electromagnetic units of M.M.F.}$$

Again, since $\frac{\Omega}{\omega} = v = 3 \times 10^{10}$,

$$\therefore\ 320{\cdot}4\,\Omega = 320{\cdot}4 \times 3 \times 10^{10}\,\omega,$$
$$= 9{\cdot}612 \times 10^{12} \text{ electrostatic units of M.M.F.}$$

In a similar manner we can solve any other problem on change of units.

THE CONDITIONS OF CHEMICAL CHANGE.

In a Paper which he has communicated to the current number of the *Philosophical Magazine*, Mr. V. H. Veley discusses "The Phases and Conditions of Chemical Change." There is much in the Paper which is of interest to electro-chemical students ; for the modern doctrines of ionic dissociation, atomic electric charge, &c., are criticised, and in some instances severely handled. The writer proposes two questions : What is chemical change ? and, What is the cause of its commencement ? To neither of these can the writer be said to give a final answer ; but the views of various authorities are clearly and tersely explained. The tone of the Paper is decidedly sceptical in regard to the modern doctrine that the conditions of chemical change are determined by the presence of ionically dissociated electrolytes. Some rather hard problems are set, in the suggestions of some well-known chemical processes in which it is difficult or impossible to discover any electrolyte. "To take an example from everyday life," says the author, "the materials of a common match-head and box do not apparently contain an electrolyte, yet the chemical change is violent enough when one is rubbed against the other." This is, perhaps, rather begging the question ; quite as much so, for instance, as if the writer should plead his inability to see any electrolyte in dry iodide of nitrogen when it explodes on percussion. Do not the conditions of mechanical friction and percussion correspond in every essential respect with the atomic conditions which are known as ionic dissociation ? The ready chemical change which accompanies the admixture of hydrocarbon oils with bromine, though it is difficult to discover any initial electrolysis here, is a better illustration of the writer's point, and one which he presses with better logic. "In fact," continues Mr. Veley, in his attempt to show that if we acknowledge the doctrine of electrolytic dissociation we must deny the doctrine of energy conservation, "many writers of the present day seem to deal with electric and chemical forces, or electrified and non-electrified atoms, as two cards in a kind of game of blind-hookey, either of which may be turned up at will. . . . . As yet there seems to be no answer forthcoming to the question—Why does chemical change ever begin ?"

THE ACCIDENT AT BOURNEMOUTH.

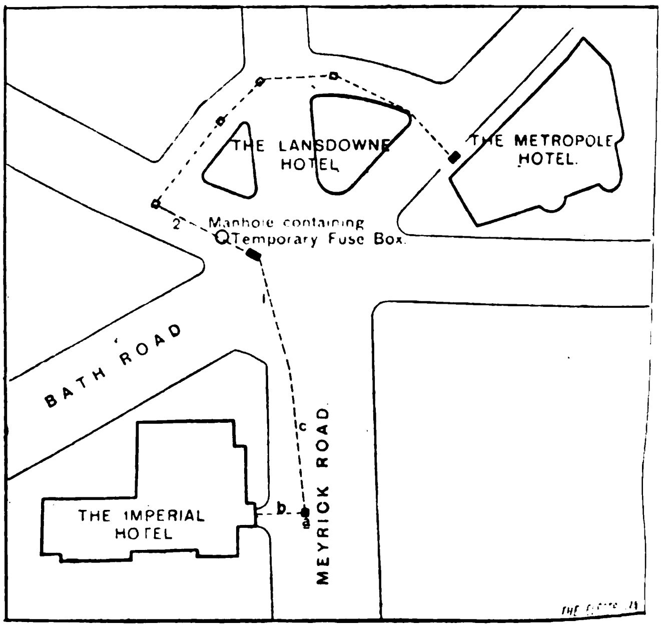
The following report has been made by Major P. Cardew to the Board of Trade on the recent accidental death of a horse at Bournemouth by an electric shock :—

Board of Trade (Railway Department), 8, Richmond-terrace
Whitehall, London, S.W., January 20, 1894.

SIR : I have the honour to report, for the information of the Board of Trade, that in compliance with the instructions contained in your minute of the 8th inst., I have investigated the circumstances connected with the sudden death of a horse at Bournemouth, under conditions which suggested that the cause of death was an electric shock, due to some defect in the mains of the Electric Lighting Company. The following account of what took place I have collected from the narratives of eye-witnesses.

Between half-past two and three p.m., on the afternoon of the 8th instant, a station omnibus drew up in the roadway opposite to the entrance to the Imperial Hotel in Meyrick-road, Bournemouth. As the horses drew up both suddenly fell down. The driver, William Dean, states that he is certain that the horses did not slip, although there was some melting ice and snow on the road at the time. The driver got down to attend to the horses and he was assisted by the following men : John King, flydriver ; W. Brown, flydriver ; T. Binden, carpenter.

All these men, as well as the driver, state positively that when they touched the horses they experienced tingling sensations in their arms and legs, which they attributed to slight electric shock. None of them, however, appear to have been injured by the shock, but the driver's foot was hurt by one of the horses treading on it. One horse was extricated and set on his legs, which appeared to be partially paralysed at the time ; the other could not rise, and died in a few minutes.



Plan showing Service to Imperial Hotel, Lansdowne Crescent, and Metropole Hotel.

On arrival at the spot about noon on the following day, accompanied by the Borough Engineer and the Superintending Engineer of the Bournemouth and District Electric Supply Company (Limited), I had the ground opened at the place where the horses fell, and the iron cover of a street box, measuring 2ft. 6in. by 1ft. 6in., was disclosed about 9in. beneath the surface of the road. On lifting this cover it was found to rest on a brick chamber about 1ft. deep, to one end of which was connected a 3in. iron pipe, and to one side a 1½in. iron pipe. The larger iron pipe contained two insulated cables, technically described as 7/20 tinned copper wires insulated with high quality vulcanised rubber to $\frac{1}{16}$th inch thickness, and protected by braided hemp. The ends of these cables projected to about the centre of the box, and were sealed up with india-rubber tape and composition. Near these ends two smaller cables of 7/21 tinned copper wires, insulated with similar material but only to barely $\frac{1}{25}$th inch in thickness, and with braided hemp outside, were joined to the larger ones and passed into the smaller pipe. The larger cables had been connected to the supply mains through fuses, contained in a large subterranean chamber, at the crossing of main roads known as "The Lansdowne," about 70 yards away. This connection had, however, before my visit been severed by cutting the cables in the chamber. The smaller cables merely completed the connection to the transformers placed in the area of the hotel, and were 34ft. in length, and the enclosing pipe was laid at a depth of about 18in. below the surface throughout. All the cables mentioned were used for the high-pressure supply of 2,000 volts.

There were no signs of any arcing or injury to the cables or to the lid of the street box, the under surface of which was 5½in. above the cables, but I noticed that one of the "dead ends" beyond the joint to the small cable was covered on the outside with a slimy moisture, and I had this end cut

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off for further test. On testing it subsequently in water with 2,000 volts alternating pressure, however, no fault was developed.

In order to thoroughly examine the cables and the street box it was necessary to move the former slightly, but they were disturbed as little as possible, and a test was then made of the insulation of both larger and smaller cables together, up to the point where the connection to the mains had been severed at the large chamber. This test made with about 100 volts from a small hand machine gave an insulation resistance of between 4 and 5 megohms from the small pipe—a result which did not indicate any serious leak, considering that the cut ends of the cables had not been sealed up, and some leakage from them was to be expected.

On consideration of the matter, however, it occurred to me that possibly the slight movement to which the cables had been subjected had sufficed to move a small defect in the insulation away from contact with the pipe, or that the fault might be such as to give high insulation with 100 volts, but to break down when the pressure was increased to 2,000 volts, so that the fault would not be discovered by the electric test I had made. I therefore requested the Electric Light Company to send for my examination the whole of the cables mentioned so soon as they had withdrawn them from the pipes. This was done, and a distinct defect of insulation was discovered in one of the smaller cables, with evident signs of sparking and some burning of the insulating material having taken place. I do not think, however, from the appearances, that the whole leakage current could have much exceeded one ampere.

Judging from the results of my investigation, and from the attached copy of the report of the borough veterinary surgeon of the *post-mortem* examination made on the horse, I have no doubt that the latter did receive an electric shock, and that probably this shock was the determining cause of death, but that, nevertheless, the shock could not have been a very severe one, and I am inclined to attach much weight to the veterinary surgeon's expression of opinion that the dilatation of the heart may have been a predisposing cause of death.

In order to further elucidate the above, I attach a rough tracing of the locality in which I have marked the street box (*a*), the small pipe (*b*), and the larger pipe (*c*).

My explanation of the occurrence is as follows:—In the first place, the soil at Bournemouth is of such a nature that it is very difficult to get what is technically known as "good earth." There are alternate layers of sand and clay, and either of these may, under certain conditions, oppose great resistance to the passage of electricity. The soil in which the street box (*a*) and the pipe (*b*) were placed was a peaty sand, but probably a layer of clay exists at no great distance below. Secondly, the accident happened during the progress of a thaw after a very severe frost. Now water in the solid form is not nearly so good a conductor as it is when liquid, and the juxtaposition of masses of thawed and masses of frozen ground may have greatly influenced the direction and amount of current flow. It is just possible that the small amount of heat produced by the current in the wires contained in the pipe may have determined a more complete thawing of the ground directly above the pipe than in other parts. Thirdly, the pipe which appears to have been directly charged from the cable was only 24ft. long and 1½in. in external diameter, and was not metallically connected to the larger pipe, but terminated at the brick-work of the street box. Even in soil of a highly conducting nature it would, I consider, be possible to appreciably charge such a short length of pipe by contact with a high-pressure electric wire. Owing to the special conditions above referred to, the potential of the surface of the ground immediately above the pipe appears to have been appreciably affected, and the horse seems to have placed its hind feet upon this charged surface. At the same time one fore foot would be four or five feet distant and very probably in contact with more freely conducting soil. A current from the charged to the uncharged, or at any rate less highly charged ground, therefore, passed through the body of the horse.

That any such result as the death of a horse should have followed from so indirect and limited an application of electricity is indeed an extraordinary occurrence, but while the field of inquiry it opens to view must be carefully studied, and any additional precautions which may after due consideration be thought necessary firmly insisted upon by the Board of Trade, I do not think there was any appreciable danger to human life in this case. Experience in many countries has shown that horses are peculiarly susceptible to electric shock, and a horse necessarily, even when at rest, is in contact with the earth at points much farther apart than are simultaneously touched by men, while the iron shoes and nails of the former and its greater weight ensure a more perfect contact where it does touch. These differences are well brought out by the testimony of the men who extricated the horses. When they touched the bridles they felt a shock, because their feet were resting on the ground about 7ft away from the hind feet of the horses; but not one of them appears to have been conscious of any shock at all, except from contact with the horses.

The suggestion that people inside the omnibus might have been injured by an electric shock is quite untenable. It is, of course, needless to point out, however, that many people's lives may be jeopardised from the result of an electric shock given to a horse, and that on this account alone it is essential that all danger of such an occurrence should be avoided.

I cannot acquit the Electric Lighting Company of blame in the matter. They had warning by their own tests that a defect of insulation existed on this circuit, but they had taken no steps to localise and remove it, although the insulation of the circuit was considerably below 1 megohm. Also on the very day of the accident, as will be seen from the attached copy of a report from one of the foremen in the employ of the Corporation, they had received a warning of the state of things, which they should at once have attended to.

I must also point out that in my opinion the use of such small and thinly-insulated wires carrying high-pressure currents for electric lighting is most injudicious. The cable which failed on this occasion is apparently exactly similar to that which caused the death of a line man on the House to House Company's system rather over a year ago, and other companies have, I am informed, experienced trouble with cables of this size and description.

In order to prevent any recurrence of similar accidents the Company should, in my opinion, take the following steps:—(1) Immediately replace all cables used for high pressure similar to that which caused the accident by larger cables having a thickness of insulation of not less than one-tenth of an inch of best quality india-rubber or some equally-efficient material; (2) connect together all the pipes in which high-pressure cables are contained, and wrap the cables where they pass through street boxes with a sufficient covering of sheet lead, or encase them in iron cases also connected with the pipes, so that the cables should be enclosed throughout in metal casing in connection with earth over the full extent of the system; (3) submit to the Board of Trade for approval, as required by Regulation 10, some efficient pattern of leakage indicator; (4) take immediate steps to localise and remove any defect of insulation which may occur on their circuits.

The Assistant Secretary, Railway Department, Board of Trade.

I have, &c., (Signed) P. CARDEW, Major, R.E.

Report of the Veterinary Surgeon.

Bournemouth, January 9, 1894.

SIR: I beg to report that, acting on your instructions, I have in conjunction with Mr. Goodall, F.R.C.V.S., of Christchurch, and Mr. Blake, M.R.C.V.S., of Bournemouth, made a *post-mortem* examination of a grey mare, the property of Mr. Melton, which was reported as having died suddenly, January 8th. We found a bruise extending along the right side of the body from about the seventh to the twelfth rib. There was an ecchymosed spot on the corresponding side of the pleura. There was marked hyperaemia of the muscles of the anterior part of the body, the muscles of the posterior part were analmic. The abdominal organs were healthy. The spleen was slightly enlarged, the substance was examined by the microscope and was found to be healthy. The lungs were congested. There was dilatation of the right ventricle of the heart, the valves were normal. The blood was fluid and black in colour. The brain was healthy. Rigor mortis was present. I am of opinion that the *post-mortem* appearances were consistent with death being caused by an electric shock. I am further of opinion that the dilatation of the heart may have been a predisposing cause of the death of the mare.

I am, &c.,

John Druitt, Esq., jun., Town Clerk.

(Signed) J. T. KING, M.R.C.V.S., Borough Veterinary Surgeon.

Report of the Foreman.

January 8, 1894.

SIR: Carter J. Hooper reports that he went to the Imperial to collect ashes about 7:30 a.m. this morning. When he arrived there his horse became startled as if by shock, and he says that he himself felt the shock of electricity in his legs, also in his arms. J. Scott, assistant ash carter, that was with him, reported as above mentioned to me. I at once sent him to the offices of the Electric Light Company in the Albert-road to report the same which he done (viz.) to some young person that was in charge of the offices at the time.

Mr. Turner.

(Signed) W. ELCOCK, Foreman.

TELEGRAPHIC COMMUNICATION BETWEEN ENGLAND AND INDIA, ITS PRESENT CONDITION AND FUTURE DEVELOPMENT.*

BY E. O. WALKER, C.I.E.

(Concluded from page 389.)

When communication between England and India was first opened, the unit of charge was a message of 20 words for £5, or at the rate of 5s. per word. In 1876 the minimum chargeable unit was reduced from ten words to one word, containing not more than ten letters, but the charge was fixed at 4s. 7d. This was a distinct improvement. In 1887, the charge was 4s. 2d. per word, and at the present time from England to India the rate is 4s. *via* Suez and Teheran, and 3s. 8d. *via* Turkey. The charges in India are altered from time to time by the Government, to prevent loss by exchange, since payment must be made to the companies in gold, a proceeding which is unwelcome to the commercial community, and which, when applied in South America, was resented, and had to be abandoned.

As regards the revenue afforded by messages in the early days of the overland telegraph, I have not complete figures. But, in 1868, the Indo-European Department and the Turkish line earned something like £187,200. The opening of the Suez route at once diverted a large portion of the traffic, and it also stimulated it. The Eastern Telegraph Company has never paid less than 5 per cent., and often more than 6 per cent. The Indo-European Company, although for a few years unremunerative, was able to pay 5 per cent. in 1874, has not paid less than 8 per cent. since 1880, and as much as 12 per cent., and in the past five years often 10 per cent. The returns for the Turkish lines are not available, but a small percentage only of the overland traffic between Europe and the East now passes over them. In 1891-92, 92·4 per cent. went *via*

* Abstract of a Paper read Thursday, February 8th, before the Indian Section of the Society of Arts.

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Teheran, and 7·6 per cent. *via* Turkey; but this is fully accounted for by the fact that the mean rate of transmission in that year by the former route was one hour, and by the latter sixteen hours. It may be remarked in this contrast that the Indo-European Department, controlling the lines from Kurachi to Teheran, has been of late years only able to show a credit balance. In 1891-92, the net profit was 1·4 per cent. This is due to the heavy outlay on the Persian Gulf cable, and this, gentlemen, is an important factor in determining the telegraphic rate to India. In 1878 an agreement was effected between the Eastern and the Indo-European Companies and the Indian Government for a "joint purse," based on the actual traffics each line dealt with. By this arrangement the Eastern Company gets 60·39 per cent. of the revenue for Indian traffic, and the other Company, with the Indo-European Department, 39·61 per cent.; for trans-Indian, or Far East traffic, the figures are 80·53 and 19·47 per cent. respectively. The actual percentages of traffic since carried differ from these figures. The averages, from 1878 to 1892, for Indian messages, are 56·5 per cent. *via* Suez, and 43·5 *via* Teheran. Although the Cable Company may have had a larger share of the earnings than the actual work done would justify, still it must not be overlooked that the support it has afforded to the overland lines in times of interruption has been immense, and the co-existence of the two routes (leaving the Turkish aside as being comparatively unpopular) has proved to be indispensable in retaining and in fostering the traffic.

The amounts earned and paid into the "joint purse," on account of Indo-European messages for some of the years, from 1878 to 1892, are given below:—

1878-79	£310,009
1881-82	360,011
1888-89	335,257
1891-92	360,098

1891-92, the share of the Eastern Telegraph Company was £217,465; of the Indo-European Company, £80,445; and of the Indo-European Department, £62,188. If the overland lines had retained all they earned in that year, their shares would have been £106,488 and £81,760 respectively. All administrations concerned earned something more for Far East traffic, with the Straits Settlements, China, Australia, New Zealand, &c., the share of the Eastern Telegraph Company on this account being £229,045, of the Indo-European Company £34,218, and of the Indo-European Department £21,164. The dividends paid by the first two were at the rate of 6½ and 10 per cent. respectively.

The capital, including Ordinary, Preference, and Debenture stock of the Eastern Telegraph Company was, in 1891-92, £6,100,000, and its reserve fund £442,014. The capital of the Indo-European Telegraph Company remained at £425,000 and its reserve was £172,839. These last figures, coupled with those of the excellent dividends distributed, and also the admirable service afforded by the Company, will show what land lines can do when well administered. The capital expenditure by the Indo-European Department, up to the year under review, was Rx.1,150,000.

The figures given above include the revenue derived from Continental messages as well as those of the United Kingdom. Supposing the number of telegrams to be proportional to the whole value of the trade, then, in 1892, one quarter would have been sent between India and the Continent and three-quarters to or from the United Kingdom. Thus out of the revenue for 1891-92 for Indian traffic, £270,000 was approximately contributed by Anglo-Indian and £90,000 by Indo-Continental messages. I would ask attention to these figures, since they are material to the subsequent argument.

Now, I have little doubt that it will surprise most to know that the total amount paid for telegrams between India and the United Kingdom in 1891-92, namely, £270,000, was only about a quarter per cent. of the value of the total trade, Rx.95,222,155. I attribute this unnatural restriction of traffic solely to the high rate which prevails. Small traders cannot, on account of the expense, use the wires, and I think my friends in India will bear me out in the statement that foreign telegrams are, as a matter of fact, sent by the comparatively few wealthy firms. Private persons, owing to the cost, rarely communicate between England and India by telegraph. Now, the last twenty years have witnessed an extraordinary extension of inland telegraphs in both countries. Speaking from experience in India, I can say that they have largely aided in the transport of produce, and in bringing up-country merchants into connection with distant markets, with which formerly communication was difficult and slow. In order to make a profit at the present day it is often necessary that transactions should be effected quickly, and whenever telegrams are made cheap it has been found that they are readily used for this purpose. Moreover, native firms are learning to deal direct with European manufacturers. Could they communicate by telegraph, at a low charge, there can be no doubt that the trades concerned would receive a stimulus. It is, perhaps, open to doubt, whether it would be a public benefit to afford cheaper means than exist at present, by which the Secretary of State could speak to the Viceroy of India. There would, however, be a large reduction in the present considerable telegraph bills of the two Governments, and they should be, equally with the general public, interested in lowering foreign telegraph rates. Setting the Continental traffic aside, India and England only exchange about 465 messages per working day. This fact, when compared with the volume of their mutual trade, and with the enormous political interests common to both countries, speaks for itself.

Now, with effect from May 1, 1891, some of the Australian colonies entered into an agreement with the telegraph companies to make up half the loss, if such loss should occur, on a reduction of charge from 8s. to 4s. per word between England and Australia. The difference was a large one, and experience has shown that a certain loss has been incurred, but that if the reduction had been spread over ten years instead of being wholly effected at once, there would have been no loss. Probably in a shorter time than that the increase of traffic would have paid for the reduction. From January 1, 1893, the rate was raised to 4s. 9d., at which it is anticipated there will not be a deficit in the revenue. I believe the situation is one in which the Home and Indian Governments might, in their own and in the public interest, exert themselves. Apart from the cheapening of communication by extending the overland lines, a course which is quite practicable, I hold that the Companies are in a position to gradually lower the rate, and that experience proves that, done cautiously, the greater facilities thus afforded will prevent loss of revenue.

The question next arises, What amount of traffic could be easily carried by the Indo-European and Eastern Companies with their existing lines should the introduction of a reduced rate largely augment the number of telegrams? I will suppose that two out of the three cables are used for through traffic to India, and that there are two through wires *via* Teheran. These four working circuits are capable of carrying at least each fifteen words per minute, or, say, to give you a better idea of their capacity, one message per minute. In 24 hours a traffic of 5,760 messages could be dealt with, or five times what passes at present between Europe and the East. But there is another feature in modern telegraphy by which, without increasing the capital outlay by more than a small sum—£15,000 in the case of the Eastern Company's cables—the carrying capacity of the circuits is almost doubled. This is the "duplex system," which by special arrangements of apparatus at the ends of a circuit, but involving no alteration of the wire or cable itself, permits of messages being transmitted simultaneously from each end. Dr. Muirhead's efficient duplex system, which was applied to the Eastern Company's cables some twelve years ago, about doubles the carrying power of a circuit, I am informed, and thus the Company is in a position to carry a very large traffic without going to the expense of laying extra cables for it. Many men will think that the public might have been allowed to participate in the advantages accruing from this new method by the concession of lower charges. Anyhow, it affords means of now dealing, in conjunction with the Indo-European Company, with over 7,000 messages daily. The lines of the latter are not, I believe, at present using the duplex system, but there is no difficulty in applying it, and increasing largely the ability of the Company to cope with a large traffic. Then the Turkish route, in capable hands, can be made as serviceable as the others. It is quite possible that, owing to telegrams on business being despatched during working hours, that the bulk of the traffic will be confined to part of the day only, and, at the same time, desirable that it should not be allowed to accumulate. Supposing even that it is dealt with between 11 a.m., London time (*i.e.*, 4 p.m., Indian time), and midnight. Then the present circuits duplexed could carry over 4,000 messages in that interval, with no excessive delay on each. Were all these Anglo-Indian messages at a rate of two rupees, or two shillings and sixpence per word, they would produce a revenue of £6,850 per day, taking each message to consist of 13·7 words, as was the average for private messages in 1891-92, or over £2,000,000 for the year of 300 working days, which, after deducting the Indian Government share, would leave something like £1,750,000 to be divided between the companies, against £650,000 at present. Of course, I am aware that even at a rate of 2s. 6d., the traffic is not likely to increase with so great a bound, but there is little reason to doubt that with India, as well as the Far East, it will be worked up to in twenty years, if charges are subtantially lowered at intervals in that period.

With a growing foreign trade, the revenue in 1891-92, from Indo-European traffic, was about the same as that for 1881-82—about £360,000. Some will attribute this to the process of condensation, or codification, which has been going on—that is, the use of letter or word cipher. No doubt this has unfavourably affected revenues, but then it is a science fostered by high tariffs. I am prone to think that the want of progress is rather due to the fact that there has been practically little reduction in cost per word for twenty years. I venture to assert that, in existing circumstances, looking at the dividends paid, the substantial reserves accumulated, the reduced cost of cables, as

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compared with twenty years ago, and at the fact that the lines can carry a much larger traffic than they do, the public has a claim, and the companies and the Governments of India and this country have an interest in making Anglo-Indian telegrams cheaper. I would add that the Indian public ought to be relieved of fluctuating charges for the messages, made to depend upon the course of exchange. The charge can, and should be reduced by 6d. yearly, until the present rate—4s.—is lowered to 2s. 6d. This course would obviate any serious falling off in receipts. No guarantee by Government, nor by the commercial communities concerned, should be required to insure the companies against loss in taking this step. Their present position is sufficiently strong financially to admit of their incurring the risk.

But, in my opinion, what is essential to the introduction of a permanently low charge is the extension of the overland systems of telegraphs. I desire to point out that there are three links to be completed in these systems, which would, with a properly organised service under central control, in connection with the European lines, certainly afford means to India and England of exchanging correspondence far more cheaply than at present. They are as follows:—Shiraz to Jask, in Persia, 575 miles, a telegraph line by this route will, at a cost of £35,000, complete the overhead wire from London to Calcutta, with the exception of the short cable across the channel. This amount is less than the cost of maintenance of the Persian Gulf cables for two years. A new trunk line from England to India, *via* the Continent, Russia, and Persia, with the necessary offices, would not, in the light of the experience we now have, and at the present chief prices of materials, cost more than £450,000. The Home and Indian Governments might possibly find it economical to construct such a line, primarily for their own correspondence. I would remind you that there are two wires by land already—from Kurachi to Jask, and from Shiraz to Teheran. The period of the Indo-European Company's concession from Prussia, Russia, and Persia, and the convention existing between India and Persia, will expire in 1895, and a favourable opportunity thus occurs of revising arrangements with regard to overland communication with India.

The second link, which it is important to complete, is that from Mashad to Herat, and thence to Kandahar and Quetta. From Teheran to Mashad, 562 miles, there is now a telegraph line belonging to the Persian Government, but maintained by the Indo-European Department. Mashad sent about 2,000 messages to the Persian Gulf stations in the year 1891-92, a fact which shows that when these out-of-the-way places are connected by telegraph with trade outlets, the local traffic is an important item in estimating revenue. From Mashad to Herat is about 240 miles. From Herat to Quetta, *via* Kandahar, some 500 miles, there are no physical difficulties; and there is every likelihood that, before long, the present Amir will look favourably upon the introduction of the telegraph, equally with other applications of modern science, into his dominions. At Quetta, the lines of the Indian Telegraph Department are connected with the Punjab and with Kurachi. I shall be told that the telegraph work in Afghanistan is perilous. No doubt at first it will be. The telegraph operations in Burmah have been difficult and hazardous, but most of the lines are now permanent and reliable. In the Afghan war, Mr. Luke, of the Indian telegraph, managed to keep the wire open from Kabul to Peshawur, and Mr. Pitman, at Kandahar, held communication with Kurachi. The difficulties now to be encountered, with a Government favourable to the enterprise, would be comparatively light.

There remains one more important gap to be filled up in the Asiatic systems of telegraphs, namely, that from Merv to Herat *via* Penjdeh. These are joined by a road about 240 miles in length along the valley of the Murghab. A telegraph line here will, when Herat is connected to Quetta, unite India with the present Russian Asiatic telegraphs that lead to Europe by the Caspian Sea. A second trunk line through European Russia, *via* Merv and Herat, and so to India, will afford a valuable alternative route in time of peace, and by this, in combination with the line of the Indo-European Company, or another through the south of Russia and Persia, the whole of the traffic between Europe and the East could be carried. Such lines would probably earn much from local traffic. The cost, not more than a million sterling, for the two separate lines, would admit of messages passing between England and India at a shilling per word, with provision yet for interest, at the rate of 8 per cent. on the capital.

It is essential to the success of the working of long lines passing through foreign territories that they should be administered by one responsible directorate, and existing circumstances point to the Home and Indian Governments, as well as the Company that has already achieved such good results, as the authorities best qualified to promote telegraphic enterprise in the localities I have indicated. No time should be lost in acquiring the rights to do so. By diplomacy and the timely grant of small subsidies, the exclusive appropriation by these routes of certain wires for an international service could be secured.

THE ST. PANCRAS ELECTRIC LIGHTING INSTALLATION.*

BY PROFESSOR HENRY ROBINSON, M. INST. C.E., M. INST. E.E.

I have pleasure in complying with the request that I should describe at the Society of Arts the Electric Lighting Installation that I have carried out for the St. Pancras Vestry. I would state at the outset that St. Pancras was the first municipal authority to appreciate the importance of preserving the business of electricity supply in its own hands.

On the passing of the Electric Lighting Act, 1882, I, in conjunction with Dr. Hopkinson, F.R.S., advised the Vestry to obtain a Provisional Order, and it was obtained in 1883. Owing chiefly to financial and other difficulties in connection with the Electric Lighting Companies, as before mentioned, public confidence was shaken, and the Order remained in abeyance. In 1888 various companies made applications for Provisional Orders by which the metropolis was proposed to be divided amongst them, but at the Board of Trade enquiry that was held in 1889, the St. Pancras Vestry succeeded in getting their district excluded from the operation of any company. I was thereupon instructed to prepare a scheme to serve, in the first instance, the south-west, or Regent's-Park, division of the district, which formed the compulsory area under the Order. In advising upon this, I kept in view the ultimate requirements of the other parts of the St. Pancras district, so that the first installation should form part of a comprehensive scheme. I decided upon adopting the continuous-current system.

The situation of the site that was originally proposed by the Vestry necessitated the employment of high tension, with five transformer sub-stations to feed a network of low-tension distributing mains. The ultimate acquisition by the Vestry of a more central site in Stanhope-street (consisting of 21,000 square feet of freehold property, purchased for £10,000) enabled me to adopt the low-tension direct supply system entirely for private lighting, and to have only one battery sub-station at the Cobden Statue, 1,140 yards from the central station. It was decided to work the public arc lamps by high-tension continuous-current independently of the private lamps. The plant was designed at the outset to serve 10,000 incandescent lamps of 16 c.p. simultaneously in use, and 90 arc lamps of 10 amperes each for public lighting.

I should mention that the action taken by the Vestry was not adopted without strong opposition being offered (which is, in fact, still continued) to the Vestry's undertaking this work. However, on January 1, 1890, authority was given by a large majority for the work to proceed. Having overcome opposition from within, a quite unexpected difficulty arose in consequence of uninvited advice and proposals being made from outside (not altogether of a disinterested character) which disturbed the minds of the Vestry.

On my advice, Dr. Hopkinson and Mr. Preece were consulted, and it was a satisfaction to me that they entirely concurred in my proposals, and the execution of the works, which had thus been interrupted, was proceeded with.

The following is a description of the works:—The buildings consist of an engine-house 106ft. by 26ft., a boiler-house 53ft. by 35ft., coal store 43ft. by 11ft., battery-room 40ft. by 14ft. 6in., testing-room, office, stores, underground tank for condenser water, containing 170,000 gallons, chimney 5ft. square inside and 90ft. high.

There are eleven engines and dynamos, which are erected on a concrete foundation surrounded by sand to prevent vibration being communicated to the walls, and the floor is carried, independently of the engine foundation, by cantilevers from the walls. The engines are of the Willans type, and the dynamos are of the six-pole Kapp type (made by Messrs. Johnson and Phillips). Nine of these are wound for an output of 680 amperes at pressure varying from 112 to 130 volts. Three are capable of giving 145 volts with a small current for charging batteries at the sub-station, and can be worked self-exciting as simple shunt machines, or separately excited. They were tested with a load of 680 amperes at 118 volts, and the steam consumption was found to be 18·65lb. per electrical horse-power per hour, working condensing, and with the dynamo separately excited. The remaining two dynamos are wound for an output of 90 amperes at from 540 to 575 volts. They are separately excited at low tension, and are used for working 86 arc lamps in the streets, as well as for charging in series four sets of storage batteries of 60 cells each at the central station, which are capable of discharging 60 to 75 amperes. The trials of these two engines showed a consumption of 19·6lb. of steam per electrical horse-power per hour.

There are five Babcock and Wilcox boilers, each being 23ft. long and 5ft. wide between the walls, with one steam drum 3ft. 6in. in diameter. Each boiler has a heating surface of 1,619 sq. ft., and a grate area of 30 sq. ft., and is capable of evaporating over 5,000lb. of water per hour, the working pressure being 170lb. per square inch.

* Abstract of a paper read before the Society of Arts on Wednesday.

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There are two 6in. steam mains along the top of the boilers fed by separate outlets from each boiler, and delivering into a 6in. main (which extends the whole length of the engine-house) at three points. The mains are so arranged that only two engines are put out of use by the removal of any one pipe. The long pipes are made of wrought-iron, the short pipes and T-pieces of cast-iron, and the bends of copper. The main exhaust-pipe, under the engine-house floor, varies from 5 to 15in. in diameter. The steam can be exhausted to the atmosphere, but under ordinary circumstances it passes into a jet condenser, which draws its water from the bottom of the underground tank. Two air pumps, driven by a Willans's compound engine, discharge the hot water from the condenser into the top of the tank. A Körting ejector condenser is provided as a stand-by for heavy loads. From the top of the tank the hot water is pumped by independent circulating pumps to a cooling apparatus, which is capable of dealing with a minimum of 10,000 gallons per hour. The cooling arrangements consist of a large surface of corrugated iron sheets, attached to framing placed round the chimney shaft, the water, after flowing over the corrugated surface, being collected beneath and returned to the bottom of the tank.

A dry-air machine is provided for the purpose of delivering dry air into the street main culverts at the rate of 5,000 cubic feet of air per hour. The air has its dew-point lowered to 40°F.

The arc lamp-posts (86 in number, displacing 479 gas-lamps) are of the Brockie-Pell type, and are placed in the centre of the road, where this is admissible. In some places, however, they had to be placed on the pavements, as tramways prevented them from being in the middle of the roads. The first lamps that were erected (in Tottenham Court-road and Euston-road) are 25ft. from the ground to the centre of the globe, but those more recently put up, which are chiefly on the pavements, are 22ft. They are fixed at distances varying from 160ft. to 245ft. apart, and are fed with a current of 10 amperes. Eleven lamps are worked in series near the central station, and ten in series at a distance. Nine arc lamps have more recently been put up in Park-street and supplied with current off the low-tension mains.

The main switchboard is arranged on the three wire system. Each dynamo is provided with a double pole switch and copper coupling straps to connect the machine to the third wire and to different bars on the feeder-board on either side of the circuit. There is an ampere meter on each dynamo. One terminal of the dynamo switch is coupled by a strap to the third wire main, and the other terminal is coupled to a bar on the feeder-board. There are four positive bars and four negative bars, and at full load one machine can be run on to each bar and worked at any pressure which may be necessary to serve the feeders which are switched on to it. Thus the dynamos may all be worked at different pressures to suit the demand in the districts which they serve. There are seven feeders, in addition to a direct supply on to the distributing mains, which are connected in a network throughout the district. The bars on the board may be connected directly in parallel or through resistance cells, which will each carry currents up to 180 amperes, offering a counter electromotive force of from 2 to 2¾ volts. By using these cells current can be supplied to the feeders at four or five different pressures from one dynamo, which enables the dynamos connected to long feeders to help those serving short feeders, and further enables regulation over large areas when only one dynamo is at work on each side of the circuit.

There is an underground sub-station beneath the open space at the Cobden Statue, High-street, Camden Town, at a distance of 1,140 yards from the central station, which contains two batteries of 58 cells each.

The mains are laid throughout on the "three-wire-system," the arterial mains being sufficient to supply 25,000 lamps of 16 c.p. in use simultaneously. The conductors are chiefly composed of bare copper strips 1½ in. wide and ⅛ in. thick, supported on edge in glazed porcelain insulators, which are carried on small cast-iron brackets built into the walls of the culverts. Some of the mains are cables laid in cast-iron pipes, and in the extensions now being carried out they are Siemens armoured cables.

The works originally authorised, I estimated would cost about £50,000, and this estimate was increased to abcut £52,000 when the Stanhope-street site was adopted. The actual cost of the works when completed was about £56,000, or within 8 per cent. of the estimate, which, I think it will be admitted, was satisfactory. During the execution of the works originally authorised by the Vestry, extensions were made by the Vestry which involved a considerable increase in the capital expenditure.

The works were so far completed as to enable public supply to be commenced on November 9, 1891 (or a year after laying the first stone). By the end of January, 1892, there were 6,500 incandescent lamps of 16 c.p. installed (or their equivalent), and at the end of 1892 there were 11,733, and at the end of 1893, there were 14,617 lamps installed, and many more contracted for, to come on shortly.

The current for ordinary supply is charged at 6d. per unit, but it is charged at only 3d. per unit for what is termed "day load," but which might be defined as current supplied for motive-power and other purposes at times other than those of maximum demand.

The public lighting is at present charged for at the rate of 6d. per unit, which covers the entire cost of production as well as for carbons, trimming, &c., together with all capital charges and maintenance, including lamp columns, lamps, street refuges, &c. The electricity department takes charge of all these matters, and the public lighting account is only debited with one item, "current used," at 6d. per unit. The cost of carbons and trimmings for the 95 public arc lights in 1893 was about £600.

Capital Expenditure to December 31, 1892.

Lands (part only utilised)	£10,027	0	0
Buildings	7.653	17	1
Machinery and plant	24,378	17	8
Batteries at central station and sub-station at Cobden statue	2,961	6	11
Mains, of which some are capable of carrying current for 25,000 lamps	33,787	15	3
Public lamps	6,723	8	4
Meters	1,556	3	9
Electrical instruments, &c.	284	16	3
Office, and other furniture, and fittings	186	7	4
Preliminary expenses	554	4	7
Total expenditure to December 31, 1892	£88,913	17	2

During the year 1893 a sum of about £10,000 was expended in extensions of public lighting, together with mains, meters, house connections, &c. A further increase of the generating plant at the central station has been rendered necessary, owing to the increasing demand for current. These works are now nearly completed, and consist of an extension of the central station buildings to receive three more engines and dynamos, three additional boilers, together with a second sub-station in Fitzroy-road, near Primrose-hill, 2,700 yards from the central station, containing two sets of batteries. These extensions will cost about £13,000.

The "fixed charges" in the shape of the permanent staff, &c., commenced in the middle of 1891, before the public supply of current began. Some of the working expenses of the Station during that year, and also in 1892, were incidental to a new undertaking. The following figures for those years, therefore, do not admit of being taken as any criterion of what the normal relation between receipts and expenses will be, but they are given as a matter of record. From the commencement of public supply in November, 1891, to the 31st of December, 1892, there were 11,733 lamps of 16 c.p., or their equivalent current, installed (including 11 motors = 36 H.P., and 92 private arc lamps), of which 6,823 were in simultaneous use. The number of units sold to the end of 1892 was 433,519. The amount charged for lighting the 86 public arc lamps (which were at work only part of the year) was £2,040, the current being charged at 6d. per unit. The total working expenses of all kinds from the commencement to the end of 1892 were £7,438. A sum of £408 was expended on the maintenance of plant. A capital sum of £4,119 was repaid, made up of £400 capital and £3,719 for interest on loans at 3½ per cent. The number of tons of coal used to the end of 1892 was 2,728, and its cost was £2,828, the price of coal being from 20s. to 21s. 6d. per ton.

For the year 1893 the following are the figures :—

Number of 16-c.p. lamps, installed, or equivalent current, including 19 motors = 61 H.P. and 110 private arcs		14,617
Number of 16-c.p. lamps, or equivalent current, simultaneously in use		6,187
Number of units sold for private lighting		397,217
Number of units sold for public lighting		197,676
Total number of units sold		594,893
Receipts for private lighting		£9,546
Receipts for 93 public arc lamps, the current being charged at 6d. per unit		£4,941
Total receipts for current		£14,487
Working expenses		£7,033
Repayment of capital	£1,628	£4,425
Interest on capital, at 3½ per cent.	£2,797	
Expended on maintenance		£1,402
Total for working expenses, repayment of capital, and maintenance		£12,860
Number of tons of coal used		3,180
Cost of coal (price about 17s. 9d. per ton)		£3,003
*Cost of coal per unit sold		1·21d.
Cost of a unit sold if capital had not been repaid		3·4d.
Cost of a unit sold with capital repaid, and maintenance		5·18d.

* This was more than it should have been.

The year 1893 was exceptionally free from fogs, and those which occurred were, I believe, chiefly on Sundays. This led to the receipts for current per lamps installed for that year being below what may be expected over an average number of years. In considering the foregoing Table, it should be remembered that the capital repaid is in respect of the cost of a site, the cost of mains, permanent charges, &c., for the supply of a far

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greater number of lights than those which were supplied during the year, so that, in future years, the cost of production will diminish, inasmuch as the fixed charges and repayment of capital will be spread over a much larger output.

The question of the terms of repayment of the capital for electric lighting by municipal authorities is now receiving serious consideration, as affecting the price at which the public can be supplied with current. The view the St. Pancras Vestry take is, that the repayment of capital should be spread over a period of 42 years, and that renewal should be met out of profits supplemented, if need be, by a rate or loan, when the extent of the expenditure justifies it being spread over several rates, by which the present generation of ratepayers would be able to have the benefit of cheap electricity, which it could not otherwise have.

It is often stated that the cost of public lighting by electricity is greater than by gas. If the same standard of illumination had to be obtained by gas as by electricity the statement would not hold good. It is entirely a question of whether or no the standard of lighting does not require to be raised. I think it does. The present lighting of the thoroughfares in the metropolis is a reproach, and St. Pancras has led the way in reforming this. I am confident that at no distant date the present inefficient lighting of the streets will be looked back upon as comparable with the old oil-lamps for which gas was substituted at a great increase in cost of public lighting.

The destruction of town refuse is now recognised as about the best way of getting rid of it, both from a sanitary and financial point of view. The heat produced by the combustion of the refuse can be advantageously utilised for various purposes, amongst others for generating steam. This has led to the combination of a refuse destructor and electric-lighting station, where the heat produced during the time of working the destructors can be applied to do the work of light loads or in aid of steam boilers. I am now, in conjunction with Mr. William N. Blair, the engineer of the St. Pancras Vestry, carrying out a combined destructor and electric-lighting station at King's-road, to serve other parts of the district, the outlay on which will be about £40,000 without distributing mains, which will connect it with the existing network, and will enable the heat produced during the day time to be utilised to do the work of charging the batteries and the light load over the whole district.

Having described the satisfactory results that have already been accomplished, I am confident that it only requires ordinary good administration for a still further degree of success to be attained, which will enable the Vestry either to lower its rate of charge below 6d. per unit, or to have a handsome amount each year to devote to the benefit of the ratepayers. I desire to record my thanks to the members of my staff, and especially to my chief assistant, Mr. Thrupp, for their aid in carrying out these works. In conclusion, I think the St. Pancras Vestry may be congratulated on the success that has attended their enterprise, which has fairly realised the anticipations and calculations upon which it was promoted.

ELECTRICITY SUPPLY IN BERLIN.

The Report of the Berliner Elektricitätswerke contains an interesting summary of the working of that concern up to June 30, 1893, and a brief *résumé* of it may be of value to English engineers. A gratifying increase of business and improvement in the supply has taken place, the number of lamps (30-watt) having risen from 272,000 to 328,000; while the output has advanced from 45·9 to 53 million ampere hours, excluding the amount consumed by the stations themselves. The following table gives the consumption since 1885 (we have translated the figures into kilowatt-hours, as they are very confused in the report) :—

—	Private lighting.	Street lighting.	Industrial power supply.
Aug. 15 to Dec. 31, 1885.	38,150	—	—
1886	303,120	3,054	—
1887-88	715,920	6,282	—
1888-89	1,173,730	19,962	12,956
1889-90	2,511,000	21,646	69,591
1890-91	3,554,400	21,8[illegible]4	274,457
1891-92	4,831,440	21,708	186,611
1892-93	5,228,600	21,576	238,042

The receipts on all heads were 3,570,696 marks (£178,535 nearly), an increase of about 8½ per cent., in spite of the reduction of the tariff in January. The use of motors has increased very considerably, from 121 with 500 H.P. to 232 with 785 H.P., nearly 60 per cent.; and they are still increasing equally fast.

Considerable economies have been effected in works' costs: coal has been reduced 23 per cent., oil 43 per cent., salaries 18 per cent., sundries 1 per cent., making a total decrease of 15·6 per cent. in the works cost per I.H.P. (probably I.H.P. hour is meant); and a further economy is to be produced by replacing at the Mauerstrasse station three 250 H.P. engines and dynamos by one 1,200 H.P. steam dynamo. An extension of the mains to the Zoological Gardens quarter has proved very successful, more than 22,000 lights having been applied for.

The position of the various accounts is then discussed, noteworthy being land account, £30,500, mains £34,000, and machinery and plant £19,000. We note that the motor account has risen considerably, the Company apparently doing a considerable business in the hire of these machines. We note also that the system of regulating clocks worked by the Company, and regulated automatically daily, which we recently referred to in these columns, is now working satisfactorily. The Company owes the large sum of £35,800, chiefly to the Allgemeine Electricitäts Gesellschaft.

After deducting from the gross receipts all cost of working, interest and repairs, there remains as net earnings 1,089,376 marks (about £54,460), which the Directors propose to divide as follows :

Reserve fund	54,468	marks,	about	£2,720
Dividend at 8½ per cent.	765,000	,,	,,	£38,250
Share of profits payable to Municipality	91,670	,,	,,	£4,580
Special renewals fund	50,000	,,	,,	£2,500
Percentage to Directors and Managers	76,500	,,	,,	£3,825
Bonuses to Staff Pension Fund	38,250	,,	,,	£1,912
Workmen's Union	3,000	,,	,,	£150
Carried forward	10,487	,,	,,	£524

The Company's share capital is nine million marks, about £450,000. As regards the prospects of the Company, it is remarked that at the end of September 96,000 amperes were taken up or applied for, the capacity of the stations being 130,000 amperes.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, February 16th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting at 28 Victoria-street, S.W. Discussion on Prof. G. Forbes's Paper on "The Electrical Distribution of Power from Niagara Falls."

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Bacon's Key to Nature," by Prof. Nichol, M.A.

SATURDAY, February 17th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture on "Light," with special reference to the Optical Discoveries of Newton, by the Rt. Hon. Lord Rayleigh, F.R.S.

TUESDAY, February 20th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read with a view to discussion: "Forging by Hydraulic Pressure," by Ralph Hart Tweddell, M.Inst.C.E.

WEDNESDAY, February 21st.

ROYAL METEOROLOGICAL SOCIETY.

8 p.m. Ordinary Meeting at 25, Gt. George-street.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Meeting at 20, Hanover-square, W.

SOCIETY OF ARTS.

8 p.m. "Electric Signalling without Wires," by W. H. Preece, C.B., F.R.S.

THURSDAY, February 22nd.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting. The following Papers will be read: (1) "A Method of Testing the Magnetic Qualities of Iron," by Gisbert Kapp, M.Inst.C.E. (2) "A Note on Parallel Working through long lines," by W. M. Mordey, Member.

FRIDAY, February 23rd.

PHYSICAL SOCIETY.

5 p.m. The following Papers are down to be read: (1) "A Method of determining Refraction Indices," by W. Littlewood. (2) "A New Electrical Theorem," by T. H. Blakesley. (3) The Attachment of Quartz Fibres," by Prof. C. V. Boys.

INSTITUTION OF CIVIL ENGINEERS.

7.30 p.m. Students' Meeting at 25, Gt. George street. The following Paper is down to be read: "Ship Slipways," having special reference to the Dover Slipway, by Walter Beer, Stud.Inst.C.E.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Transformations of Electric Currents," by Prof. Silvanus P. Thompson, F.R.S.

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THE CITY OF LONDON ELECTRIC LIGHTING.

The Paper which was read in part by Major-Gen. WEBBER at the Institution of Electrical Engineers on Thursday last, deserved, as the President remarked, better treatment than was accorded it by the meeting. The Paper was in the hands of some of the members on Thursday morning, so that the only chance of securing a useful discussion was by adjourning it until the next meeting. As this was not done, doubtless for good reasons, the critical examination of the Paper was thus lost. The answer to a question asked by Mr. KAPP, but not given in Gen. WEBBER's reply, is, we believe, that, according to the original design, the low-tension mains were not to be connected, but that each network served by one transforming station should be independent; and that a high-pressure concentric main should be laid between the neighbouring transforming stations, so that they might help one another in case of the failure of the direct mains from the generating stations. To what extent this has been actually carried

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out we have no information. The remarkable reticence about this work is doubtless due to the fact that the first part of the plant was put down in a great hurry to make some sort of show before the period within which the public lighting had to be completed expired, and that much of the subsequent work has been tentative or experimental. Some day, when, perhaps, nearly all interest has disappeared, an account of the results will be given. Mr. KAPP did not see the advantage of discontinuity of the supply networks, but a great advantage surely is to be found, as we pointed out three weeks ago, that earths on one such network will in no way affect leaks on another network. The difference of potential of any network from earth is quite indeterminate, so long as it is completely insulated. One leak, large or small, will put one side to earth, and nothing more will happen. The leak, if serious, would soon be detected, localised, and removed. The only apparent advantages of connection are the equalisation of pressure, in case of an exceptional local demand, and security from extinction in case of a complete breakdown at a sub-station.

The light thrown upon the coal consumption for Brush arc lighters and for Thomson-Houston machines is interesting. The reliability of, and immunity from injury in case of short-circuit of these dynamos has been proclaimed for many years. We have always understood that low-current density and underloading sufficiently accounted for the former virtue, and that the latter depended upon self-induction which wastes no energy, and not upon high resistance. The use of parallel arc lighting has been ridiculed by series arc light men on account of the added resistances. But when five arcs, not Brush lamps, perhaps, nor Thomson-Houston, can be run on 200 volts as at Brighton, or with 90 amperes and 450 volts as at St. Pancras, the current being supplied from really first-rate English continuous-current dynamos, this 7lb. of coal per unit which, we understand, is the lowest that the contractors were prepared to accept, needs a little explanation. The arc lamps are either burning or not burning, and if the plant is run at all it is run on full load. There is no question of load-factor here, unless, indeed, keeping steam up all day in view of a fog is taken into account in making this liberal allowance of coal.

Some rather mild remarks were made by Gen. WEBBER on the intricate financial operations which were the real cause of the delay in getting to work on the City lighting, and of the scramble and inevitable increase of expenditure when a start was at last made. But mild as these remarks were they drew forth a rather angry reply from Mr. J. B. BRAITHWAITE, JR. This gentleman spoke of the unfortunate moment at which money had to be found. BARINGS had just collapsed, and the time allowed for the completion of the public lighting, time which had been wasted in financial haggling, was running out. The contracts for the public lighting of the two first districts were dated May, 1890, but the first sod was not cut until January, 1891. It seemed to Mr. BRAITHWAITE that it was a matter of great interest to electrical engineers that men should have had the pluck to come forward to save the contractors and find the cash to provide, as he rather unpleasantly put it, for the experts' fees. Interesting, no doubt, but peculiarly so to these "plucky" gentlemen who, shortly afterwards, pocketed £25,000 or so, and this, not from the profits of an undertaking to which they had subscribed at considerable risk, but before any business had been begun. One would think, to hear these speeches, that some benevolent deed had been done, something good for trade. What was done was to secure a profit of 50 per cent. on the venture, and to secure for the Brush Company the job for which they had been worrying for years. On November 30, 1891, at the extraordinary meeting for winding up the Pioneer Company, Mr. BRAITHWAITE said that the Company had "stepped into the breach in February last, when things were very dull." The nominal capital of the Pioneer Company was £100,000; but, according to the statutory returns, only £25,000 appears to have been actually called up and paid. And it is these pioneers, with whom "the Lord Mayor, as head of the City, had acted almost as a philanthropist in his desire to serve the City by heading the Board of Directors in promoting the Pioneer Company," who stepped out of the breach with £75,000 eight months after they had stepped in, and whether the bonus was really 50 per cent. as stated, or whether it was 200 per cent. as it would appear to have been, does not really matter now.

Two other speakers supported Mr. BRAITHWAITE on Thursday last. One said that if they were to avoid this sort of thing no large schemes could be carried out. The other observed that the way in which the capital was subscribed was the hardest part of the concern. We do not, therefore, complain, but agree with Gen. WEBBER that the public have only themselves to thank if this sort of thing is necessary. The money was not, in the first place, subscribed for electric lighting, but for a gamble. There was nothing about gambling in the Articles of Association of the City of London Electric Lighting Company; of course there are degrees of gambling: every insurance premium, for matter of that, is a bet that a certain event will not come off. It is an absurd paradox that when money is difficult to raise, the only remedy is to create more difficulties. We hope that the times have not gone by when capital could be raised direct on the merits of an undertaking, and subscribed directly to it on reasonable terms, without being thus bled by a pioneer company. One of the London supply companies was financed in the old-fashioned way, without any "assistance" whatever from middlemen, much to the disgust of this fraternity; another received so meagre a reply from the subscribing public that their direct offerings were, we believe, all rejected, and the Company had to be floated by the underwriters. All engineers and contractors are aware how valuable are the services of "the City" to industrial enterprise, but many promoters talk as if they ought to be thanked for promoting trade. This £75,000, to which we have referred, was part of the capital subscribed for the purpose of putting down electrical machinery and mains. But as to at least £25,000 of it not a penny was used for this purpose, and never came near the electrical trade. It went into the pockets of these "plucky" gentlemen, who worked the pioneer company. This is called pluck. Probably because someone was plucked. We would rather call it luck, and as such, can congratulate them on it.

But we must repeat once more that we do not complain. This mode of procedure appears at present to be inevitable, and so long as the public tamely submit to it, they, and not the financiers, are to blame. Contractors would rather that undertakings were financed thus than that nothing should be done, and very properly. The public are satisfied when at last, after being tossed from one company to another, someone has to do the work, and when dividends are paid. The labourer of to-day has strange delusions about capital, but the company promoter and financier have acquired, if possible, more erroneous views. Labour and capital are necessary to each other; but these plucky and benevolent pioneers ought not really to be necessary, for every thousand pounds that they secure is a thousand pounds that might have been invested reproductively. We hope that the City of London Electric

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Lighting Company will be as successful in earning dividends by industrial work, as was the City of London Electric Lighting (Pioneer) Company in earning a bonus by financial enterprise. The undertaking is an important one, but nothing to make a fuss about. The remarkable feature of the main laying is the speed with which it was carried out. There does not appear to be anything, either in the distributing or in the generating plant, that could not have been done quite as well by any of our leading electrical firms. To talk about it as was recently done, as though it were a more remarkable undertaking than the Tower Bridge, simply because it has cost more, is to show a lamentable ignorance of both electrical and of civil engineering.

THE LIVÈT REFUSE UTILISER AND STEAM GENERATOR.

The first prominent suggestion of the utilisation of town refuse as a fuel for raising steam and developing electric power was made by Prof. George Forbes at the Edinburgh meeting of the British Association in 1892. Although such fuel had for some time been used for raising steam, it had never been definitely employed for electric lighting purposes. The proposal at Edinburgh came as an adjunct to a scheme of energy storage, which Prof. Forbes advocated as being specially suited to the geological features of "modern Athens"—namely, a scheme of storage based upon the elevation of a large mass of water to a height, in an enclosed system of hydraulic mains. In this paper Prof. Forbes drew attention to a point which is of essential importance in relation to the utilisation of town ashbin refuse for electric lighting, viz., the necessity for burning such a fuel at a high temperature and at a steady rate. To utilise such a fuel for electric lighting would, therefore, necessitate some form of storage being adopted. Various modes of storage have been proposed since the publication of the above-named paper, and among these we may mention the system of thermal storage devised by Mr. Druitt Halpin. It will presently be seen that in the Livèt system a novel form of energy storage is in operation.

The actual value of ashbin refuse as a fuel must be a very variable quantity, depending largely upon the locality, and varying considerably from time to time in each locality. Prof. Forbes, in his Edinburgh B. A. Paper, expressed the opinion that 10lb. of ordinary refuse would equal 1lb. of average coal, and he cited a case where it required 75lb. of such refuse to produce one horse-power-hour. At a more recent date, Prof. W. C. Unwin, in his Howard lectures before the Society of Arts (January and February, 1893), gave some instructive figures bearing on this question. According to the statements there made, it would appear that for the proper sanitary combustion of refuse it is requisite that a very large quantity of air—from 7lb. to 8lb. per pound of refuse—should pass through the furnace grate. Under such conditions as these, Prof. Unwin asserts, it has been found possible to obtain one horse-power-hour by the combustion of 40lb. of refuse.

Engineers who have compared these figures with the usual duty of average coal must have been struck with the inferior quality and wasteful treatment of this form of fuel. The principal causes of this inferior duty are:—(1) The small proportion of actual combustible element in the refuse; (2) the burden of water which it contains, and which it must evaporate; (3) the large percentage of mineral matter, causing clinker and ash, which drops from the grate in a heated state, and may waste a large proportion of the furnace heat; and (4) the great weight of air which must be heated by the furnace and rejected up the chimney at a high temperature. In average instances the percentage of actual combustible will probably not exceed 20 per cent., the burden of moisture in the refuse will be not less than 25 per cent., and might frequently be doubled; while the remaining large percentage would form ash and clinker.

There are, however, circumstances which tend to make ashbin refuse a very valuable fuel; not, indeed, from the thermal point of view, but from the commercial aspect. The fact that the material must be got rid of, and promptly, will always militate against a high price being placed on it, wherever companies may offer to purchase it from vestries; and, at the present time, is sufficient inducement to the latter to willingly pay as much as from one to two shillings per ton to have it removed for them. Again, where vestries are themselves occupied in getting rid of the refuse, it is found that the least expensive method they can adopt is to burn it. This being so, the prime cost and the working expenses of the furnaces are a necessity independently of the utilisation of the furnace heat for raising steam. The additional expense due to the boiler and steam plant is all that can be laid at the door of utilisation; and, it may be remarked, the expense is much smaller than in ordinary cases where coal is burned. Prof. Forbes has commented on the "wise provision of nature" which has made the amount of town refuse just sufficient to give the population electric light. The absurdity of any such balance must be evident when we recollect that this relation depends on the inefficiency of the generating plant—by no means a provision of nature. However, from the fact that refuse may be mixed with superior fuel, such as coke breeze or slack, it will be seen that electric lighting need not suffer from a temporary failure of a supply of refuse, even though the storing of refuse is prohibitive.

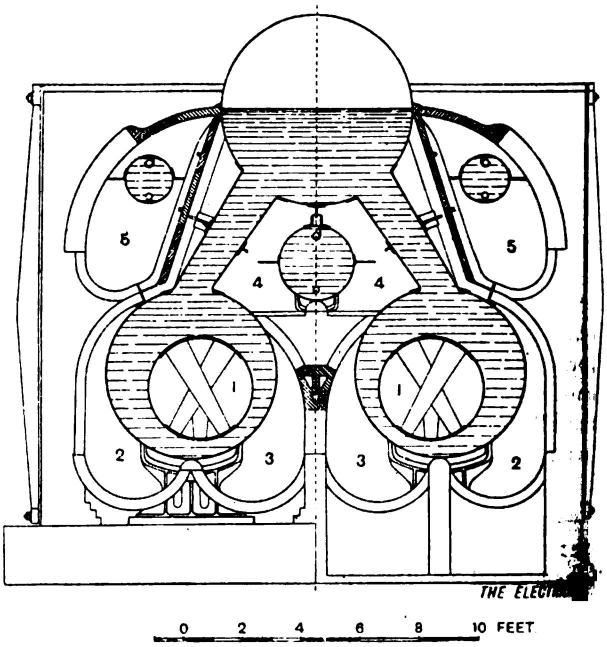

Fig. 1.—Transverse Section showing Setting.

An interesting experiment, conducted on a fairly large scale by the Atlas Contracting Syndicate, at Halifax, in Yorkshire, is one of the latest steps towards the solution of the problem of adapting refuse burning to the purposes of electric lighting. At this town a furnace has been erected, according to the plans developed in the patents of the late M. Livèt. These patents are owned by the above-named syndicate, who purpose developing them for municipal and other electric lighting plant. The principal features of novelty are exhibited in the furnace, though the form of the boiler calls for some description and comment. A transverse section of the entire plant is seen in Fig. 1, while Fig. 2 shows the longitudinal section. The boiler, it will be seen, is of composite structure. There are two separate internal furnaces, as in the Lancashire boiler, each provided with the usual form of Galloway stiffening and circulating tubes; but each of these two flues is contained in a separate cylindrical shell, as in the Cornish boiler; and again, these shells are completely filled with water, and are connected to a large steam drum or evaporator by means of a number of vertical return tubes, as in the elephant boiler. In addition, there are three small water cylinders, which act as feed water heaters, or economisers, which are placed in the external flues,

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and which are connected together, and with the main feed pipe, in the manner shown in the front and back elevations (Figs. 3 and 4). It will be noticed that the internal furnaces are stayed eccentrically with the shells in which they are placed. The object of this is to produce rapid circulation, by giving more heat to the water one side than on the other. It seems doubtful if, with the Galloway tubes in the internal flues, the circulation will be very much improved by this device; while the serious strains that will arise from irregular expansion must weaken the shell, increase the risk of explosion, and reduce the life of the boiler. This type of boiler has the merit of a large water room and an extensive evaporative surface; moreover, the water level is several feet above the furnace crown, a fact which enables the boiler to do abnormally heavy duty for a considerable time, with no risk of "bringing down the firebox." The ratio of total useful heating surface to the grate area is stated by Mr. Glaskin, the engineer to the syndicate, as being 50 times the grate area; as against 30 or 35 times in the usual Lancashire type of boiler. But it must be remembered that the boiler includes the feed-heater or economiser, the surface of which is not usually included. During some short experiments which we witnessed, in which no actual measurements were made, it appeared that the average thickness of fuel on the grate was about 10 in., the fuel being stoked by hand on the spreading system.

The Livèt furnace has been designed to facilitate draught; but in this particular plant it has been modified to suit the special requirements of the fuel. In its ordinary form the

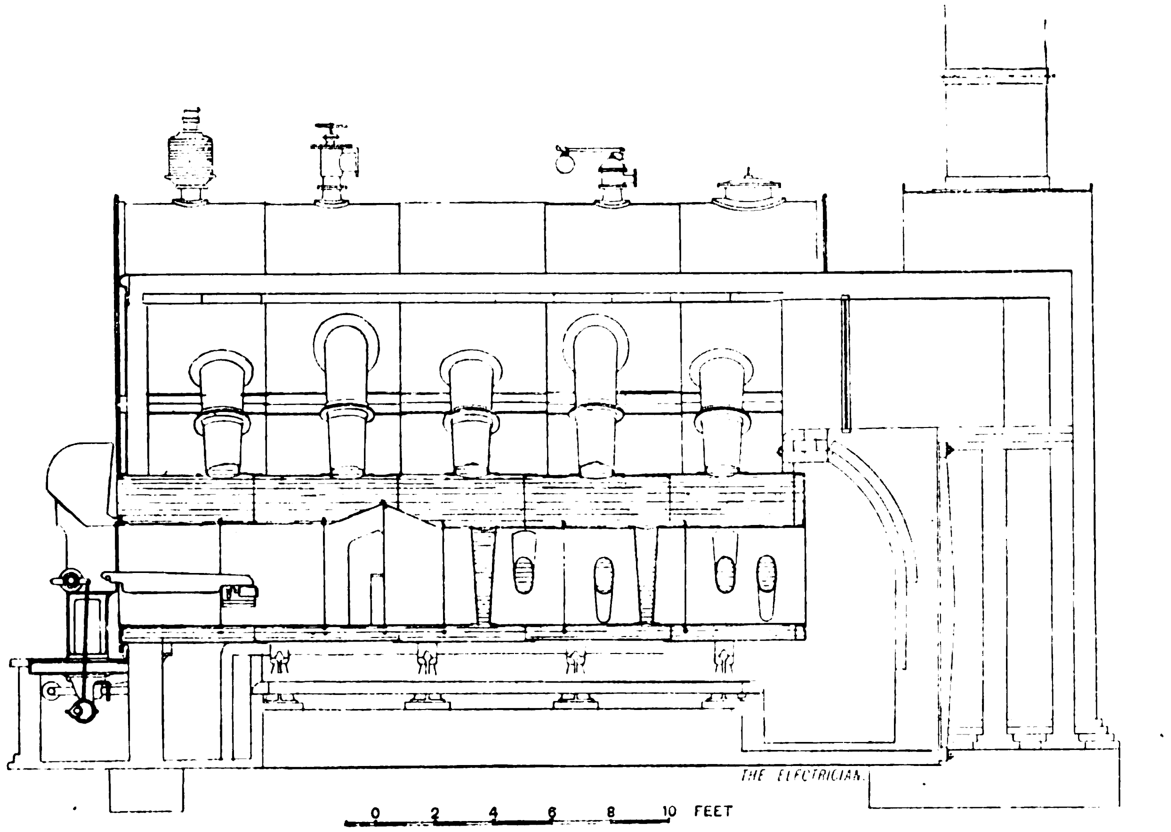

FIG. 2.—Longitudinal Section.

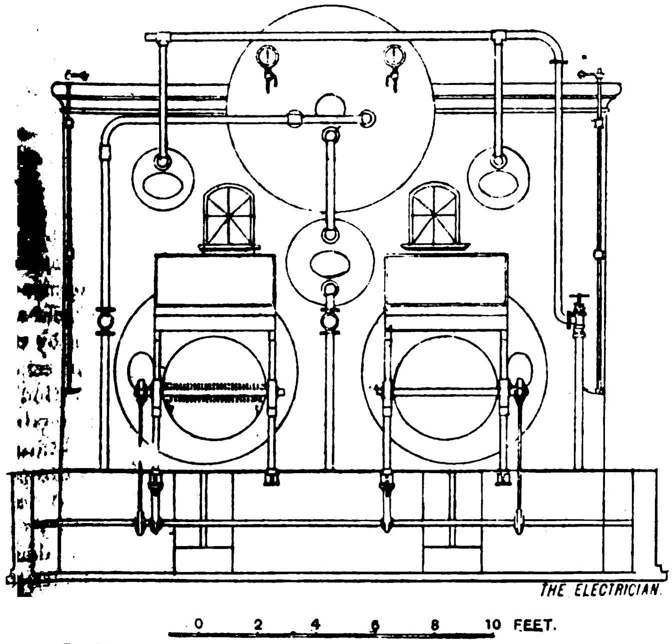

FIG. 3.—Front Elevation, showing Mechanical Stoker and Feed-Pipe Connections.

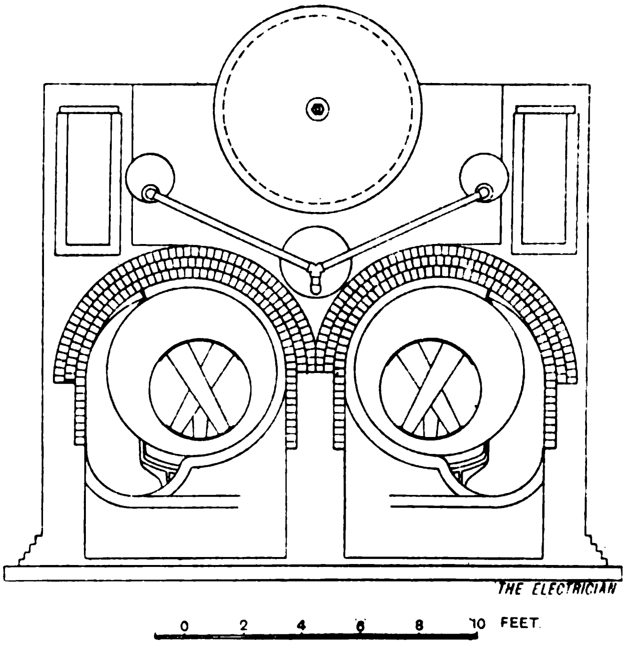

FIG. 4.—Back Elevation, showing Cross Connections for Feed-Heaters and Mud Drum.

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Livèt flue is systematically expanded in section from the furnace to the top of the chimney. That is to say, if we refer to Fig. 1, we shall find that the gases first pass to the back of the boiler along the internal flues (1), then forward along the external flues (2), then to the back again by (3), then by (4), and finally they reach the smoke chamber and the chimney *viâ* (5). In each succeeding flue the sectional area is increased; moreover, the volume of the gas is diminished by cooling, so that the velocity is continuously reduced. The effect of these conditions is, therefore, to transform a part of the velocity-head into pressure-head, resulting in an onward pressure on the advancing gases. If this is done gradually and without shock, it is found to materially add to the effective draught. In the Halifax furnace, however, there is a sudden and enormous expansion of the flues at each end of the boiler, for here the flues lead into chambers for receiving the dust which

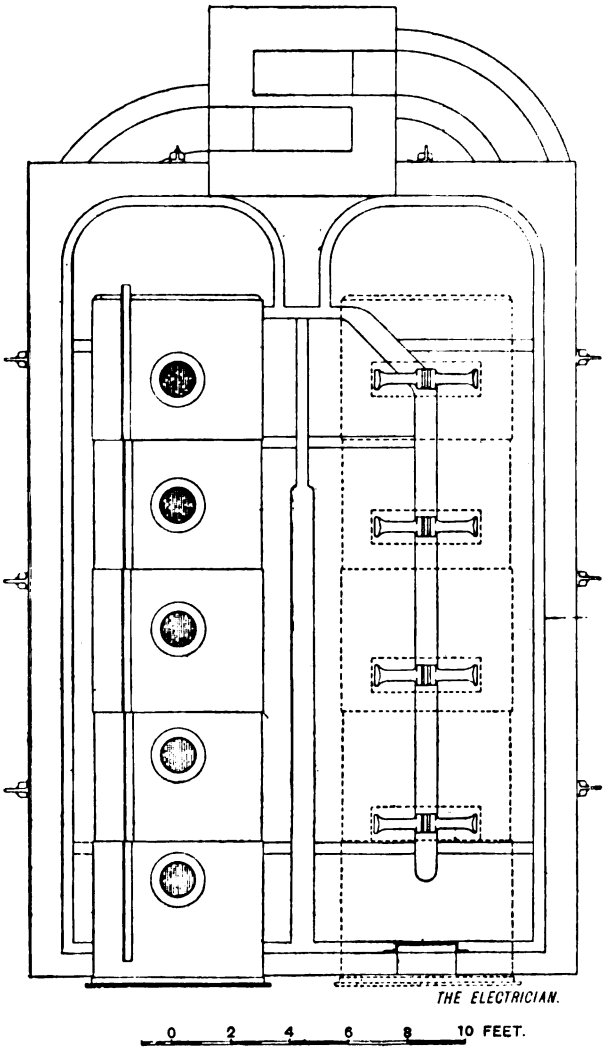

Fig. 5.—Sectional Plan, showing Setting.

the in-rushing gases sweep from the grate. Entering these, the gases suddenly slacken in speed, and deposit the suspended solid matter. It may be that it is necessary to sacrifice some of the efficiency of the draught in this way in order that the useful heating surface may be kept clean; but we cannot help pointing out that this practice must materially check the passage of the gases through the flues, and reduce the draught-power of the chimney. The height of the chimney in the present instance in 110ft.; it is constructed of bare wrought iron. The initial temperature in the chimney averages 300°Fah. for refuse burning, and 350°Fah. for coal burning. The accompanying Fig. 5 shows the mode of setting the boiler, the lower shells resting upon a series of cast-iron stools, which are also shown in Fig. 1. The flues belonging to the left half of the boiler are partitioned from those belonging to the right half, the gases circulating independently until the chimney is reached. The Vicars mechanical stoker is shown in some of the accompanying drawings, as this is used when coal slack is burned. With town refuse in its ordinary state, it is, however, impossible to use a mechanical stoker.

We have already commented on the need for ample storage in conjunction with refuse utilisers, when the latter are used for electric lighting. The character of an electric light station load diagram is too well known to require description. In order to meet the very widely-varying demand for power, and at the same time to consume the refuse at the high temperature which sanitary considerations dictate, Mr. Glaskin has devised a system which he has named "coal storage." In this system the refuse is mixed with coal slack in varying proportions, as occasion may require; when the load is great the proportion of coal being great; when it is small, the coal being absent or in small proportion. While this method must undoubtedly tend to get over what is a very great difficulty in electrically utilising refuse, it does not entirely surmount it. For "coal storage"—if we adopt the name—has neither the elasticity nor the durability which is required; it is neither capable of dealing with long periods of absolute idleness followed by short periods of great activity, nor is it competent to cope with any large sudden change in the load. Combined with a very large water room, such as is offered by the Halpin system, or with electrical storage, "coal storage" might be found to answer well enough.

We must now consider some of the specific claims which have been made by the Syndicate, and by their engineer in his report which lies before us. We notice first a small table giving the evaporative performance of the Livèt boiler, as compared with the performances of Lancashire boilers. Here it is:—

"It will, perhaps, be most to the point to quote the summary of trials made with Lancashire boilers by Sir Lyon Playfair and Prof. de la Bèche. under instructions of the Admiralty, and of Mr. Lavington E. Fletcher for the Lancashire and Cheshire Coal Association:—

	Pounds of water evaporated per pound of coal.
Playfair and de la Bèche	8·13
L. E. Fletcher	10·77
Livèt	13·13."

Each of these tests was made with coal alone. Whatever may have been the origin of each separate item, we can only characterise the bald collection of the three items in this table as highly misleading. We fear that the engineer has not been careful to see that he is comparing things which are under similar conditions. To offer the performance of a Livèt boiler and feed-heater by contrast with the performance of a Lancashire boiler destitute of a feed-heater is scarcely a fair basis of comparison. Again, the figure given on the authority of Messrs. Playfair and de la Bèche is by no means as high even as the average figure obtained by these engineers, in their Admiralty series of Lancashire boiler trials. Moreover, if we remember rightly, the trials of Lancashire boilers cited in this table were made as long ago as 1850-67, and are by no means comparable with modern performances. In passing, we may mention that Mr. L. E. Fletcher obtained a performance in Lancashire boilers, without an economiser and *without the use of the external flues*, better than the 8·13lb. given by the engineer as representative of these boilers under fair conditions. Mr. Fletcher also obtained an average evaporation of 11·56lb. in Lancashire boilers with economisers. In modern times an evaporation of more than 12lb. is commonly obtained in these boilers. The 13·13lb. given in the table as the performance of the Livèt boiler means nothing at all, until the conditions of the trial and the quality of fuel have been exactly stated. We very much doubt if anything like this performance could be obtained under the usual conditions in which engineers are accustomed to make boiler trials. With coal having a theoretical evaporation of 14lb., this figure means that the Livèt boiler is credited with the incredibly high efficiency of nearly 94 per cent., the radiation, clinker, chimney, and other losses being only 6 per cent!

It is to be regretted that the interests of this invention have been prejudiced by such comparisons, for these can do no good to what is, without doubt, a genuine and satisfactory

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attempt to solve the problem of the utilisation of dustbin refuse. That this refuse is a good basis for steam production there can be no doubt; that the Livet boiler can utilise it steadily, and with the production of no noxious fumes, there is also no doubt. But it yet remains to be shown that this fuel, when consumed in this type of boiler, can be adapted to the peculiar conditions of electric power generation. It is to be regretted that attempts have not been made to imitate these conditions, and to ascertain exactly the performance of this steam generator when placed under them for an extensive period.

SOME NOTES ON THE ELECTRIC LIGHTING OF THE CITY OF LONDON.*

BY MAJOR-GEN. C. E. WEBBER.

To the industry generally the history of the inception, and of what led up to the accomplishment, of the public lighting of the streets of that part of the metropolis known as the City of London may have, for several reasons, a special interest, and be worthy of record. By those who may not already know it, it should be understood that the Commissioners of Sewers hold a similar position, and have similar powers to those that were possessed by the Metropolitan Board of Works and by the London Vestries before the London County Council came into existence; in fact, they are the local authority, possessing jurisdiction distinct from that of the Corporation, the Common Council, the Bridge House Committee, and such bodies; having the direction and control of expenditure on works, for which purposes their engineer and surveyor is Mr. William Haywood, C.E., a gentleman distinguished no less as a colonel of volunteers, late and for many years commanding the 1st London Rifle Volunteers,† than as an engineer. I think there is a good deal in which the question of what led up to the lighting of the City by electricity so much differs from ordinary cases, that a slight sketch of its history—which has never, I believe, been published—is not out of place on the present occasion. The City is at the head of our municipal institutions, both as regards antiquity, wealth, and organisation. From an imperial point of view, it is regarded as the heart of the commerce of the world. In respect to public lighting by electricity, I believe I can show you that it also has taken the lead.

In 1878, when the Municipality of Paris celebrated the International Exhibition of that year by lighting the Avenue de l'Opera with Jablochkoff lamps, run with Gramme machines by the Société Générale d'Electricité, Mr. William Bassingham, deputy-chairman, and Col. Haywood, engineer of the Commissioners of Sewers, severally reported to the Streets Committee, in such detail, and in such terms, as to ensure the question never being dropped until the accomplishment of the results which we can nightly witness at the present time.‡ It is nearly 15 years since the date of those reports—years that have been momentous to all of us electrical engineers.

Col. Haywood's report could not have dealt more exhaustively with the question, subject to the difference in knowledge at the present day, than if it was now to be compiled. He pointed out that no section of the metropolis was more interested than the City in obtaining an efficient illuminant, for, that within its boundaries the Gas Light and Coke Company then collected a rental of £370,000 per annum. No doubt that example of street lighting in Paris induced the Commissioners to take up the subject. The 64 electric lamps in a thoroughfare 980 yards in length, placed 30 yards apart on alternate sides, were said to give a nominal candle-power of 20 times that of the 300 gas lamps previously used, allowing that one Jablochkoff candle gave 100 times as much light as a gas burner using 12-candle gas at 5ft. an hour. The cost price of these lamps (estimated then at 6d. an hour, as they were extinguished at midnight) was £50 a year each, which, for 64 lamps, came to £3,200 a year, as against the cost of the gas lighting during the same hours, which came to £1,200 a year at 5 centimes per gas lamp an hour. Colonel Haywood at that time considered that the Avenue was lighted "vastly in excess of all reasonable requirements"; and although he went no further than stating that in his opinion there were places in the City—such as by King William's Statue, in front of the Mansion House, and in the Circuses—where the convenience of the large traffic "might justify the expense of employing the electric light during the busiest hours of darkness," he nevertheless recommended the Commissioners, "that as early as possible an ample experiment be made by lighting with electricity during the winter months of 1878 one or more of the public thoroughfares within their jurisdiction." In consequence, in November, 1878, the same company commenced lighting the Holborn Viaduct with 16 Jablochkoff lamps, placed about 110ft. apart. They were run from sunset till midnight, replacing 86 gas lamps.* The results arrived at after three winter months' work were, that, while only doubling the light (allowing a loss of 50 per cent. with the globes) of the 86 gas lamps, the cost—namely, 5·73d. per hour—of 16 Jablochkoff lamps was four times that of gas at ¼d. an hour.

The discouragement produced by this experiment only continued for one year, and in the spring of 1880 the Commissioners (at the instigation of several members whose names have since been connected with improvements in lighting the City) again decided to renew experiments on a more extended scale by lighting New Bridge-street, Queen Victoria-street, Queen-street and Queen-street Place, King William-street to the Bank, Poultry, Cheapside, St. Paul's Churchyard, Ludgate Hill, New Bridge-street and the Bridge. The thoroughfares in which the trials were to be made were divided into three districts, and out of six competitors who tendered in October, 1880, the following were selected, and the year's work lasted from April 1, 1881, to April 1, 1882:—The Blackfriars Bridge district to the Brush Company; the Southwark Bridge district to the Electric Light Power Generator Company (Lontin system); the London Bridge district to Messrs. Siemens. Col. Haywood reported in June, 1882, that, allowing 50 per cent. of loss through the use of globes in the several districts the increased light afforded, and the cost of the same under the tenders, in proportion to that of gas, were—

	Increased light.		Relative cost.
No. 1 (Brush)	15	......	About the same.
No. 2 (Lontin)	14	......	Twice.
No. 3 (Siemens)	13½	......	3¾.

Thus the City of London had taken the lead in making a practical experiment on a large scale.†

The encouragement afforded by the results may be estimated by the following:—(*a*) The Commissioners decided to experiment again in four additional areas, and, calling for tenders, received, in May, 1882, offers from eight firms. In one tender only was the question raised of supplying light for private consumption. (*b*) Messrs. Siemens's offer to continue lighting No. 3 district at £3,600 a year, being an advance of £1,330 on their original contract, was declined, and that firm retired from the City. (*c*) An arrangement with the Brush Company to continue for another year lighting No. 3 district at a cost of £800 per annum was made.

But, as we all know, the Electric Lighting Act of 1882, which obtained the Royal consent and became law in that year, appeared, and with it a flood of applications for Provisional Orders and Licences, three of which covered the area of the City, and obliged the Commissioners to hold their hands and consider the position in which the Act placed them, after having already had the subject in hand for nearly four years. In November, 1882, the Streets Committee of the Commissioners of Sewers consulted Mr. Preece; and I shall take this opportunity to remind him of a statement he then made, and has since repeated, on the subject in which, I am happy to be able to say, he showed an accuracy of foresight in which later experience has fully supported him. At that date he wrote:—"I know of no branch of engineering where more forethought is necessary to calculate all the contingencies likely to be met with than a system designed to illuminate a large city like that of London."

Meantime, an experiment with public lighting by glow lamps had been in progress. In April, 1882, the Edison Company commenced an experiment with that means of illumination on the Holborn-viaduct for a length of 466 yards, upon which Col. Haywood reported after a twelvemonth's run. Ninety-two 16-c.p. glow lamps replaced the gas burners in the existing street lanterns, 86 14-c.p. gas batswing burners being displaced. The result in light and cost was that the electric lighting contractors gave 1¼ times the light at the same price as gas—namely, £4. 10s. 4d. per burner per annum. That this experiment led to but negative results we all know. If it showed anything, it was that the substitution of a glow lamp in the ordinary street lantern for the lambent flame of a gas jet, so that the incandescent filament is directly visible, is a very poor and unintelligent application of the electric light, and puts it in a position in which it is at a great disadvantage in comparison with gas. I believe that the glow lamp for public

* Paper read before the Institution of Electrical Engineers, February 8, 1894.

† Colonel Haywood joined the corps in 1859 as a private, and rose through each rank to be Lieut.-Col. in 1876, and retired from that position in 1882.

‡ As international juror for telegraphs and allied electrical applications of that year, my notes on the installation show that the Avenue and Place de l'Opera, and the Place du Théatre Français, only represented a small fraction of the application of the Jablochkoff lamp then running in France.

* At the same time the Metropolitan Board of Works had been making experiments with the same Company's plant on the Victoria Embankment, including photometric comparison of the gas and electric light.

† It was estimated to cost over £8,000, but, through the inability of the contractors in No. 2 to commence lighting in time and for other reasons it actually cost about £5,400.

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lighting purposes never quite recovered from the results of that experiment.

The City was one of the earliest areas upon which the electric light manufacturing companies set their eyes. Hardly had the 1882 Act become law when, as I have said, three companies commenced applications for Provisional Orders. As still now occurs, the local authority took alarm, and began to investigate the subject for themselves. Most complete reports as to the law, engineering, and science of the question were made by Mr. Baylis, Col. Haywood, and Mr. Preece. These gentlemen may be said to have been amongst the very first to compile information for a local authority on the subject of electric lighting; and, although ten years have passed, the terms they used, conclusions arrived at, and recommendations made, differ very little from those that have since, and up to this date, been, and are being, laid before similar governing bodies for their information and guidance. The general tenor of the recommendations made in 1883, especially by Mr. Preece, were that the Commissioners ought to obtain their own Provisional Order or Licence, and, either by contractors or by their own officers, to carry out the undertaking for themselves, both for public or private supply. The consequence was that in March, 1883, the Commissioners decided to apply to the Board of Trade for the necessary Licence under the Act of 1882, for the whole City, having in its terms a compulsory area of a limited size, and to oppose all other applications for Provisional Orders and Licences under the Act of 1882. Although tenders from a number of electric light manufacturing companies were called for and received, it is of moment to note that Mr. Preece reported that their terms were all "eminently unsatisfactory." No doubt his criticisms were correct, but, as the length of time of the proposed contract was limited to seven years, it is not surprising that they were not such as could be accepted. The lowest and highest offers for each public light arc lamp were £36 and £71 per annum respectively. In spite of amendments in those proposals, Mr. Preece could still find nothing to recommend them; but we, who look back to what has transpired in the interval, can realise that all proposals made in those days, when the security offered was such that capital recoiled from it, were neces sarily wild and unsatisfactory, and were mostly made by firms who, if they were sound, must have secretly hoped never to be called on to carry them out.

Meantime, the Anglo-American Brush contract for lighting, for about 4,030 hours per annum, New Bridge-street, Ludgate-hill, and St. Paul's-churchyard still ran on, and was costing the City at a rate of less than £25 a lamp. Then, in 1883, commenced a period during which companies proposing to obtain statutory powers within the City were kept at arm's length, and during which, Mr. Preece, instructed by the Commissioners, made experiments on the subject of public lighting by arc and glow lamps, partly with the aid of the Anglo-American Brush and Edison contract installations then running. In 1883 he reported "that, while the arc lamp is admirably adapted for the illumination of large spaces, the glow lamp is eminently adapted for our streets and narrow thoroughfares." Mr. Preece's report to the Commissioners of Sewers, of August, 1884, while being very exhaustive as to the whole question of electricity supply generally, is certainly also the standard report on the subject of public lighting. He then stated, however, that "the lamp which, in my judgment, best lends itself to street lighting is the glow lamp, and of the glow lamps I prefer the 50-candle lamp for the main thoroughfare." Notwithstanding the Holborn experiments, Mr. Preece recommended further trials of public lighting with glow lamps, combined with a means of distribution for private lighting within a small area that would require about 5,000 private lamps, at a cost to the City of about £40,000. He also brought very prominently to notice the very valuable proposals of Mr. Trotter connected with his dioptric lantern, to which I shall myself allude later on. These further experiments were never carried out, but I think the meeting will be glad to hear from Mr. Preece if any modifications would now be admitted into his views, on a subject which the meeting is aware is not yet satisfactorily settled.

For more than a year the subject slept.* At that time it fell to my lot to be placed in engineering management of the Anglo-American Brush Electric Light Corporation, and since then, up to July, 1892, I was intimately acquainted with all that has gone on connected with the lighting of the City of London.† The original contract of 1881 of that Company for lighting New Bridge-street, Ludgate-hill, and St. Paul's Churchyard, with arc lamps, still ran, but there were many outward signs of considerable repairs being necessary in the mains. These mains had been laid into the district under the roadways from the Brush Works in Belvedere-road, along Bankside, and over Blackfriars-bridge, and they consisted of two circuits of 7-16's drawn into the same cast-iron pipes, with insufficient draw-boxes and means of inspection; although the insulation was sound throughout the greater portion of their length, there were many points at which it had been attacked, by the pipes having been hastily laid where they were exposed to soil saturated by sewage liquids and other gases and with insufficient means of access for localisation and removal of faults. The currents were generated by Brush arc dynamos, old-pattern armatures, having belt-gearing, to engines, which, with the boilers, formed part of the power which was used in the Brush factory, on which the demands were irregular and occasionally very heavy. The fact was that the Brush Company, when they tendered for the work in 1881, understood it was to be an experiment, out of which little or no actual profit could be expected, and little thought that arrangements which would have been good enough for twelve months would be continued by the City authorities for five years, only terminating through the initiative of the Brush Company, and by the permission of the Commissioners, in December, 1885.

No public body has probably taken more pains than the Commissioners to weigh carefully the *pros* and *cons* bearing on the question of their becoming themselves the undertakers for supplying electricity;* and I think now that, but for the host of offers, merely speculative and otherwise, which was being continually sent in to them and diverting their attention from the issues most in the interests of the ratepayers, they would in the end have decided on raising the necessary capital to do the work themselves.

In November, 1885, a set of proposals was formally made by the Brush Company to contract for the public and private supply of a district of the City, and this was considered by a committee, of which Mr. J. C. Bell was chairman. This was the first practical arrangement on a large scale that had ever come before the Commissioners, and its terms are almost *verbatim* those that were eventually adopted in January, 1889, as the conditions under which the Commissioners would receive tenders. From that moment the question of the lighting the City made a fresh start on a tangible basis as to cost and mutual advantages; and, although it took five years to mature, there was no longer any serious question of the Commissioners themselves becoming the undertakers. In 1886, 1887 and 1888 the matter was again from time to time before them, and throughout that time it was due to the personal exertions of some enlightened members of the Streets Committee that the matter was kept continually to the front.† One of the reasons for the delay was due to a great reluctance on the part of the Commissioners to permit any company to have a Provisional Order within its area of control. The chief reason for this was the condition of things at and below the surface. The occupation of the subsoil by sewers and subways, by the systems of gas, water, and telegraphs, and by various other objects, is entirely exceptional. They would have much preferred that all powers for the disturbance of the surface should be conferred by themselves only, and not by statute. There is no doubt that the ratepayers of the City would now be in quite as good a position if no Provisional Orders had been granted, and if only the contracts that were eventually entered into between the Commissioners on the one part, and the Brush Company and Messrs. Laing, Wharton and Down on the other, were existent. Owing to more than the ordinary rights of user of the soil of thoroughfares and streets being vested in the City Corporation, statutory powers were not necessary to enable them to grant way-leave.‡

In February, 1888, the Commissioners called for a report giving a *résumé* of all that had been brought before them in the previous ten years, and I must here say that it fully establishes the claim of the Brush Company that a large share of the credit for the eventual results was due to their persistence in holding the ground when all others had retired, and in keeping the subject always before the local authority in a manner and in terms which, by their moderation and practical sense, were bound in the long run to commend themselves to business people. The object of this report was to show that the successful use of arc lamps for illuminating large spaces had asserted itself all over the civilised world.§ The advantage of having a contract with a company to supply current to public arc lamps at 3·1d. per unit, including trimming and carbons, instead of at 8d. exclusive of the same—the usual price in Pro-

* In November, 1885, a well-known writer reported to the Commissioners:—"At the present time there is a complete stagnation in electrical enterprise in England, in such enterprise as would undertake the supply of electricity upon a large scale for public and private purposes in towns."

† My own connection with the public lighting of the City of London dates back to the sixties, when I assisted the late Dr. Letheby, City Analyst, in a series of experiments connected with carburetting gas for street lamps.

* So late as April, 1890, they deputed Mr. Preece to report to them on the electric lighting of the public streets of Taunton with arc and glow lamps.

† Mr. Frank Green, Mr. J. C. Bell, Mr. Graham King, Mr. Bridgeman, Mr. Pannell, and others.

‡ There is ample experience to show that if much of the Act of 1882 had been repealed, so far as the metropolis was concerned, as was more than once urged on the Board of Trade, this and many geographical and other anomalies which have kept up, and will for many years keep up, the price of electricity in London, might have been avoided.

§ The successful lighting on a large scale by the Brush Company of the Colonial, Manchester, and Glasgow Exhibitions was described.

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visional Orders—was dwelt on. The unsatisfactory nature of the proposals made to the City by other parties was fully exposed. The great advantage to the City if the terms of the form of contract originally proposed by the Brush Company in 1885 were adopted, and the misrepresentations which suggested monopoly that had been made, were dispelled; and, it is a remarkable fact, that the then proposed charge of 1s. per unit for private lighting was not considered excessive in view of the circumstances of the probable demand for business premises in the City.

January, 1889, found the Commissioners, again and finally, roused to activity by the Electric Lighting Act of 1888 (due to the personal exertion of Lord Thurlow, the Chairman of the Brush Company), and, the City having been divided into three districts for the purpose of the contracts, tenders were publicly called for; and it may here be remarked that the Company, which, during eight years, had done so much to keep the matter before the public, at that moment was in no better position in March, 1889, as regards tendering, than any other firm which was then only dealing with the matter for the first time.* But yet another stage of opposition had to be got over before the final arrangements for this great undertaking could be said to be on a satisfactory footing. Major Marindin, in April, 1889, had reported against the claim of the City to be exempted from the operation of the Electric Lighting Act, and had, in face of the opposition of the City, recommended the approval by the Board of Trade of the applications for Provisional Orders from two of the above-named companies. The Brush Company had for several years, in deference to the views held by the City authorities, refrained from making applications for Orders, and therefore their absence from the list of applicants in 1889 was intelligible. In the terms of Mr. Preece's report on Major Marindin's contention, the City had been "regarded merely as a local Vestry with some ancient rights that have to be respected"; and that "the amount of lighting and the capital necessary to be expended in the City, which far exceeds that for any other portion of the metropolis," had been overlooked. Major Marindin, by his recommendation, had neglected not only the geographical part of the question, but the fact that the Commissioners of Sewers had been for years studying and experimenting on the question of effective public street lighting.

The tenders for public lighting the main thoroughfares with arc lamps, which eventually were reported on in November, 1889, by Mr. Preece and Col. Haywood, were:—

The Metropolitan Electric Supply Company's revised tender to light the Western district with 121 lamps at £26	£3,146
The Anglo-American Brush, the Central district with 138 lamps, at £26	3,588
The London Electric Supply Corporation, with 136 lamps (half the lamps being extinguished at midnight), at £24. 2s.	3,290
Total for the main thoroughfares	£10,024

and the acceptance of these was recommended.

But of them the Brush Company alone (consistent with their original proposal) had not applied in 1889 for a Provisional Order, and had agreed to the division of profits under a sliding scale—namely, that if the profits exceeded a cumulative dividend of 10 per cent. per annum upon the capital invested, the excess was to be divided equally between the contractor and the consumer—and also had agreed that power should be reserved to the Commissioners to acquire the undertaking and works by purchase at the end of 21 years, in all other respects in accordance with Section 2 of the Electric Lighting Act of 1888. Meantime, no Provisional Orders had been granted for any part of the City area, owing to the withholding of the usual recommendations from the Local Authority which the Act requires. But on the last day of June of that year the Brush, and the Laing, Wharton, and Down Companies gave notices for the Western and Central and the Eastern districts, respectively, and the ordinary statutory steps followed in due course. The Brush Company had, as stated, accepted the terms of the Commissioners' contract, and the Laing, Wharton and Down Company now decided to fall into line with them;† and in May, 1890, those contracts were sealed, and the Provisional Orders became law in that Session of Parliament.‡

Not until 1891 were a similar contract and Provisional Order granted to the Brush Company for the Western district. Thus, after nearly 13 years of deliberation on the subject, the scheme for supplying electricity to the City of London for public and private consumption became legally possible, and all the special powers which the Commissioners sought to obtain in the interests of their ratepayers had been secured.

* The contractors who tendered were the—
1. Central—Anglo-American Brush Corporation.
2. London—London Electric Supply Corporation.
3. West—Metropolitan Electric Supply Company.
4. All—House-to-House Electric Supply Company.
5. East—Messrs. Laing, Wharton and Down.

† The Commissioners had required Mr. Preece to report fully on the Thomson-Houston system of arc lighting as established at Sheffield and the St. Pancras station, as well as at Taunton.

‡ The names of Mr. E. Garcke and of Mr. Sydney Morse are so well known in connection with the industry, that it is appropriate to record here that to them is largely due the credit for carrying through final arrangements for these Orders, which were exceptionally intricate in their character.

Capital Expenditure.

The question of raising capital for electricity supply companies has not differed much in its conditions from other sister industries. This Paper would be less instructive if that part of the subject was overlooked, and it is noteworthy that, even with a field for the supply of electricity in which the gas company had a gross income of over £370,000.* Even in 1891 it was not thought prudent to do what is called "go to the public," in the first instance, with a plainly stated prospectus. Such a statement most certainly would have shown that the supply of electricity to the City should be an undertaking affording as sound an investment as could be found anywhere, and also one which at an early date, under the operation of the sliding scale already alluded to, would allow of the cost of the current being reduced below the maximum of 8d. As we all know, a very old way of commencing to raise capital has been brought out under a new name, namely, by the starting of a "pioneer company," which is one way of getting an instalment of capital together to make a beginning. Of course there is no engineering justification for it, but the financial physician has prescribed it, and hence this first capital must be spent with a primary object of showing that something can and will be done. The future of the undertaking from the structural point of view may become quite a secondary consideration, and, indeed, may be ignored if it interferes with the parade with which it is intended to "draw" the investing public. They—the public—have only themselves to thank if this sort of thing is necessary. Engineers and Contractors have no real interest in its existence.

The contracts with the Commissioners for the public lighting of the City were dated:—

For the Eastern district, May 28, 1890;
" Central " " 19, "
" Western " February 5, 1891;

and they required that the main thoroughfares should be completed with arc lamps in the Eastern and Central districts by February 28 and 19, 1892, respectively, and in the Western district by November 5, 1893. The "first sod was cut" on January 5, 1891, when a junction-box was constructed on the west side of the Mansion House, with an inscription inserted in the wall. The first street was lighted in July, 1891. The arc lighting generating plant was permanently fixed in the pioneer buildings, but in other respects the installations were designed to be temporary. The two Companies, namely, the Brush Electrical Engineering Company and the Laing, Wharton and Down Construction Syndicate, to whom, as has been stated, the Provisional Orders and contracts had been granted, had, in February, 1891, tranferred their interests, through an exploration company and an electric and general investment company, conditionally, to the City of London Pioneer Company, of which Company I was appointed the engineer after the contracts had been made. These interests included the obligation to complete the purchase of sites for generating stations—one at the Wool Quay, in Lower Thames-street, the other at Meredith's Wharf, in Bankside. Part of the consideration for the transfer of the responsibilities and liabilities of the "*concessionaire*" companies was in each case a provisional contract for the supply and erection of the entire plant and equipment of one temporary (or pioneer) and one permanent generating station for the supply of current to, and for the transforming of current in, each district. In similar cases the work of pioneer companies has been confined to the task of financing. Unfortunately—I think—in this case the City of London Pioneer Company had to undertake actual work, so far as the public lighting was concerned, because the time remaining—namely, about 12 months—in February, 1891, when the contracts for the Central and Eastern districts had to be completed, was even then very short. But these provisional contracts for temporary work included some private lighting;† the object being the old-fashioned one, to create a display—in my opinion—at the expense of good work, and with the risk of a legacy of trouble, anxiety, and failure. Suffice it to say that, in spite of every possible precaution to prevent it, no small part of this temporary work has had, or will have, to be moved or altered after having been put to work; and a large part of the money spent on these temporary installations—

* The day and night populations of the City, respectively 261,061 and 50,652 in 1881, had altered in 1891 to 301,384 and 37,694. The day population, as compared with towns and counties in England and Wales, is larger than 26 counties, and all other towns except Liverpool, Manchester, Birmingham, Leeds, and Sheffield. Before 1891 there were 3,136 public gas lamps, costing £10,530 per annum.

† The first current for private lighting was commenced on December 11, 1891, to the Mansion House, but it was more than six months after before the plant could be run during daylight hours.

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amounting, together with other expenses, to a very considerable sum—must be more or less wasted.*

On July 13, 1891, while the pioneer contracts were still uncompleted, all the interests acquired by the pioneer company were taken over by the City of London Electric Light Company for a further consideration, by which means the lighting of the City was, with the consent of the Board of Trade and of the City authorities, amalgamated into one undertaking instead of three, and it was at last possible to begin work in earnest, with a hope that the words "temporary" and "provisional" were past.

The estimates for works upon which the capital of the new Company was raised amounted to—

Buildings	£53,000
Equipment of the three stations	493,250
Distribution	342,850
Total	£889,100

This was exclusive of the cost of the sites.

The contracts for public lighting with the "*concessionaire*" companies, which had been taken over from the pioneer company, besides providing for the supply and installation of the plant and equipment for one station for each district of the City, provided also the arc and glow lamps for the public lighting, with their fittings, exclusive of posts and lanterns, in every respect sufficient to enable the new City Company to fulfil the terms of the contracts with the Commissioners of Sewers, as follows :—

Eastern district. (Laing, Wharton and Down Company.)		Central district. (Brush Electrical Engineering Company.)		Western district.	
Arc.	Glow.	Arc.	Glow.	Arc.	Glow.
233	307	138	302	144	297

Total arc, 515. Total glow, 906.

Besides this, the contracts between the same parties required the work to be done for equipping the stations and providing the plant for the supply and conversion of current for private lighting to be in accordance with detailed specifications and schedules of prices. It was agreed that these details and prices were to be laid down afterwards and settled between the engineer of the Company and the contractors ; differences (if any) to be referred to Mr. Preece.

The contracts required that the output of the Brush stations for the supply of the Central and Western districts, and of the Laing, Wharton and Down Company's station for the Eastern district, should, including the pioneer plant, be as follows :—

——	Public and other arc lighting.	Private lighting.
	Kilowatts.	Kilowatts.
Eastern district	450	4,800
Central ,,	330	3,900
Western ,,	220	3,400
	1,000	12,100
		1,000
Total kilowatts	...	13,100

Adding together the cost of the contracts and estimates, and dividing by the total of 13,100, we obtain the following total cost per kilowatt :—

Preliminary expenses	£8,000
Work done by the pioneer company, including some work of distribution	46,000
Extras on ditto	10,000
Contracts for the stations	493,250
Estimate of cost of completing distribution	342,850
	900,100
Add 8 per cent. for the cost of the sites of the generating stations	72,008
Total	£972,108

Namely, total per kilowatt, nearly £75.

* I had been through such troubles in connection with electrical and other engineering too often not to throw all my weight into the scale against temporary work of any kind. It is only before an assembly of engineers that an engineer can hope to find any appreciation of such a situation. Neither financiers nor contractors sympathise with his efforts to prevent unnecessary expenditure, except so far as it affects their own interests. The financier does not mind so long as the total expenditure is within his estimates of what the investor will stand ; and the contractor need only care if he is going to accept any payment in shares, and not always then. Besides this, there is the long series of harassing engineering consequences arising out of crude, hasty, and ill-considered work preliminary to a great undertaking. Many of us have been through it, and learnt to take it as part of the day's work ; but, all the same, it is always regrettable.

Anyone present will realise that the preparation of detailed specifications for the equipment of an electric light supply station, both for generating and transforming, requires the fullest technical description. Besides that of the boilers, engines,* and dynamos, there are the questions of the arrangements for transport and conveyance of coal and refuse, economising, condensing, and stoking ; there are also the details of foundations, drains, subways, travellers, lifts, cranes, and the lighting of the station, as well as telephonic communication with, and equipment of, transforming substations. I need not say that the preparation and agreement as to the details of specifications, after a contract is made and the total price to be paid is fixed, is a somewhat novel task for the engineer of the spending company. In this case the putting of the cart (as it were) before the horse fortunately did not end in miscarriage. The engineers on both sides † were anxious, while doing justice to their employers, to arrive at a fair and reasonable solution, and Mr. Preece could tell you that it ended in only about half-a-dozen points of difference between them and me having to be referred to him, in specifications containing nearly 120 pages of closely-printed matter.

In these specifications, although the specialities of the two contracting firms were well known, nothing was laid down to confine them to their own particular make of engines, boilers, dynamos, transformers, and lamps. The contractors described to me the sizes of the units they desired to employ. They are not limited to any particular form of driving, and, as far as possible to produce uniformity, the speeds and electrical conditions which they desire to use are allowed. Economising, automatic stoking, and condensing, and all possible accessories—including testing and switchroom apparatus and fittings—are required of capacity equal to the full output of the plant. All the conditions of the different stages of generating are rigorously prescribed so far as the results under test are concerned. For instance, it is laid down in the specifications that, after providing for all extraneous steam consumption and waste, the standard of consumption of coal, including the steam used in the condensing pumps, shall not exceed 5lbs. for the high-tension alternating currents, and 7lbs. for the high-tension continuous currents, per Board of Trade unit delivered at the terminals of the primary mains in the stations. Amongst the extraneous uses of steam to be excluded from the above basis are included that used for the power expended in moving water, coal, and refuse. The tests to prove this are adapted to the circumstances of running the station‡—a matter, as most of us know, not always easy. Therefore their nature and number are to be subject to the approval of the engineer, so as not to clash with the conditions of statutory supply from the station. The tests of each unit estimated to have an output of 400 kilowatts, or of each group of units with an output of 1,200 kilowatts, are necessarily dependent on the circumstances of the load on the station. The alternating plant—both Brush and Thomson-Houston—was experimental at the time the contracts were made, therefore the first examples had to be under trial for six months. These trials had to be coincident with the supply, and dependent on the load on the station, and the contractors for that period were to be responsible for failure of all kinds. Under strict penalties, the contractors are answerable for the dimensions of foundations, flues, and chimneys, and are required to guarantee absence of vibration, noise, and smoke nuisance.

As regards the boiler tests, under the usual conditions of temperature, external and at the base of the chimney, and state of barometer, and with coal having a calorific value of 13,500, it is obligatory that 77 per cent. of the heat is transferred to the water by the boilers and economisers together. As regards the consumption per horse-power of steam in the engines, the Brush Company have agreed to a limit with full load of 22lb. of steam exhausting to the atmosphere, and 18lb. when condensing. The Laing, Wharton, and Down Company have agreed to a limit of 20 and 17 respectively. For the commercial efficiency of the electrical 400-kilowatt generators, 80 per cent. when working at full load is prescribed, 2 per cent. of that only being allowed to be absorbed in the excitation. Besides, there was given a description of every test which each portion of the plant would be required to

* Prof. S. P. Thompson's opinion, in November, 1891, on the types of engines which the contractors, under the restrictions and definitions contained in the specification, proposed to adopt, was that. while expressing his own opinion on the advantages of triple expansion, and of engines of the closed type, he confirmed entirely the conditions that the choice should be of the vertical and direct-coupled type ; he postponed his final opinion until six months' running of the first group of 400 kilowatt units had been completed. It is to be hoped that he will be able now, more than two years having passed, to give electrical engineers his further experience in the subject.

† Mr. Raworth and Prof. Kennedy, assisted by Mr. Wharton, represented the two contracting companies, while I represented the City of London Electric Lighting Company.

‡ The contractors could not provide means of running their large dynamos at their works. All real tests had to be made after delivery. This was an inherent difficulty for the engineer.

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sustain. At the same time, the widest latitude as regards *design*, throughout the whole of the station plant and accessories, is allowed.*

I do not know if the meeting considers if any better way could be adopted for protecting the expenditure of capital and stimulating the energies of contractors, after it had been decided by others how much should be spent, how much should be the maximum output of the plant, and who were to be the contractors.

(To be continued.)

* The essence of these specifications was that, except in respect to a few points not within the scope of the contractors' work as electrical engineers, all details of design were left to them, subject to the final approval of the engineer.

LEGAL INTELLIGENCE.

Alabaster and others v. Harness and others.

This case came yesterday before a Divisional Court of Queen's Bench, consisting of Mr. Justices Mathew and Collins, on appeal from the Master and Judge in Chambers, who held that the defendants' objection to answer interrogatories administered to him was a good objection on the ground that it would tend to incriminate him. The plaintiffs' (the appellants) contention was that it was not a good objection, and that the defendants ought to answer. Mr. Bankes, who appeared as counsel for the appellants, said the action was brought by the proprietors of the *Electrical Review* against Mr. Harness and the Medical Battery Company (Limited) to recover damages for maintaining an action which was brought by Dr. Tibbits against them. The interrogatory the plaintiffs sought to have answered was with reference to the communications which passed between defendants and Dr. Tibbits, and the payments made, or promised to be made, with reference to the action of Tibbits *v.* the Proprietors of the *Electrical Review*. The defence was that the offence of maintenance was indictable at common law. Mr. F. Dodd, who appeared for the respondents, contended that they were not bound to answer the interrogatory. Their Lordships dismissed the appeal, and directed that the costs should be the defendants (the respondents) in any event.

Edison-Bell Phonograph Corporation (Limited) v. Smith and another.

Mr. Justice Wright, on Thursday last week, delivered judgment in this case, which has been briefly reported in *The Electrician*. The learned Judge said this was an action for an injunction and damages in respect of infringement by the defendants, G. Albert Smith and J. Lewis Young, of a patent, numbered 19,153, and dated July 15, 1890, taken out by Mr. Edison, and by him assigned to the plaintiff company. The defence was a denial of the validity of the patent on the ground of want of novelty and of utility. The patent was in respect of improvements in connection with the phonograph. It was claimed by the defence that for some years the Graphophone Company had been advancing on similar lines to the present patent in the perfecting of phonographs. In the early history of the invention there had been a single diaphragm, and the defendants in their machines merely carried out this idea. The defendants' contention was that claim 1 of Mr. Edison's specification was for a bald idea, and was, therefore, bad; and that, if any of the claims were upset, in the absence of disclaimer of the invalid claim, the whole patent was bad; and, further, that, with the exception of claims 2 and 4, all the plaintiffs' claims were bad. The learned Judge, having stated the course of invention before the date of the patent in question, said that the then existing defects might be summed up as being that the parts of the phonograph were too numerous, and, the minutest accuracy of adjustment being essential, this had to be obtained and continually renewed by skilful manipulation of several parts frequently applied, and requiring judgment in order to ascertain that each working part was precisely in its proper relation to every other. The inventions made by Mr. Edison in 1889 disclosed in the plaintiffs' patent reduced the number of separate parts, and tended to produce automatically and with mechanical certainty, accuracy, and rapidity effects which previously depended on personal judgment and nicety of manipulation. The foundation of the improvement was the discovery that the floating weight which had been thought applicable only to the reproducing point was sufficient to regulate also the recording point. This made it possible to return to the system of using a single diaphragm under conditions which made it no longer a single diaphragm, but two diaphragms combined into one and carrying both the recording and the reproducing point, and means were devised by which such an arrangement became effective, either of the two points being brought to bear at will in the same line. This was the substance of the invention, though the plaintiffs seek to protect also certain improvements in details. The first claim was attacked for being too wide and general and for want of novelty; the third, fifth, sixth, seventh, and eighth on the ground of want of novelty and utility. Even if Mr. Edison's evidence stood alone he (the learned Judge) could see no reason to doubt that each of the details contributed something important, though minute, and was novel in its application to the phonograph, and was the result of prolonged study and experiment by a person of the highest mechanical genius. Each contributed to the machine becoming automatically accurate and rapid, and was adopted in the machines sold by the defendants. Each of them (except, perhaps, the seventh and eighth) appeared to be claimed only in combination with the principal invention, and if that was new and useful and properly described the patent was not, in point of law, invalidated by the addition of a claim for a further combination with the good invention of something which is not new or not useful, and which is not claimed except in that combination, because such an addition does not widen the patent or debar the public from the free use of the old or useless matter except when in combination with the principal invention. There remained the question whether the patent is invalidated by the first claim. That claim appeared to him to be on the face of it a claim of monopoly for every form of phonograph in which the two styles are attached to one diaphragm, so that either style can be brought to bear on the cylinder. It was a claim for a particular arrangement of essential parts of a machine, as disclosed in the specification. The claim was for a monopoly of that arrangement when carried out by any means substantially similar to those in the specification. He was, therefore, of opinion that there was both novelty and utility in the use of a single diaphragm carrying the two different points in such a way that either can be brought to bear, and there would, consequently be judgment for the plaintiffs.

Keith, Prowse and Co. v. the National Telephone Company (Limited).

This was a case tried before Mr. Justice Kekewich, and was of importance to persons hiring the use of telephone wires and apparatus. It was a motion by the plaintiffs for an interim injunction to restrain the defendant company from cutting, disconnecting, removing, or otherwise interfering with any wire which, on December 30, 1893, was used or connected for use as a private wire, or an exchange wire, for telephonic communication for the purposes of the plaintiffs' business. The plaintiffs originally (October, 1889) rented a private wire from the defendant company under an agreement, by which the plaintiffs agreed to pay £11 per annum for each wire, payable quarterly, the first quarter ending September 30, 1889, and each subsequent payment to be made on the corresponding day in each quarter, the agreement to terminate at the end of three years. The agreement stipulated that it should be subject to all proper wayleaves, permissions for attachments, poles, and other easements, being obtained and retained by the company; and the renters covenanted to give every facility in their power in the way of poles, attachments, &c., for running their own wire, and also those of other subscribers to the company's system, whether exchange or private. The agreement expired by effluxion of time in June, 1892, but the parties went on by mutual consent as before, the rent being continued to be paid on the same quarter-days, but no fresh agreement in writing was entered into. On the 29th December last, the plaintiffs gave notice to the company to terminate the existing arrangement or tenancy at the expiration of six months from "December 31, 1893." In reply, the company sent the plaintiffs notice, dated Saturday, "December 30, 1893," terminating the existing agreement "forthwith," and demanding rent up to "31st inst.," and informing the plaintiffs that they (the company) would on Monday morning, January 1st, proceed to disconnect the wires and remove the instruments. Thereupon the plaintiffs on the same day, December 30th, paid the rent demanded, and at once applied for and obtained from the Vacation Judge an *ex parte* injunction restraining the threatened proceedings until over the first day of the present sittings. The main question was whether the ordinary law of landlord and tenant could be applied to a hiring of telephone wires under such circumstances as in the present case so as to require from the Company as "landlords" either a six months' notice of determination if it is a yearly hiring, or a three months' notice if a quarterly hiring. The plaintiffs contended that the relation of landlord and tenant subsisted between the parties, and that the plaintiffs held the use of the wires and apparatus on a yearly or at least a quarterly tenancy, which could only be determined on due notice, and that the acceptance by the defendant company of rent for December 31, 1893—that is, a day after the notice determining the tenancy—constituted a waiver of that notice. The defendant company, however, contended that what the plaintiffs were really seeking was specific performance of an alleged contract; but that the contract was not one of which the Court would order specific performance, since it could not see to the electric batteries being kept filled, and so forth; also that the analogy of "landlord and tenant" was misleading. In the present case the contract was nothing more than a contract to supply certain chattels, a supply of electric current, and the services of workmen to keep up that supply; and, therefore, the meaning of the arrangement was simply that it should continue only so long as was convenient to both parties.

In delivering judgment, his LORDSHIP said he should only deal with two points—first, Was this a case in which the Court should grant an injunction if the plaintiffs made out an equity other than that for specific performance, it being impossible for the Court to compel complete specific performance in a case of this kind? Here there was no question of erecting apparatus; the only question was as to maintenance. It appeared to him that the difficulty of supervising the maintenance of apparatus ought not to prevent the Court from interfering with the cutting of the telephone wires and the removal of the instruments. An analogy might be suggested in the case of an agreement for the tenancy of manufacturing premises, the lessor providing steam or motive power set up in some neighbouring building, and then, in breach of the agreement, threatening to cut off the power. The Court would say that that he could not do; the agreement was to let the premises with the power, and cutting off the power would be a breach of the agreement. Then came another question, whether the action of the defendant company had rendered it impossible for them to say that the agreement was at an end. There was some argument as to whether this case could be regarded as a case of "landlord and tenant," and it was said that the plaintiffs, and not the defendant company, were really the "landlords" because, it was urged

the plaintiffs were grantors of an easement to the defendants to set up poles and apparatus on their, the plaintiffs', property. In his opinion that was not the case. The company erected these poles and apparatus; they belonged to them, and though the case was not that of landlord and tenant of real property, still there was a hire agreement, and the plaintiffs, who were to have the enjoyment, were described as "renters." His Lordship thought that the position of landlord and tenant as regarded these chattels was established. Then, upon this agreement, his Lordship assumed for the present purpose that under clause 8 the company might determine the agreement by notice "forthwith." They determined it "forthwith" on Dec. 30, 1893. At the same time the company demanded rent up to "December 31st"; the amount was paid and accepted as "rent." The result was that the company demanded and received rent for a day beyond the time of the determination of the agreement. It was not competent for them to affirm and disaffirm in that way; and, according to the law of landlord and tenant, they must be regarded as having waived or abandoned their equity. In his opinion the company had no power to say that the agreement was determined on December 30th, for they had received rent for the 31st, and therefore the plaintiffs were tenants, having the right to use the apparatus for that day. The original agreement was for three years from July 1, 1889, and therefore would come to a conclusion on June 30, 1892. From that time forward the plaintiffs continued to use the apparatus without any new agreement, and the rent was paid according to the old agreement. The result was that there was a holding-over upon the terms of the old agreement. He did not mean to decide that point; but, as his decision on the preceding point might be regarded as implying that now the company might intervene and say "We determine the tenancy to-day, and we will take care not to ask for rent beyond to-day," he would say that that question was not argued sufficiently before him to enable him to pronounce a decision on the point; but his present impression was that the receipt of rent after June 30, 1892, and the continued occupation by the plaintiffs, constituted a tenancy from year to year. He did not think that the company ought now to interfere without the question being submitted to judicial decision. He should, therefore, grant an injunction restraining the company from interfering with the private wires pursuant to the notice they had given. The injunction would continue until the trial of the action or further order, and the costs of the motion must be costs in the action. The injunction would extend only to the private wires, and not to the exchange wires, which were not in question.

CORRESPONDENCE.

PERSONAL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I saw with much surprise an announcement in your current issue that I am about to leave England. I wonder it has not occurred to you that, before publishing a statement which, if erroneous, may injure my professional relations in this country, it would be proper for you to make quite sure your information is correct; and this you could have easily done by inquiry at my office.

I cordially dislike the importation of personal matters into a scientific paper; but as your statement is calculated to alienate my present and possible future clients, I would ask you to allow me to make the following corrections:—

(*a*) My leaving England shortly is not even in contemplation.

(*b*) My leaving it at a future date (which will give me ample time to finish all the work I have in hand) is in contemplation, but is by no means certain.

(*c*) I have been offered an important appointment in Germany, and am in negotiation about it; but the matter is still pending, and will not be settled either way for about a month. Whether I shall leave England or not I do not even know myself at present, so that your statement was certainly premature and may, perhaps, also turn out to have been incorrect.—Yours, &c., GISBERT KAPP.

31, Parliament-street, Westminster,
February 10, 1894.

[We received the information in a very detailed form from a source which, we understood at the time, was authorised by Mr. Kapp himself. We greatly regret the possibility that the premature publication should be in any way likely to injure Mr. Kapp's professional relations in this country.—ED. *E.*]

IS THE HIRE WORTHY OF THE LABOURER?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should much like to call your attention, and that of interested readers, to a subject which must be extremely important to many electrical engineers, especially the younger generation.

The principal electric stations employ men who are variously termed "superintendents" and "electricians-in-charge." Their duty consists of taking sole responsible charge of the running of the station for a certain number of hours every day, usually eight. During this time they are "in command" of the station, and every accident or mishap has to be set right, and accounted for, by them. Naturally, therefore, they comprise in themselves the duties of the men under them; that is to say, they must have had practical experience of driving, stoking, &c., and in emergencies may have to carry out those duties. Added to this they must have had a sound theoretical training, as well as some workshop experience.

Yet, in a great many stations, they get paid lower salaries even than the stokers. If they have to work overtime, which happens fairly often, they do it with the privilege of receiving nothing for their trouble. In a great many cases the electrician's pay is a third less than the driver's. Can this be just or reasonable?

I well understand the electric lighting company's desire to keep down working cost, but surely the shoe should not be pinched at this point. At any rate they ought to afford to pay as much for electricians as for drivers. The cause of this state of things is, in a great measure, to be looked for in "over supply," and in the presence of young men well supplied with money, who will take a post for a mere song, in consideration of experience gained.

If the companies have not sufficient justice to pay their electricians better, and to enable them to live moderately on their pay, the electricians must find a remedy. I prefer conciliatory measures, but if these fail, "union is strength."

Trusting to your kindness to insert this note, and hoping some readers will write in support of my statements.—Yours, &c., SUPERINTENDENT.

DOUBLE-ACTING GAS ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the remarks I made on the driving of alternators by gas engines, in your issue of December 22nd last, I did not refer by name to any maker of engines, nor did I refer to any particular installation. I thought it best to treat the subject impersonally, and on general grounds, but Mr. Hartley, on behalf of Messrs. Dick, Kerr and Co., now challenges me to come to closer quarters with reference to double-acting engines, and I beg you will allow me to make the following observations.

I referred to a double-acting Otto engine, and not to the obsolete Griffin engine, which has a six-stroke cycle and a scavenging charge of air, which helps to cool the cylinder and piston. It is said that Messrs. Dick, Kerr and Co. have "turned out hundreds of double-acting engines," and I accept the statement; but it refers to engines of the Griffin type, and has little bearing on the working of the double-acting Otto engine which has been introduced recently. In the latter the explosions are more frequent, and there is no scavenging.

Mr. Hartley admits that an engine of this type requires "two admission valves, two exhaust valves, and two ignition valves," whereas a single-acting engine requires one of each. He argues, however, that it is no worse to have a set of valves at each end of a gas engine cylinder than at each end of a steam engine. To this I would say that it is common knowledge that the valves of a gas engine are not only more numerous, but are more difficult to keep in order than those of a steam engine; and this being so, I cannot help feeling that from a practical point of view it is wrong to nearly double them in number. The steam engine gives troubles of its own; but in a gas engine the frequent corrosion of the exhaust valve, the cleaning of the ignition valve, and the renewal of the ignition tube, are troubles from which the steam engine is free. All these defects Mr. Hartley thinks it right to double.

I have not said that a double-acting gas engine is wrong in principle—I do not think so—but I do say that the double-acting Otto engine now made is not as good as a single-acting engine for practical purposes.

I have not measured the consumption of oil or water; but I was told by the attendant of an engine which has been

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working a few months that it consumed more oil and more water than an ordinary gas engine of the same power. I also know that there was trouble about the water supply for cooling the engine, although there was a circulating pump. The extra cost of oil or water cannot, however, be serious; but there remains the awkward fact that if a double-acting engine needs more cooling, as I believe it does, there must be an equivalent loss of heat and a consequent additional loss in efficiency.—Yours, &c., J. EMERSON DOWSON.

February 12, 1894.

DRIVING ALTERNATORS BY GAS ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have only to-day noted an article by Mr. J. E. Dowson in your issue of December 22nd, or I should have commented thereon earlier. The author remarks, "*It is tolerably certain that double-acting gas engines as they are now constructed, will not be used to a large extent, and for practical purposes we need only consider the well-known single-acting engines.*" Had Mr. Dowson said, "*Single-acting gas engines will not be used to any large extent and we need only consider double-acting engines,*" he would have shown a clearer understanding of the wants of electrical engineers.

No matter what the system of electrical distribution may be, an engine with four impulses per two revolutions is a far more satisfactory motor than an engine with only one impulse and three waste strokes. Yet how can this greater number of impulses be obtained in single-acting cylinders, with the Otto cycle, without excessive cost, complication and clumsiness? Two double-acting cylinders give exactly what is wanted in a neat and effective way.

Gas engines driven by generator gas give such economical results, that the extensive adoption of this power for electric lighting is only a question of time. Gas engine manufacturers, who wish to come in for their share of this work, should turn their attention to the development of double-acting engines.

Messrs. Dick, Kerr and Co. recently built for me an engine of 100 H.P., which is now working a small alternating current central station at Rugby with Dowson's gas. In this engine, I had two double-acting cylinders placed one behind the other, the two pistons being connected by a rod coming out of the front of one cylinder and entering the back of the other, the front piston rod driving on to a connecting rod in the ordinary way. Thus, in this engine, there are two impulses per revolution, with only one connecting rod, one crank, and only two main bearings. All the parts in front of the cylinders are exceedingly simple, and need be of no larger size than for a 25-H.P. engine of the ordinary type. The blow of the explosion is only equal to that of an ordinary engine of one quarter the power.

This tandem double-acting engine does not, as Mr. Dowson says, take more oil than other engines of the same power. More cooling water may be required, but this I doubt. Even if it is so, it does not matter, for the tanks are arranged so that this water is used again and again.

I anticipated trouble with the piston rods, but there is no more trouble with these than in a steam engine. This engine is by far the most perfect one yet devised for electric lighting work *of all descriptions*, even for direct-current systems using accumulators. The starting is effected by using one cylinder as a steam engine, with steam from the gas generator boiler, until the engine gets explosions in the other cylinder. This simple and efficient starter could not be used in a single-cylinder single-acting engine. In all, except certain details, the above-mentioned tandem double-acting engine has given great satisfaction. I have had troubles, but these are all in a fair way to be overcome. I do not like the arrangement of connecting the two ends of the cylinders so that one gas valve supplies both ends. It would be more satisfactory that the four explosion chambers should be independent of one another, and act practically as four separate engines. The Rugby engine will shortly be altered in this respect.

I do not believe that engines of this type will yet work alternators in parallel *satisfactorily*, but if parallel running becomes possible, it will be effected far more easily by double-acting cylinders than by any arrangement of single-acting engines. For *satisfactory* parallel running, it is necessary that there should be a continuous turning effort, and this means that governing must be done, even with a four-impulse engine, by controlling the power of the impulses and not by cutting out. To arrange this is difficult. We tried a valve gear at Rugby for effecting this, but it was, in my opinion, too complicated for general use, and it was therefore removed. The engine is now governed by cutting out either one, two, or three of its impulses, as necessitated by the load. Even at the *lightest* load the engine gets one impulse per two revolutions, which is as much as a single cylinder single-acting engine gets at *full* load. I am a consistent advocate of parallel running in alternating central stations, but, convenient as this method of working is, I would sacrifice it rather than lose the great advantages of using cheap gas power. Parallel running might be effected by some arrangement by which the alternators could be coupled mechanically, but this would probably only be satisfactory on a small scale.

Another advantage that the double-acting engine has, is that it can always be made of twice the power of single-acting engines. For driving large dynamos direct, a most compact plant can be made by using two double-acting cylinders placed side by side vertically, as in marine engines. I believe that this is the form that the large central station gas engine of the future will take.

I apologise for trespassing so far on your space, but I have recently had a good opportunity of continuously testing a large double-acting engine, and I think my experience may be of value to your readers.—Yours, &c.,

21, Carlton-hill, N.W. J. A. MCMULLEN, M.I.E.E.

ELECTRIC WAVES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The publication of an English translation of the late Prof. Heinrich Hertz's Papers on the propagation of electric action through space cannot fail to give a great impetus to the study of electric and magnetic phenomena in this country, and will, no doubt, give rise to much discussion. Without in the least desiring to underrate the value of these Papers, and whilst recognising to the full the epoch-making nature of Prof. Hertz's work, it is impossible not to feel, after reading "Electric Waves," that our ideas of even fundamental matters are still very far from being clear. The particular point which struck me when reading the work was the care the author takes when arranging his experiments to distinguish between electric and magnetic effects, and the seemingly inadequate manner in which these two effects are treated in the fundamental considerations upon which he bases his equations. Indeed, electric waves, magnetic waves, and electromagnetic waves would seem to be used by Hertz and others as synonomous expressions.

At the instance of Lord Kelvin, the title of the German work, "Untersuchungen über die Ausbreitung der elektrischen Kraft," was changed in the English translation to "Electric Waves." That such a title should have been selected is interesting. Indeed, to a limited extent, it seems to be in conflict with the author's, and, I may even say, with the generally held theoretical views.

Speaking of the electric and magnetic forces Hertz* says, "Starting from rest, the interior of all bodies, including the free ether, can experience disturbances which we denote as electrical, and others which we denote as magnetic. The nature of these changes of state we do not know, but only the phenomena which their presence causes. Regarding these latter as known, we can, with their aid, determine the geometrical relations of the changes of state themselves. The disturbances of the electric and the magnetic kind are so connected with one another that disturbances of the one kind can continuously exist independently of those of the other kind; but that, on the other hand, it is not possible for disturbances of either of the two kinds to experience temporary fluctuations without exciting simultaneously disturbances of the other kind." Now the statement that although electric and magnetic fields may "continuously exist independently," they cannot "experience temporary

* "Electric Waves," p. 197.

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fluctuations without exciting simultaneously disturbances of the other kind" must surely mean that electric and magnetic waves cannot exist independently, that radiant energy must be electro-magnetic. Numerous other passages might be quoted, some of which would lead one to think that pure magnetic waves can exist, and others that pure electric waves also can. One passage of Lord Kelvin's I will venture to quote from the preface: *"The title alone of the other Paper, 'On the Energy lost by Radiation from Alternating Currents,' is in itself a valuable lesson in the electromagnetic theory of light, or the undulatory theory of magnetic disturbance." Are we to regard this as indicating Lord Kelvin's opinion that pure magnetic waves may exist, but that light waves are electro-magnetic ?

In a letter to *Nature*, Prof. Simon Newcomb† makes some suggestions concerning the nomenclature of radiant energy, and remarks, "The nomenclature of the subject has come down from a time when it was supposed that there were three distinct kinds of rays in the spectrum, severally known as light, heat, and actinic rays." . . . "I cannot but think that the general understanding and application of the now received theory of the subject, which recognises in this form of energy no differences of kind except wave length, has been materially retarded by the want of a corresponding nomenclature." Now even if electric waves and magnetic waves cannot exist separately, the one kind may be so powerful that the effects of the other kind are almost negligible. Referring to his experiments on this subject Hertz ‡ says: "As required by theory, the mechanical effects of the electric and of the magnetic force prove to be, in general, of the same order of magnitude; the preponderance of the one over the other in each particular case is mainly determined by the proportions of the neighbouring parts of the ring and of the fixed conductors. The more these approximate to the state of infinitely thin wires, the more the magnetic force comes into prominence; the broader the surfaces which are attached to them, the more is the magnetic force overpowered by the electric force." As a matter of fact, the mathematician must recognise differences of kind as well as of degree, though no doubt such a course will add very materially to his difficulties. On this point Lord Kelvin§ seems even to go further, for not only must we distinguish between magnetic and electric fields, but also between resinous and vitreous electricity and north and south polarity. He says: "Fifty years ago it became strongly impressed on my mind that the difference of quality between vitreous and resinous electricity, conventionally called positive and negative, essentially ignored as it is in the mathematical theories of electricity and magnetism, with which I was then much occupied (and in the whole science of magnetic waves, as we have it), must be studied if we are to learn anything of the nature of electricity and its place among the properties of matter." Hertz‖ also remarks, after giving his fundamental equations, "I wish to point out once more that I only attach value to the theory of electromagnetic forces in moving bodies here proposed from the point of view of systematic arrangement. The theory shows how we can treat completely the electromagnetic phenomena in moving bodies, under certain restrictions which we arbitrarily impose. It is scarcely probable that these restrictions correspond to the actual facts of the case. The correct theory should rather distinguish between the conditions of the ether at every point and those of the embedded matter. But it seems to me that, in order to propound a theory in accordance with this view at present, we should require to make more numerous and arbitrary hypotheses than those of the theory here set forth." The time has clearly scarcely arrived when the nomenclature of the science can with safety be based upon theoretical considerations.

It seems, therefore, that we know of at least two kinds of transverse wave energy; but whether, when the lengths of both kinds of waves are sufficiently short, they are both capable of producing visible rays, or whether light results from one only, can only be cleared up by experiment. To quote Hertz* again, "The details of the experiments further prove that the particular manner in which the electric force is propagated exhibits the closest analogy with the propagation of light; indeed, that it corresponds almost completely with it. The hypothesis that light is an electrical phenomena is thus made highly probable. To give a strict proof of this hypothesis would logically require experiments on light itself." Here light is regarded as an electrical phenomena, not an electromagnetic one. It seems as though to the words electric and magnetic specific and generic meanings are indifferently attached.—Yours, &c., R. M. Deeley.

* "Electric Waves," p. 14.
† *Nature*, November 30, 1893, p. 100.
‡ "Electric Waves," p. 193.
§ Roy. Soc., President's Address, *Nature*, December 7th, 1893, p. 137.
‖ "Electric Waves," p. 268.

* "Electric Waves," p. 19.

SUPPLY COMPANIES AND COOKING APPLIANCES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In *The Electrician* of last week, under the head of Trade Notices, you refer to the efforts of the Gas Light and Coke Company to increase their business by further advertising the uses of gas for cooking and heating purposes. You add that you are surprised that the makers of electrical heating and cooking appliances do not follow the same course, so that the public may know where to obtain them. In this we think you have confounded the Gas Light and Coke Company, who are a supply company, with manufacturers. We think that the Gas Light and Coke Company are right, and that it is the duty of supply companies to inform all users of their current that electric cooking apparatus is now satisfactory, and cooking by electricity can be carried out at a reasonable cost. We have suggested this course to some of them, but have received the reply that they do not care to mention manufacturers' names; whereas the Gas Light and Coke Company in their circulars give the names of five firms whose appliances are recommended for use.

It is very evident that so soon as electric supply companies have satisfied the demand for lighting they will have to turn their attention to utilising their supply during daylight hours. Why should they delay any longer in this matter. It is so evident that increasing the day load will tend to reduce the total cost of the production that nothing need be said on this point.

It is only fair to say that some of the supply companies, notably the City of London Electric Supply Company, are beginning to see this, and to this last Company we have recently supplied a number of large ovens. We believe they intend to let them out to some of their customers, and we also believe that other companies are proposing to follow the same course.—Yours, &c., Crompton and Co. (Limited).

Electric Cooking and Heating Branch,
148, Brompton-road, S.W.

THE MILEAGE OF THE SUBMARINE CABLES OF THE WORLD.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The following discrepancy in the total mileage of the submarine cables of the world seems to be worth while drawing your attention to.

In his Presidential Address before the Institution of Electrical Engineers, January 26th, 1893, Mr. Preece gives the total length of the submarine cables of the world as 139,571 miles. *The Electrician* Electrical Trades' Directory for 1894 gives 153,649 as the total mileage, presumably up to the end of 1893. During 1893 4,767 miles of submarine cable were laid. The total mileage, therefore, to the end of 1892 was 148,882.

The difference between this figure and that of Mr. Preece amounts to no less than 9,288 N.M., which surely calls for some explanation.—Yours, &c., R. C.

February 13, 1894.

BOOKS RECEIVED.

"Laxton's Price Book for 1894." Price 4s. (London: Kelly and Co., Limited, 182, High Holborn.)

"Munro and Jamieson's Pocket-Book of Electrical Rules and Tables. (London: Charles Griffin and Co., Limited, 12, Exeter-street.)

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TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

Our readers are reminded that the 1894 Edition of "The Electrician" Electrical Trades' Directory and Handbook is now ready. This valuable book contains 1,000 closely-printed pages, and several new and useful features have been added. The price of the Directory and Handbook is 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

"Electromagnetic Theory," by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application to the Publisher.

Tenders Invited.—The Vestry of St. Mary, Islington, invite tenders for the supply and erection of the necessary plant and machinery required for the supply of electric current within the parish, and also tenders for supplying the conduits and mains which are to be laid by the Vestry. The specification is divided into 10 sections, and contractors may tender for the whole or any one or more sections. Specifications, conditions, &c., may be obtained of Mr. Albert Gay, Vestry Hall, Upper-street, London, N., on and after the 19th inst.; and tenders must be sent in to Mr. W. F. Dewey, Vestry Clerk, at the Vestry Hall, not later than noon on Wednesday, March 21st. Further particulars will be found in our advertisement columns.

——— The Vestry of St. Pancras invite tenders for (1) Lancashire boilers, economisers, feed pumps, &c.; (2) engines, dynamos, condensing plant, &c., for their electricity and refuse destructor station in King's-road. Drawings may be inspected and specifications, &c., obtained from Prof. Henry Robinson, C.E., 13, Victoria-street, London, S.W.; and tenders must reach Mr. Albert E. Pycraft, the chief clerk, at the Vestry Hall, Pancras-road, London, N.W., by noon on March 5th. Some further particulars appear in our advertisement columns.

——— The Town Commissioners of Ballymena require tenders for lighting the town, either by gas or electricity, from August 16, 1894, until May 16, 1895. Specifications, &c., may be obtained from the Town Clerk, to whom tenders are to be sent by March 3rd.

Tenders Accepted.—The Corporation of Darwen have accepted the tender of Mr. T. Barton, of Blackburn, for a complete generating and distributing plant to be used at present for the lighting of the new technical schools, but which, we understand, is intended to form a nucleus plant for the lighting of the town. The plant and apparatus includes Barton dynamos, switch and distributing boards, Siemens' cables, E.P.S. storage batteries, and Stockport gas engine.

——— The tender of Messrs. S. J. Waring & Sons, of Liverpool, has been accepted by the Clerks' Cafe Company, Limited, for the electric wiring and the ventilating of the Cafe Hamilton, Chapel-st, Liverpool, for the sum of £320.

——— The Wolverhampton Town Council have accepted the tender of the Bedford Engineering Company, Bedford, for the supply of an overhead travelling crane at the Corporation's electric lighting works in Commercial-road, for the sum of £187. 10s.

Sale by Auction. — Our advertisement columns contain an announcement of the sale by auction, by Mr. William Lamb, at St. Helens, Lancashire, on Tuesday, the 27th inst., of Abell's Electrical Engineering Works, Raglan-street, St. Helens. The property comprises the buildings, with an "Otto" gas-engine, various machine and other tools, stock of electrical appliances, &c., the whole forming a complete manufactory, with plant and stock ready for immediate work. Further particulars may be obtained of the auctioneer, or of Messrs. Barrow and Cook, solicitors, St. Helens.

Appointment.—The Great North of Scotland Railway Company have decided to attach an electric light department to their existing telegraph department, and we understand that extensive plant and apparatus will shortly be put down. Mr. L. Le Gros Horne (of the electric light department, G.P.O., London) has been appointed to the post of superintendent of telegraphs and electric light to the Great North of Scotland Company.

Bankruptcy.—Mr. Moses Humm, electrician, 8, Westbourne-road, Forest Hill, Kent, has been adjudicated a bankrupt, and the first meeting of creditors will be held at 24, Railway-approach, London Bridge, on February 21st, at 11:30, and the public examination at the Greenwich County Court on February 27th, at 1 o'clock.

Liquidations.—A petition for the compulsory winding up of Latimer Clark, Muirhead and Co. (Limited) has been presented by Messrs. Willans and Robinson (Limited), and is down for hearing at the Royal Courts of Justice on the 21st inst.

Liquidations.—The secretary to the Richmond Electric Lighting Company has issued a circular in which he states that the debenture holders of the Company having taken action and obtained the appointment by Mr. Justice North of Mr. James Worley as Receiver and manager of the property and business, it is impossible for the Company to pay the debts as they fall due, and the shareholders have therefore passed a resolution for liquidation, and Mr. Worley has been appointed liquidator.

——— The creditors of Messrs. Latimer Clark, Muirhead and Co. (Limited) are required to send their names and addresses and the particulars of their debts or claims to Mr. James Worley, of 27, Leadenhall-street, London, E.C., the liquidator. The full text of the notice will be found in our advertisement columns.

——— At meetings of the Orient Electric Light Company (Limited), held on December 7th and 29th, it was resolved to voluntarily wind up the Company, Mr. Robert Wolfenden, of 43, Finsbury-square, E.C., being appointed liquidator. The Company was registered on November 29, 1887, with a capital of £5,000, divided into 20 shares of £250 each, to carry on in India, Burmah, Ceylon, and elsewhere, the business of an electric light, heat, and power supply, and a telegraph and telephone company in all or any of its branches. At the time of making up the last return (December, 1891), 13 shares were taken up, and calls of £100 paid on each had been made.

Re J. and W. Weems.—In this bankruptcy Mr. J. Gourlay, C.A., trustee, announces the payment of a first dividend of 2s. in the £, payable on and after Thursday, March 29th next, at 24, George-square, Glasgow.

New Russo-German Tariffs.—Under the Commercial Treaty recently concluded between the crowned heads of Russia and Germany, and which is to come before the German Reichstag for confirmation in due course, a rearrangement has been made in several groups of manufactures in which our readers are interested, more particularly as, under the "most favoured nation clause," Great Britain participates in any modification of international tariffs. The proposed Russo-German tariff on telegraph wires of all kinds is reduced from 4 to 2 gold roubles; on dynamos of all kinds from 4.80 to 4.32 gold roubles; on gas, air, or petroleum engines, from 1.70 to 1.40 gold roubles—these latter rates applying to all machinery not specially rated. The tariffs on technical apparatus are reduced from 8 to 6 gold roubles. Other articles upon which the tariffs have been reduced are iron or steel wire covered with thread or gutta-percha, from 9 to 2.20 gold roubles; and chloride of zinc, from 1 to .80 gold roubles. A reduction from 8 to 6 roubles per pood is made in the duty on driving belts for machinery (unsewn). The gold rouble is taken at 3s. 1½d., and the pood is 36lbs. avoirdupois.

Telegraphic Addresses.—We have received a copy of "Sell's Directory of Registered Telegraphic Addresses." This work, the outcome of Mr. Sell's efforts to obtain recognition from the Post Office for his work in the compilation of registered telegraphic addresses, is now issued, and forms a bulky volume of more than 1,000 pages, in addition to a useful gazetteer of the United Kingdom, and some general information usually to be found in such compilations. The list is compiled under the direct authority of the Postmaster-General, and forms a first issue under these auspices, but is the eighth annual publication of Mr. Sell's book. It is unfortunate that Mr. Sell should consider it necessary to warn the public against using telegraphic addresses given in other publications; there is nothing whatever to prevent others than Mr. Sell compiling a list of telegraphic addresses of equal authenticity to his own, although due credit may still be awarded to Mr. Sell for his courage in overcoming the obstinacy of the postal authorities, and bringing together the list under review.

Messrs. Pyke, Harris and Co.—This firm forward us illustrated sheets of several of their specialities.

The Boudreaux Dynamo Brush Company.—We understand that this brush, which was fully described in *The Electrician* a year ago, is being extensively used in France, Belgium, Germany, and other parts of the Continent, and the rapidly increasing sale proves the favour in which it is held. It is claimed that the conductivity is much greater than that of similar gauze brushes, because, being made of very thin sheet, they are more solid.

Messrs. Mather and Platt, Limited.—The London branch of this firm has just completed an extensive installation of the electric light at the residence of Mr. R. C. Christie, near Sunningdale, Surrey. The generating plant includes a 12-I.H.P. vertical boiler and engine driving a No. 4 Manchester dynamo, and a two-barrel slow-speed pump for supplying an overhead tank from a well in the engine-house. A set of 54 Chloride Company's cells are included. Nearly 100 lamps are used, and the plant provides for the supply of light to several outbuildings.

Messrs. T. and W. Ide.—Mr. William Ide has retired from the well-known firm of Messrs. T. and W. Ide, glass benders and merchants, of Ratcliff, London, E., and Mr. John Ide has been

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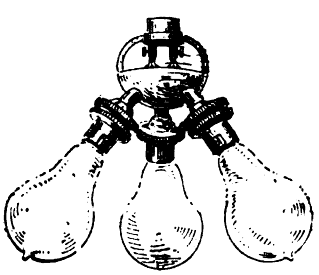
admitted a partner in the firm, which will be carried on under the same name.

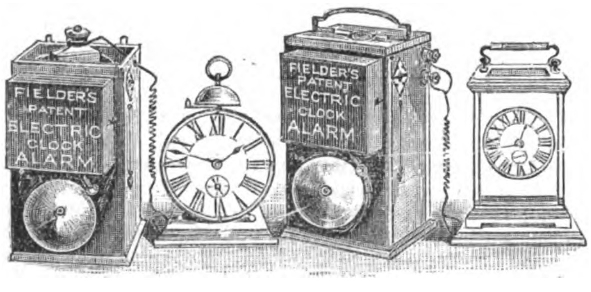
MESSRS. VERITY AND SONS' CATALOGUE.—We have received from Messrs. Verity and Sons a copy of their new catalogue, devoted to the display of the large variety of electric light fittings and accessories manufactured by them, which are here illustrated in endless profusion. The catalogue contains more than 300 large, well-filled quarto pages, throughout which illustrations, particulars, and prices appear of brackets, standards, electroliers, pendants, shades, reflectors, and, in fact, artistic and all kinds of electric and combination fittings are shown, many of which, although of most elaborate design, are manufactured and sold at very low prices. It is impossible, with such an immense range of choice, to particularly specify designs of more than usual merit, or to do justice in the limited space at our command to such a work; but we can safely recommend architects, electric light contractors, dealers in electric fittings, and all concerned or interested in the installation of the electric light to consult the bulky volume issued by Messrs. Verity and Sons, where, if anywhere, their requirements must



Verity's Improved Detachable Ball Body for 2, 3, 4, and 5-light Combinations.

surely be catered for. The book comprises 21 sections, commencing with plain and inexpensive brackets, and ending with electrical etceteras. Included in this latter section is an illustration of an improved detachable ball body, to fit an ordinary bayonet lamp-holder, and adaptable for two, three, four, or five lights off the same holder. Some time back, in these columns, we referred to the handiness of such an arrangement, and are pleased to find that Messrs. Verity have considered it worth their while to include it in this list. A single-light pendant is converted into one with two or more lights without disconnecting any of the wires, but by simply removing the lamp and inserting the plug at the top of the body into the ordinary bayonet lamp holder, the body can be instantly detached to allow of the shade to be removed for cleaning. A patent is applied for for this device, which we think will be in considerable demand for ball-room and other festive purposes. On page 237 a very useful brass deck fitting is shown, with a 3-light combination enclosed. Another section of the book in which several excellent examples of Messrs. Verity's special branch of work is well represented is Section VI. (Ceiling Fittings). The book is well printed throughout, in a variety of colours, setting off the various sections to the best advantage; it contains over 1,000 illustrations, and weighs 3½ lbs.

ELECTRIC CLOCK ALARMS.—Mr. Walter Fielder, of Shakespeare-road, S.E., is introducing a new patent electric clock alarum of a very simple character. The illustration below shows the combination applied to either a circular or square clock. By a simple



contrivance at the back of the small stand, the winding key, is placed in a metal slot, and upon the hands on the dial reaching the set time, contact is made automatically, and the alarum rings until the person for whom the call is intended removes the plug, when the ringing ceases. The clock is not fastened to the stand, nor is it in any way connected with the electric current, and can, in fact, be placed in any part of the house, so long as the electric circuit is completed. The stand and battery case is made in walnut wood, and the whole can be obtained with a circular clock for 15s. 6d., or with a square carriage clock for £1. 1s. Mr. Fielder is himself the sole patentee and manufacturer of the combination, although several wholesale houses are taking up its sale. There should be no difficulty in creating a considerable demand for this useful domestic appointment. It should be added that the electrical portion can be used as an ordinary electric bell, the metal contact plate forming a push, and, of course, the clock can be used quite independently of the electrical part of the apparatus.

NEW WORKS.—Messrs. Baird, Thompson and Co., engineers, have lately acquired the large freehold property known as the Charlton Engineering Works, Islington, London, N., together with the adjoining property and the machinery and plant contained therein. The works are being entirely overhauled and fitted with the latest improvements in labour-saving appliances, &c. The buildings are to be lighted throughout with the electric light.

MESSRS. MAVOR AND COULSON.—We have received a copy of the latest edition of the catalogue of plant, issued by this firm. The catalogue is entitled "Electric Light and Power," is well bound, and contains a considerable amount of practical information which should be useful to electrical engineers and to intending users of electric current. The illustrations are numerous and well executed; they represent the various dynamos, motors, regulators, lamps, &c., made and supplied by the firm.

NEW BOOKS AND NEW EDITIONS.—Messrs. Whittaker and Co. announce a second revised edition of Mr. Bowen Cooke's work on "British Locomotives," and a new work on "Surveying and Surveying Instruments," by Mr. G. A. Middleton. This firm will also shortly issue the second volume of Sir David Salomon's "Electric Light Installations," and the third and concluding volume is now in the press.

SMOKING CONCERT.—The staff of the City of London Electric Lighting Company will hold a smoking concert at the London Tavern, Fenchurch-st, London, E.C., to night (Friday) at 7.30 p.m., under the chairmanship of Col. H. C. Seddon.

ABERDEEN.—The Governors of Robert Gordon's College have considered the report presented by the City Electrical Engineer on the question of the electric light in the College premises. A committee appointed to consider the subject has reported that it is desirable to extend the lighting to the whole of the College buildings, and that, as the present plant is unsatisfactory, the proposals of the electrical engineer, that a re-wiring be effected, and the currents taken from the Town Council's mains, has been adopted.

ABERGAVENNY.—Power has been granted to the Improvement Committee of the Local Board to engage the services of an expert to advise them in the matter of lighting the district by electricity.

ACTON.—The Local Board have, on the advice of the Finance Committee, instructed their Surveyor to make inquiries as to the cost of installing a system of electric fire alarms throughout the Acton district.

AYR.—At the Town Council meeting on Monday it was stated that the initial cost for introducing the electric light into Ayr was between £16,000 and £18,000. It has been agreed to appoint an electrical engineer to survey the burgh and to report on the most advantageous method of electric lighting by steam-power, and to furnish estimates of the probable expense of the whole scheme, which are expected to confirm the above figures.

BANDON (IRELAND).—The local electric lighting company have decided to take no further steps in applying for a Provisional Order for the lighting of Bandon by electricity during the present year, and this being the case the Local Board have also decided to take no further action in the matter for the present.

BLACKPOOL.—At the last meeting of the Town Council a proposal from the Electric Light and Tramways Committee that the Local Government Board be asked permission for the Council to borrow £24,000 for electric lighting plant and extensions (repayable in thirty years), came up for discussion; and Councillor Pearson, in moving a confirming resolution, said it was his pleasurable duty to present a favourable report on the electric lighting scheme, and he therefore asked for permission to extend the station, so that they could supply the demands already made upon it. They had over-spent on the estimate of their last borrowing powers between £3,000 and £4,000, and they propose to expend immediately in extensions a further £15,000, and for future extensions £5,000, making in all £24,000. The excessive expenditure was accounted for by the fact that the Committee had found it necessary to take into their own hands the meters and transformers, instead of permitting purchasers to put down their own. They had this apparatus now in stock in sufficient numbers to serve them for some time to come. They had also decided upon more artistic arc light pillars for a certain portion of the area, which cost £15 in place of the £7 originally estimated. This latter alteration had received the Council's approval. They had sought the advice of Mr. R. Hammond as their electrical engineer in all matters. There had been a considerable increase in the consumption of the electric current, and a decrease in the cost of production, which must ultimately benefit the borough. In October last it cost them £72 to produce 3,107 units, as against £41 in December for 3,119 units, showing a

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greater production for a less cost, and at the end of the year they were producing current at 3d. per unit. The demand was much in excess of their present plant. For their extensions they would require extra engines of 500 H.P., and orders in hand—even without any order from the Tower Company—would require at least another set of plant. He estimated that they would be able to supply twice the amount of current now produced at a cost of about 2d. per unit for the extra output. Several amendments were produced, but ultimately the Committee's proposals were adopted by a large majority. Mr. Holroyd Smith's terms for estimates of cost and supervision of the works in connection with the placing in repair of the Corporation's electric tramways were also approved.

Bristol.—Energetic efforts are being made to convince the Bristol Corporation that the inhabitants of St. George are in earnest in their demand for the electric tramway. A large provisional committee is being formed in order to concentrate public opinion on the subject, in which the inhabitants of the district feel very strongly. Complaint is made that hitherto the important district of St. George has been isolated from Bristol, owing to the absence of communication.

Church Lighting.—The parish church of Leamington is now lighted by electricity. A 24-light electrolier is suspended from the dome, and an ornamental 10-light pendant is fixed to the roof of the sanctuary. The nave, transept, side aisles, and choir stalls are lighted by bracket lamps. Altogether there are 120 16-c.p., and about 70 25-c.p. lamps. The work has been designed by Mr. F. W. E. Jones, of the Midland Electric Light Company, the fittings being supplied by Messrs. Glover and Co., of Warwick.

Club Lighting.—The Committee of the Manchester Reform Club, in their report for the past year, state that the introduction of the electric light had occupied the Committee's attention for some years past, and during the past year it had been decided to proceed with the matter. The work had been entrusted to Messrs. Verity and Sons, who completed the installation in October last, at a cost of about £600.——The Committee of the Junior Reform Club, Liverpool, have called a meeting of the members to discuss the advisability of introducing the electric light. A report has been prepared.

Derby.—The Local Government Board have finally sanctioned the borrowing by the Corporation of £30,000 for electric light purposes, and £1,600 for land upon which the central station is to be erected. The Electric Lighting Committee's report has been submitted, in which it is recommended that Mr. J. E. Stewart be appointed engineer and manager of the electric lighting works, at a salary of £260 per annum, and Mr. A. P. F. Moore as assistant engineer, at a salary of £109. 4s. per annum. The Committee have now completed their staff appointments, and will commence operations when the works are formally taken over on the certificate of Messrs. Bramwell and Harris. The report was adopted.

Dover.—It has been decided to instal the electric light in the Connaught Hall, and an estimate has been received and accepted from the Brush Company for the necessary work, fittings, &c., for the sum of £572. 12s. The lighting of the Maison Diew Hall (estimate cost, £330) has been deferred.

Drogheda.—The offices and yards of the Drogheda Steam Packet Company have been lighted by the electric light, which is voted a great improvement upon the old gas lighting.

Edinburgh.—A considerable extension of the electric lighting at the new Caledonian Station, Princes-street, has just been completed. The whole of the completed platform and offices are now lighted by electricity, and seven 2,000-c.p. arcs have been erected in the shunting and goods yard, in addition to about 400 16-c.p. incandescents provided for the goods sheds, offices, and signal boxes. Gas has been entirely dispensed with.

Harrogate.—A public meeting was held at the Town Hall last week to consider the expediency of the Corporation undertaking the installation of electric light for the public lighting of the borough, for which they had already obtained power. The Corporation recently decided to put down a refuse destructor in conjunction with the electric lighting plant, but upon this additional scheme difference of opinion has arisen amongst the members of the Corporation. A resolution was proposed at the meeting, asking the Corporation to reconsider the question with the view of transmitting their rights to a private company, but an amendment was proposed, calling upon the Council to themselves take up the question of developing the electric light in the Borough. The meeting, however, was against this course, and decided by a large majority in favour of the original resolution.——At the meeting of the Corporation the decision come to at the above town's meeting was discussed, and it was pointed out that many other improvements had been effected in the town in spite of public meetings carrying resolutions against such improvements. After the discussion the recommendation of the Electric Lighting Committee that the Council itself carry out the electric lighting order, was carried.

Harrow.—The Local Government Board have intimated to the Harrow Local Board that a public inquiry will be held at the Local Board offices as soon as arrangements can be made, in reference to the application for an electric light Provisional Order and other local matters.

Liverpool.—An important inquiry has been held by the Local Government Board as to whether the time has come when the important districts of Toxteth Park, Walton, West Derby, and Wavertree should be incorporated with the City of Liverpool. The advantages of this incorporation were pointed out by the leading members of the Corporation, and particular attention was drawn to the fact that whereas West Derby, which is larger in area than Liverpool itself, has hitherto strongly opposed the incorporation, it now comes forward with a proposal that it would be for the general good that such incorporation should take place. So far as the scheme of incorporation affects the Liverpool Electric Supply Company, a friendly agreement has, we understand, been arrived at to extend the purchasing clause of the Company's Order so as to enable the Corporation to give notice of their intention to purchase the Company's undertaking in the year 1900, instead of in the year 1897 as under the original arrangement.

Limehouse.—The Electric Committee of the Board of Works have prepared a report, which was to have been presented at the last meeting, but owing to additional information coming to hand at the last moment, the report has been deferred until the next meeting of the Board.

London County Council.—The Finance Committee have recommended, and the Council have approved, the loan of £9,000 to the Islington Vestry towards the purchasing of a site for the central lighting station; and the loan of £29,700 to the Vestry of St. Pancras towards the cost of electric lighting works, the loan to be for a period of 25 years. Some discussion took place upon the St. Pancras loan, the Vestry contending that they should be allowed a longer period than that based upon the life of the work, in order that they might have equal advantages with an independent electric light company, which does not have to pay off its capital. The Council, on the contrary, were of opinion that although the contentions of the Vestry were admitted, it should be remembered that a private company was not able to borrow money at 3½ per cent. as the Vestry could, and that the Company would be compelled to establish a reserve fund to meet depreciation and other contingencies, including that of a possibility of being bought up by the local authority. A motion approving of the contention of the St. Pancras Vestry was subsequently lost. The Council have also had under their consideration a considerable extension of the Metropolitan Fire Brigade, and contemplate the expenditure of about £100,000. We understand the Council have under consideration the advisability of adding to the number of street fire alarm posts, which have proved so useful in the past.

Londonderry.—The Corporation have had an exhaustive debate upon their electric lighting scheme, which has met with every possible opposition from the gas interests. A discussion of 2½ hours' duration was mainly taken up by petty squabbling over purely personal matters, which certainly reflects but little credit upon the Councillors as business men. It appears that the original estimates have been somewhat exceeded, and this has been made the occasion for a perfect tirade of abuse against the chairman of the Electric Lighting Committee, the electrical engineer, Mr. Blake, and other prominent officials of the Corporation. So highly does party feeling run in Derry on this question that the *Sentinel* (which is the mouthpiece of the opponents of electric lighting) devotes nearly five columns to this miserable wordy war. After a considerable waste of time a resolution was moved by Mr. Councillor Hastings as follows:—"That, having considered the position of the electric lighting scheme, and that as 170 lamp pillars are already erected and cables laid thereto, the Council authorise the borrowing of sufficient money to complete 170 arc lamps, and leave the same in proper working order; and that no further electric lighting of the city, either public or private, be undertaken by this Corporation without the careful consideration and consent of the Council." In discussing this resolution, and in reply to a question, Mr. Councillor Magee, the chairman of the Electric Lighting Committee, stated that the number of lamps in their present contract was sufficient for the efficient lighting of the city, but the citizens had been getting used to luxuries, and required more light, hence the increase in expenditure over and above the original estimates. After agreeing to insert the words "not to exceed £5,000," Mr. Hastings' resolution was agreed to.

Margam.—At the monthly meeting of the Local Board the Lighting Committee recommended that the district be lit by electricity, and that Messrs. Drake and Gorham be authorised to prepare a report on the subject.

Manchester.—At the last meeting of the Council exception was taken by Mr. Alderman Leech to the arrangement proposed to be entered into between the National Telephone Company and the

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Council with regard to the laying down of telephone wires. The National Company has undertaken to place their wires underground, at their own expense, to the satisfaction and with the approval of the Corporation; to pay for the opening of the streets and further repair; and to pay the Corporation a yearly rental. It was this arrangement to which exception was taken, the point of the objection being that the Corporation were breaking away from their connection with the Municipal Corporations' Association. Four speakers pointed out that the recommendation of the General Purposes Committee to accept the arrangement with the National Company was one which would benefit Manchester, and should be entered into regardless of any connection between the Corporation and the Association. A discussion ensued, in which the Lord Mayor strongly supported the arrangement with the National Company, and this was agreed to by a large majority. It is proposed that the terms of the agreement shall be embodied and scheduled with the Act of Parliament which the Corporation is now promoting.

MISSENDEN (BUCKS).—The Vestry have entered into an agreement with an electric light company to light the streets of the village during the winter months This is the first district in the county that has adopted the electric light for street illumination, although the Wycombe Town Council occasionally "discuss" the subject.

NEWCASTLE-ON-TYNE.—An offer has been made to the Corporation by one of the electric lighting companies serving Newcastle to light Grainger-street, one of the principal thoroughfares, with electricity at the same cost as for gas. The City Lighting Committee have decided to obtain fuller details before accepting.

NEWPORT.—In a letter dated February 6th, Messrs. Crompton and Co. (Limited) repeat an offer made by them on the 27th ult., to the Town Council, viz., to lay down a low-pressure plant for the sum of £19,500, and to work the same for a term of years at about one-half the cost of that estimated for a high-pressure system, the plant supplying a larger area than that contemplated in the specification. Messrs. Crompton and Co. are also prepared, if required, to supply and work a high-pressure plant. A meeting of the Local Gas Company was held on Tuesday, and the subject of the possibility of early competition with the electric light was mentioned. It was suggested that the greatest care should be taken that the illuminative power of the gas was kept up to the highest possible standard, and it is likely the Gas Company may shortly announce a reduction in the price of their commodity. The Parliamentary and Improvement Committee have finally considered the question of the electric lighting tenders, and find, on exhaustive consideration, that the difference between Messrs. Crompton & Co.'s tender and the combined tender of Messrs. Fowler & Co., and Messrs. Siemens Bros. & Co., is £1,913. The Committee visited Messrs. Crompton's works, at Chelmsford, and were invited to consider the advantages of the low-tension system. After careful consideration, however, they adhered to the high-tension system, and recommended that the all-round tender of Messrs. John Fowler and Co. (Leeds), Limited for the whole installation (except the cables), at £19,797, be accepted, subject to such variations as may be required, and that the tender of Messrs. Siemens Bros. and Co., for cables, at £2,896, be accepted on condition that these cables are made in England. At the meeting of the Council, at which the report of the Committee was presented, a resolution was proposed that Messrs. Fowler and Co.'s tender be declined, and that the tender of the Uskside Engineering Company to supply the engines be accepted, and Messrs. Crompton and Co. be granted the balance of the contract on the basis of the amount of their original tender, and on condition that they consent to give to Newport firms the making of any machinery, tubes, or other work that could be done in Newport on equal terms. Councillor Wilkinson, who proposed this amendment, objected to more than £2,000 being needlessly sacrificed, and submitted a memorial from the Engineers' Society, the Steam Engineers' Society, and the Iron Founders' Society, urging the acceptance of Messrs. Crompton and Co.'s tender on the conditions stated in his amendment. After adequate discussion, the Committee's recommendations were adopted, the voting showing 5 for the amendment, 20 against, and 10 neutral.

OSWESTRY.—An attempt to bring about a satisfactory arrangement between the Town Council and the electric lighting company was made at the last meeting of the Council but without effect.

PADDINGTON.—The Guardians have appointed a special committee to consider and advise upon a proposal to light the workhouse infirmary by electricity.

ROTHESAY.—The Harbour Trust has appointed a committee to report as to the practicability of introducing the electric light at the harbour.

SOUTHPORT.—It was recently proposed to introduce the electric light into the new infirmary, and at a meeting of the Board of Guardians the subject has been discussed, but the final decision has been left for a future meeting.

SOUTH WALES INSTITUTE OF ENGINEERS.—In reference to a paragraph which appeared in our issue of January 19th, we are requested to state that the electric light installation was not put down by Messrs. Verity and Sons as there stated, this firm having only supplied the fittings to instructions.

STAFFORD.—At the meeting of the Town Council last week the Electric Lighting Committee reported that their engineer, Mr. Bell, had had several interviews with Dr. John Hopkinson on the subject of their electric lighting scheme, and that the necessary plans, drawings, and specifications were ready for obtaining tenders for buildings, plant, &c. The Committee recommend that tenders be obtained for electric lighting machinery and other necessary works, and Mr. Alderman Peach, who proposed the adoption of the Committee's report, stated that considerable progress had been made towards carrying out the powers of the Provisional Order of 1890, inasmuch as the sanction of the Local Government Board had been obtained to the loan of £20,000 (as stated in our last issue), and drawings of the proposed central station were now submitted. Under the Committee's plan the new works had been so designed that the whole could be duplicated without alteration or demolition. Included in the plant proposed to be put in were three Lancashire boilers, which would supply the gas works with steam as well as the electricity works, and room would be provided for additional boiler capacity. Dr. Hopkinson's recommendation was that three horizontal compound high-pressure steam engines should be put in, each of 100 H.P., and the space so arranged that two additional 200-H P. engines could afterwards be added. Included in Dr. Hopkinson's recommendations is an accumulator set of 112 cells. The station's capacity is to be arranged for 5,000 16-c.p. lamps before extensions are required. The Committee estimate that the capital required will necessitate an annual payment of £790, and that the estimated annual working expenses, including repairs and maintenance, would amount to £1,250 per annum. The accounts of the Gas and Electric Light Committee were to be kept strictly separate and distinct. The Committee's report was adopted without discussion.

ST. IVES.—In reply to a letter from Messrs. Baily, Grundy and Barrett, the Town Clerk has been instructed to state that the Council have no opposition to offer to a private company lighting the town by electricity.

STIRLING.—The Board of Trade having informed the Stirling Town Council that, in order to place themselves in a legal position in opposing the application of the Caledonian Electric Supply Company for a Provisional Order, the Council must itself apply for such Order, a special meeting of the Town Council is to be held to consider the letter from the Board of Trade, which has taken the Councillors by surprise.

WARMINSTER.—A 2,000-c.p. Brockie-Pell arc lamp has been placed over a new memorial fountain in the market place at Warminster, current for the lamp being obtained from the lighting installation of Mr. M. Hill at the Station Saw Mills. After a provisional trial, three additional lamps are to be erected, by which means the whole market place will be lighted electrically.

WEST HARTLEPOOL.—The Town Council have discussed a resolution approving of the erection of the overhead system of electric traction, on condition that poles be erected on one side of the thoroughfares only. Ultimately, after some discussion, the matter was again referred back to the Committee which has the matter under consideration for further report. It has further been proposed that application be made by the Council to the Board of Trade to grant the Council a Provisional Order to supply electricity within the district. This matter has also been referred back to the Property and Lighting Committee for further report.

COMPANIES' MEETINGS AND REPORTS.

Kensington and Knightsbridge Electric Lighting Company (Limited).

The seventh ordinary general meeting of this Company was held on Thursday at 1, Great George-street, Westminster, Mr. Granville R. Ryder presiding.

The SECRETARY (Mr. R. S. Erskine) read the notice calling the meeting.

The CHAIRMAN said: It is gratifying to us, after working away at this Company several years to find ourselves able to present to you what is in all respects a satisfactory report, and not only satisfactory so far as it shows that we are able to give you a further one per cent. dividend, but also in the prospect which it gives us of the future. With regard to the figures, I think the increases in them are encouraging. Of course, as a basis of comparison, it is necessary to keep back the new district and confine ourselves entirely to the old district, the new one only having come in for a broken period of the year, I find that we have increased the number of houses and shops connected

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with the system from 550 in 1892 to 650 in 1893. With regard to the 8 c.p. lamps we have increased the number from 47,441 to 59,267, an augmatation of 11,826. After deducting from the 724,308 units of electricity sold in 1893 the 28,600 required for the new district, we have a total of 695,708 units for the old district as against 535,343 for the year 1892. That is an increase of 160,365. The satisfactory thing about this increase of one-third in the electricity supplied, is that it was obtained at an increased cost of only about one-sixteenth. The gross earnings, less rebates, for 1892 were £16,628, whereas for 1893 they amounted to £20,746, an increase of £4,117 in the twelve months. Now, it is especially gratifying to find that the profit on that increase has been over 50 per cent. That is to say, the additional profit has sprung from £6,828 to £9,049, an increase of £2,221 on the enhanced gross earnings of £4,117. It might be alleged that we have reached the limits of expansion in our district. As a matter of fact, I consider we have done little more than touch the fringe of the business which we may look to obtain in future years. If you take Prince's Gate, Rutland Gate, Ennismore Gardens, Exhibition-road, and other roads of a like character in the neighbourhood, all inhabited by better-class people, I think you will agree with me that they will all eventually have the electric light. I feel strongly that the electric light is the light of the future, and there must come a time when all the superior houses will avail themselves of it. Then there are large flats being built in different parts of the estate, and large houses are being converted into flats, which are good customers of ours. It is no doubt thought by many that the time would come when we must reduce our price. When that time arrives I cannot say that I shall fear the result very much, because with a reduction in price will come a great increase of business, and with it a cheaper output of electricity. Therefore I think there will be a considerable compensation for any loss in price by increased business and the reduction in the cost of supplying the electricity. With regard to the capital account, which we do our best to put down, I may say that in a company like ours it is impossible to altogether close it. During the past year it has increased by £19,860, being made up of £7,260 of the Five per Cent. Second Preference and £12,600 of the Four and a-Half per Cent. Mortgage Debentures. That increase of capital has been spent on the purchase of the freehold of one of our stations, the purchase of the new district from the Chelsea Company, on laying additional mains, &c. The next point to which I wish to refer is the writing down of the renewal account. What we feel is, that while we are increasing our profits we should try and write down to the largest extent we can, in fairness to the present shareholders. We have written off against preliminary expenses and the cost of the debenture issue about £379, thus reducing that amount to £500, and we have written off law suspense account £779, and in other ways we have made provision for depreciation and renewals, amounting in the aggregate to £2,456, which I think is a considerable sum for one year. It is impossible to say very much about the new district for the short time we have been working it. Its gross revenue for the half year we have have had it has been £953. I cannot say how much of that is net profit, but I shall look for from 9 to 10 per cent. in future upon the outlay. Upon the whole, I think the accounts are satisfactory, and point to a prosperous future. I will now move the adoption of the report and accounts.

Sir FREDERICK J. BRAMWELL, Bart., F.R.S., seconded the motion.

Mr. HEDGES inquired if they had reduced their price for electricity since last year?

The CHAIRMAN replied that they had, in the way of making a considerable rebate to their large consumers.

The resolution was then agreed to unanimously.

The CHAIRMAN then moved the declaration of a final dividend, making 5 per cent. for the year, on the Ordinary shares.

Mr. G. H. HOPKINSON seconded the motion, which was carried.

On the motion of Mr. J. F. ALBRIGHT, seconded by Mr. HEDGES, a sum of £500 was voted to the Directors for their services during the past year.

The retiring Directors, Mr. R. W. Wallace and Mr. A. S. Bolton, were re-elected, and Messrs. Lovelock, H. W. Whiffen, and Dickinson were re-appointed auditors.

A vote of thanks to the Chairman brought the proceedings to a close.

India Rubber, Gutta Percha, and Telegraph Works Company (Limited).

The thirtieth ordinary general meeting of this Company was held on Thursday, at Cannon-street Hotel, Mr. S. Wm. Silver (Chairman) presiding.

The SECRETARY (Mr. W. J. Tyler) read the notice convening the meeting.

The CHAIRMAN said: I presume you will take the report as read. Now, I think when we last met I held out favourable prospects for the year which has recently closed. Since then, we have had that much-to-be-deplored stoppage of the collieries. That has interfered with our operations to a certain extent, exercising an effect upon our working expenses. I think I may here mention that the steamer which returned from laying the cable on the West Coast of South America, brought back several hundred tons of coal, which have been found useful in our works. It is rather a remarkable thing that we in England should be importing coal from the West Coast of South America. The effect of the stoppage was felt by industrial concerns such as this. The stoppage of mills, I need not say, reduced the quantity of material required for engineering purposes. At the time of our last meeting I certainly did not look upon our general sales as the sheet anchor that they have proved to be. We have fallen back upon them, as you will have discovered from the report. We have done little in submarine telegraph work. We have had a contract to fit up the City of Brussels with the electric light, and to the credit of Mr. William Gray (the youngest son of our managing director), and Mr. Russell, who was associated with him in the undertaking, it has proved a complete success. Well now all this means that more capital is required, looking at the way in which our money is invested in works, in stock, and in other respects. Hence, in the best interests of the shareholders, and to put us in a position to purchase on the most favourable terms, we have determined to recommend the placing of a further sum to reserve. I cannot help referring to the stagnation of trade, which has enhanced the competition we experience and increased our difficulties in doing good business. There is plenty of business to be done, but the difficulty is to select that which is not likely to prove unprofitable in any way, and I must say that the greatest care and caution have been exercised by all in connection with this concern. It affords me very much pleasure to recommend the adoption of the report, which, under the circumstances, as I have in a very few words pointed out to you, is to be looked upon as of a satisfactory character. I will, therefore, move:—

"*That the report and accounts now presented be received and adopted and that a dividend of 5 per cent., and a bonus of 2½ per cent., free of incom tax, which, with the interim dividend of 5 per cent. already paid, equals 12½ per cent. for the year, be now declared.*"

Mr. ABRAHAM SCOTT seconded the resolution, and added that the trade for the past year had turned out better than he expected would have been the case.

General TREVOR said he wished for some additional information with regard to the reserve fund, which stood at nearly half a million sterling, namely £450,000. That was a very respectable sum, and one of which they might all well be proud. If a bad year should come, in which no profits were earned, the debenture holders would have to be paid their full 4½ per cent., and even the Ordinary shareholders would expect something with such a handsome reserve fund. What he wanted to ask, therefore, was whether the Directors could dip into it. Was the £450,000 liquid and of a tangible character and invested in Consols, or safe Government and Colonial securities? If the whole sum was in their business it would be very difficult without crippling their operations to take any of it. That some of it was invested was clear because the accounts showed that they had debentures and shares in other companies to the extent of £207,042. He would also like to know whether that was the value of those debentures and shares now, or whether the figures represented the prices they originally paid for them? They might be worth more at the present time, or possibly less. Of course, the reserve fund was required for other purposes besides equalising the dividend in bad years, and paying the debenture interest. He imagined, however, that no portion of it was needed for maintenance of steamers, as there appeared in the accounts a separate item for that of £10,000. Before the accounts were passed he hoped the Chairman would tell them the nature of the reserve fund, and whether it could be drawn upon at once, if necessary, and it would depend upon the Chairman's answer whether he made any motion.

Mr. LAMONT remarked that he could understand it might be necessary at times to receive payment in shares of other companies, but he thought that, as a matter of principle, it was not advisable that one company should hold a large amount of shares in other companies. Of course, if the Chairman said it was necessary for the successful carrying on of the business, he had nothing further to say on the point. He also shared the curiosity of the last speaker as to whether the value of these debentures and shares, as given in the accounts, was their cost price or what they stood at on December 31st last.

The CHAIRMAN, in reply, said, I think General Trevor has studied the accounts pretty closely, but he has scarcely carried his investigations far enough. You will see that our capital is employed in land, buildings, and machinery, and without our reserve I am afraid we should have very little to fall back upon as an industrial concern and instead of having 12½ per cent. to declare, I think if we got 1½ per cent. it would be about as much as they could pay. I put that plainly to you, as many gentlemen present are men of business, who will appreciate what I say. I think it would have been well if General Trevor had studied both sides of the accounts thoroughly. Mr. Lamont, I think, referred to certain investments which, in the course of business, are desirable. That is so, and they are such as we could realise if necessary.

Gen. TREVOR: Is the value given their present value?

The CHAIRMAN: Yes.

Gen. TREVOR: Not what we may have paid for them, more or less, when we bought them?

The CHAIRMAN: No; certainly not.

Gen. TREVOR: Do I understand that the whole of this £450,000 of reserve is in the business?

The CHAIRMAN: Actively engaged.

Gen. TREVOR: Then it is in point of fact additional capital, although not raised by debentures or shares?

The CHAIRMAN: Without interest.

General TREVOR: Of course, I fully understand that without that working capital of £450,000, upon which no interest has to be paid, the dividend would be smaller. That I understand perfectly, but the question is whether it should be called a reserve fund? It is not actually reserve unless you can dip into it.

The CHAIRMAN: That is the usual course, sir.

General TREVOR: You could dip into the £207,000 of debentures and shares if you wanted?

The CHAIRMAN: Certainly.

General TREVOR said that after the Chairman's explanation he had no motion to submit to the meeting.

The resolution was then carried unanimously.

The CHAIRMAN: The next resolution I have to place before you is one for the re-election of Mr. Scott and Mr. Henderson as directors. In moving that these friends remain on the board, I have pleasure in saying that they have proved of great value and importance to us. I am sorry to

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say that Mr. Henderson is unavoidably absent, and therefore, if you will allow me, I will put the two names together.

The Hon. HENRY MARSHAM seconded the resolution, which was passed.

Mr. GEO. HANBURY then moved, and Dr. Small seconded, the re-election of Mr. J. F. Clarke as auditor at a fee of 30 guineas, which was agreed to.

The CHAIRMAN said he might mention that the gentleman they had been good enough to elect as auditor was a member of the firm of Turquand, Youngs and Co.

At the request of the meeting, the CHAIRMAN then called upon Mr. Matthew Gray (Managing Director) to give an account of his recent visit to the Continent on the Company's business.

Mr. GRAY said that in consequence of their having the contract for lighting the City of Brussels with the electric light, he visited that place, and was pleased to find that the work had been done very satisfactorily—in fact it was the best central station he had seen. The authorities at Brussels were satisfied, and he thought it was very probable that they would go in for an extension of the electric light to a considerable extent. After visiting Brussels he went to the Company's factories at Persan-Beaumont in France, where he found everything in first-rate order and fully employed. Their factory at Silvertown was also well maintained and busily occupied. The competition during the past year had been very keen and they had had to fight over and over again several battles, but they had managed, as the shareholders were aware, to make a little profit. All the stocks and the value of the works had been very carefully gone into for the past twenty years, and he could assure them everything was in a very healthy condition. They turned out a great variety of articles and a great many of each sort. For instance, they had 500 girls employed in making bicycle tyres alone. There were numerous other matters he could tell them about, but he thought it hardly worth while detaining them.

A vote of thanks to the Chairman and Directors, proposed by Mr. LAMONT, and seconded by Gen. TREVOR, terminated the proceedings.

Newcastle and District Electric Lighting Company (Limited).

The seventh ordinary general meeting of this Company was held on Monday at 57, Westgate-road, Newcastle-on-Tyne. Mr. J. D. Milburn, the Chairman, presided.

The CHAIRMAN, in moving the adoption of the report (which appeared in our last issue), said that during the year they had had an increase of nearly 100,000 units of electrical energy. That came partially from the North-Eastern Railway Company, at the station and other works, but also to a large extent from individual consumers. That was to be looked upon as very satisfactory, because the more work they got to do the more it consumed of their standing charges, and the more profit, up to a certain degree, it allowed them to make. They had been able to effect considerable economy in coal consumption. The drift to the river, and the condensing plant, introduced by Mr. Parsons, had been a very great success, although the cost had been greater than was anticipated. The difficulties of sinking and tunnelling down to the river were, of course, unknown quantities to begin with, and did not come out quite as they expected; but their highest hopes in the direction of economy were now being realised. They had gone into the question of the utilisation of the town refuse as fuel, and it was found possible, not only to do a good deal with the fuel, but also to set up a paper factory alongside the works. Mr. Parsons, who had gone into the matter thoroughly, pointed out, however, that, with duff coal at 3s. or 3s. 2d. per ton, very little economy could be got with anything of the kind. The fuel was all very well, it would burn, but it took a lot of labour to shovel it on to the fires; and if they could get their boilers singing away at full pressure with coal as low as 3s. 2d. per ton, they could hardly go into a question such as that. There was another matter which went into the question of cost. They would see in the Gas Company's report that the Directors said that the policy of reducing the price to 1s. 10d. per 1,000 cubic feet had not fulfilled the expectations they formed of it, and that they were going to put the price back again. It was calculated in electric lighting that 6d. per unit was equal to 5s. per 1,000ft. of gas. But the more they had opportunity and experience of knowing how the light was used the more they were convinced that a great deal of waste took place in electric lighting. Now that the new lamps had come in this had to a certain extent disappeared. They found that a consumer put in exactly double the size of a lamp he required, and then ran it to death, with the result that at the end of two or three months he got out of it only two-thirds or a half of the power of the lamp, but had to pay all the same for the big effulgence he ought to have had. A lamp cost about 3s. 9d., although lamps were made and sold in this country for 9d. and 1s.; but there was a question as to the legality of that. It would be found great economy, after using the lamps three months, to take them out and destroy them and put in fresh ones; and if people who had had 25 c.p. lamps would remove them and replace them by 16 c.p. lamps, they would probably find no difference in the light, and pay very much less. Even an 8-c.p. lamp would give a very good light indeed. Great saving might be effected in this way, and he felt that they were approaching the day when the cost of the electric light would assimilate itself with that of gas. There was the question of the reduction of their own price, but they did not feel quite yet that they could recommend it; they had had no complaints. Gradually their customers were waking up to the better use and idea of the economy of the electric light, and they hoped that that would popularise the idea of the light. They had recommended the same dividend as last year. Probably they might have done a little more, but they felt that they might some year have drawbacks, and they might have some bad luck; and it was only right that they should be prepared for that. The feeling of the Directors was that they should not go backwards. If they got 6 per cent. this year, it would not be pleasant for the shareholders to go back to 5½ or 5 per cent. another year. They had applied to the Local Stock Exchange for a quotation, with the result that very shortly the shares would be quoted in the local list, and anybody who wished to buy or sell shares would have every facility for doing so.

A SHAREHOLDER asked if it were correct that the Corporation intended to have their own central electric lighting station, and, if so, would not that mean serious competition?

The CHAIRMAN said that the Company had made special agreements with the Corporation both with regard to the cost of street lighting and also in regard to the limitation of dividend, so that if the Corporation were attempting what was suggested, they would have a great amount of opposition to meet.

Sir BENJAMIN BROWNE seconded the adoption of the report, which was unanimously carried.

Mr. J. D. Milburn and the Hon. C. A. Parsons, the retiring Directors, were re-elected, and Messrs. Strachan and Co. were reappointed auditors, after which, a vote of thanks to the Chairman concluded the meeting. An extraordinary meeting was then held, when the Articles of Association were so altered as to allow the shares to be quoted in the local lists.

Liverpool Overhead Railway Company.

The ordinary half-yearly meeting of the shareholders of the Liverpool Overhead Railway Company was held at the Law Association Rooms Liverpool, on Tuesday, Sir W. B. Forwood presiding.

The CHAIRMAN, in proposing the adoption of the report, which appeared in our issue of the 2nd inst., said:—From this report you will see that the gross earnings for the six months amounted to £18,518. 4s. 7d., to which must be added £3,293 balance brought forward, making the total available sum £21,811. 11s. 2d. Deducting from this working expenses for the half-year £13,732. 11s. 2d., interest on debentures, and also interest on calls paid in advance, we have left over the sum of £5,452 available for dividend. Out of this your Directors propose, subject to your approval, to pay a dividend at the rate of 5 per cent. on the Preference shares, and at the rate of 1 per cent. on the Ordinary shares, which will leave a balance of £2,598 7s. 1d. to be carried forward to the next half-year. Your Directors are well satisfied under all the circumstances with the result, for during the greater part of the half-year the trade of the port was most depressed, and the dock omnibuses obtained a considerable measure of support. The total number of passengers carried reached 2,475,639, or roundly at the rate of five millions per annum. The dock omnibuses have probably carried at the rate of 2,500,000 per annum, so that we have a total traffic of about 7,500,000 against 2,300,000, the number carried by the dock busses before the railway was opened. Thus during the first year of the railway's existence the dock traffic has increased threefold, which in itself is a most encouraging feature. Every day the regularity and convenience of this Overhead Railway forced itself more and more upon the public attention and public support. You will notice that during the half-year we have run 46,429 trains, and of these 93·35 per cent. have been on time—a record for punctuality, I believe, never before obtained in the railway world. In comparing the details of revenue and expenditure with the particulars for the preceding half-year, it may appear at first sight that we have spent more money during the past half-year. This arises from the fact that during a considerable portion of the first half we only ran a 10 minutes' service, and therefore our locomotive expenses were lighter and we had no charge for general maintenance and depreciation of machinery, which in our second half absorbed £1,730 9s. 10d. Making these corrections the cost of working comes out precisely the same in both half-years. You will, however, notice that it is over 72 per cent. of our receipts, which looks large as compared with the experience on ordinary English railways, but this test is a fallacious one. If our fares were equal to those charged on ordinary English railways our income would be very much larger, and the ratio of expenses greatly reduced. A better test is to compare our cost of working with the South London electrical railway. Our cost works out 1s. ½d. per mile, and the South London 1s. ¾d. per mile. We hope still to make further economies, and I may mention in this connection that we have taken over the generating station, and that our saving during the first month amounted to £150. The extension to Seaforth will be opened in March, and we have contracted for the erection of three new stations, one near the Nelson Dock, one at the foot of Sandhills-road, and the other at the end of Langton-street, leading to the northern dock system. These stations will be a great public convenience, and will, we hope, give considerable traffic. And now, gentlemen, I have told you my story. I do not intend to enter into the realm of prophecy, for we have a shareholder for whom I have the highest possible respect, who not only treasures up all your chairman's prophetic utterances, but has an inconvenient habit of asking him to live up to them. A chairman of an omnibus railway has many difficult things to encounter, but still, gentlemen, I have never wavered in my opinion that we have a good property. Mechanically it has been a great success, and financially it will also be a success. All we want is a little patience and more faith in our undertaking. It is one of which we may all feel proud, and which is to-day doing a great work in facilitating the trade of the port.

Mr. R. HOBSON, in seconding, expressed his sanguine feelings in regard to the future of the railway. He felt very strongly that it would be a success, but they must give them a little time.

The CHAIRMAN having replied to questions put by shareholders respecting station accommodation, the report was then adopted.

The CHAIRMAN then proposed the payment of dividends at the rate of 5 per cent. per annum on Preference shares, and 1 per cent. per annum on Ordinary shares, less income tax, and that the balance on the net revenue account be carried forward. He hoped that this resolution was the forerunner of many of a still more gratifying character.

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Mr. G. H. ROBERTSON seconded the motion, which was carried.

The re-election of Mr. James Barrow and Mr. Richard Hobson, the retiring Directors, and of Mr. George Nicholson, the auditor, having been carried,

A vote of thanks was accorded the Chairman, and the proceedings terminated.

Cuba Submarine Telegraph Company (Limited).

The forty-fifth ordinary general meeting of the Cuba Submarine Telegraph Company (Limited) was held at the Company's Offices, No. 58, Old Broad-street, on Wednesday last, Mr. Thomas Greenwood presiding.

The SECRETARY (Mr. James Scott) read the notice convening the meeting, and the report of the Directors and statement of accounts were taken as read.

The CHAIRMAN said: Gentlemen, the Directors are pleased to meet you to-day, and to be able to present so satisfactory a report for your consideration. The depression in trade, which has so materially affected a large number of our industrial undertakings, has had some little influence on the receipts of our Company. In comparing the traffic receipts for the past half-year with those of the corresponding half of 1892, there appears to be a reduction £1,122, which has arisen entirely from the exigencies of the trade, not in any sense from a reduction of rates, which has not yet been made. The interest on our investments is rather larger, for during the time that the Australian banks were rearranging their affairs we were without the interest on the money deposited with them, and during the past half-year we have received some arrears which have brought down the sum of increase by £335, so that our net receipts for the half-year were only £787 less than those in the corresponding period of the previous year. Turning to the other side of the account, the London office charges are a little less this year, because there were travelling expenses to Madrid in the corresponding period of the previous year, which were not incurred last half-year. Our outlay at stations has been slightly increased, and I suppose this is likely to continue to do so, because there is always a gradually-improving scale of remuneration paid to the officers and clerks of the Company in consideration of their long and faithful service. Almost all our agreements with our staff have been made on the principle of being increased in ratio to the length of time they are in the employment of the Company. We have also a larger increase in the charge for depreciation on stores and cable in stock. Altogether we have a difference of £470 of expenditure in comparing this half-year with the corresponding half of the preceding twelve months. But this half-year we have had no cable repairs, the consequence being that we have been able to reserve £1,500 against any loss from the deposits with banks and to carry £5,000 to the reserve fund, bringing it up to the large sum of £105,000. I am not quite sure that that policy would have been pursued by the Board but for the fact that we shall find it necessary soon to lay another cable. As intimated to you in the report, the cable which was laid in 1870 between Batabano and Cienfuegos has given out, although we have been using it almost up to the present time, but it has shown lately some indications of further depreciations, and although it has not ceased to speak altogether, its efficiency has been so much reduced that it will probably soon refuse to speak at all. It may recover itself, as it has done before, and in that case we shall continue to use it as long as we can, but it is hardly safe to trust to it, and consequently, we think, that it is desirable to lay another cable between these two points. Under these circumstances the reserve is highly necessary and proper. Perhaps the shareholders would like to know what the ages of our cables really are, since nothing has been said upon the subject in our printed reports. Our cables extend from a distance of about 600 miles in round figures. The portion between Santiago and Cienfuegos represents about 400 miles, and the section between Cienfuegos and Batabano represents about 200 miles. In 1870 cables were laid over both sections, but the section of 400 miles was abandoned in 1881, and the section of 200 miles is the one to which I have referred as being defective in insulation, and will probably have to be abandoned. We have, over the 400 miles, two working cables, one having been laid in 1875 and the other in 1881. We have also, one good working cable laid three years ago over the 200 miles section, and it is over it that we shall soon have to lay another. These are the whole of the items worthy of being brought under your notice, and I will therefore move the first resolution:—

"That the report and accounts for the half-year ended December 31st last, now submitted be received and adopted."

Mr. CHARLES W. PARISH seconded the resolution.

Mr. M. CURRY asked what would be the cost of laying the new cable?

The CHAIRMAN replied that it would be impossible to give the exact figure until the contract was absolutely made. But on referring to the past accounts it would be found that they had laid a cable over the same distance for about £25,000.

The resolution was carried unanimously.

The CHAIRMAN next moved—

"That the following dividends for the half-year be now declared upon the shares of the Company, viz., at the rate of 10 per cent. per annum, subject to income tax, on the Preference shares, and 8 per cent. per annum, free of income tax, on the Ordinary shares, payable on and after to-morrow."

Mr. GEORGE KEITH seconded the resolution, which was agreed to *nem. con.*

The Rev. J. W. BROWN then proposed a vote of thanks to the Chairman and Directors, which was seconded by Mr. S. T. WENTWORTH, and cordially passed.

The CHAIRMAN expressed his acknowledgment, remarking that it would be no fault of the Board if the dividend in the future were not as good as it has been in the past.

The proceedings then ended.

Oriental Telephone and Electric Company (Limited).

The Directors of this Company give notice that an extraordinary general meeting is to be held on Wednesday next, the 21st inst., at the Cannon-street Hotel, E.C., at one o'clock, for the purpose of considering and passing the following resolutions. The Directors point out that it has been their desire for some time past to effect the amalgamation of the two classes of the shares in the Company, so that only one class might exist, and that to be dividend-bearing and free from liability. Since the recent decision in the House of Lords, which was adverse to the interests of holders of Vendors' shares, negotiations have again been opened with the largest holders of these shares in the Company, resulting in a Committee of the Board of Directors meeting these shareholders, and, after protracted sittings, agreeing to the resolutions, which will be submitted to the meeting. Under the new arrangements the Company undertakes to pay all costs of the recent litigation. Arrears due on the Ordinary shares of the Company are to be cancelled, and the Ordinary shareholders will be relieved from all liability as to calls, and the Vendors' shares will come in for immediate dividend, there being only one class of shares of £1 each fully-paid. Ordinary shareholders are to receive one fully-paid share for every two shares held of 11s. paid, and the holders of fully-paid shares will receive 18 for every 20 now held, and the holders of Vendors' shares 15½ for every 20 shares now held.

1. That for the purposes of the reconstruction, hereinafter mentioned this Company be wound up voluntarily, and that Henry Grewing, Esq., and George Bland Frost, Esq., be and they are hereby appointed liquidators for the purposes of such winding up.

2. That, pursuant to Section 161 of the Companies Act, 1862, the liquidators be and they are hereby authorised and directed to transfer to a new Company all and singular the undertaking, property, assets, and effects of this Company, not including uncalled capitall, upon the following terms, with such modifications and additions, if any, as the liquidators may consider expedient:—

(*a*) The new Company shall be incorporated under the Companies Acts, 1862 to 1890, with the name of the Oriental Telephone and Electric Company (Limited), and with a nominal capital of £200,000, divided into 200,000 shares of £1 each.

(*b*) The Memorandum and Articles of Association of the new Company shall contain the same provisions as the Memorandum and Articles of Association of the old Company, subject to such modifications as may be desirable to give effect to the scheme of arrangement the subject of these resolutions.

(*c*) The consideration for the said transfer may be satisfied by the allotment to the liquidators, or as they may direct, of 171,497 fully-paid shares of the new Company.

(*d*) The new Company shall take over and discharge all the debts and liabilities of this Company, and perform all contracts and engagements now binding on it, and shall indemnify this Company and the liquidators against the same.

(*e*) The new Company shall pay (*a*) all the costs of the plaintiffs and defendants of the action Ness *v.* Addison (1891, N. 515), and of the appeals to the Court of Appeal and House of Lords so far as they have not already been paid by this Company; (*b*) the costs of all parties of and incidental to the subsequent negotiations relating to this scheme; and (*c*) the costs of and incidental to the winding up of this Company, and the carrying the said scheme into effect. All such costs to be paid as between solicitor and client.

3. That the liquidators be and they are hereby authorised to enter into such agreements with the new Company or a trustee for the new Company for the purpose of carrying the scheme into effect as they may consider expedient.

4. That the said 171,497 fully-paid shares in the new Company be distributed among the members of this Company as follows, that is to say:—

(*a*) That 58,125 of the said fully-paid shares of the new Company be distributed among the holders of the 75,000 Vendors' shares in this Company, numbered 1 to 75,000, rateably in proportion to the Vendors' shares held by them respectively, being in the proportion of 15½ shares in the new Company for every 20 Vendors' shares in this Company.

(*b*) That 3,372 of the said fully-paid shares of the new Company be given to the holder of the 3,746 fully-paid shares issued by this Company other than those numbered 1 to 75,000.

(*c*) That the remaining 110,000 fully-paid shares of the new Company be distributed among the holders of the 220,000 hsares of this Company upon which 11s. have been called up rateably in proportion to the number of such shares held by them respectively, being in the proportion of one fully-paid share in the new Company for every two shares in this Company upon which 11s. per share have been paid.

(*d*) As regards fractional parts of shares the liquidators may sell any shares which cannot conveniently be divided and divide the proceeds among the persons entitled thereto, and generally may make such arrangements in relation thereto, as they consider expedient.

Should the above resolutions be passed by the necessary majority, they will be submitted for confirmation to a subsequent meeting, of which notice will be given in due course.

Chelsea Electricity Supply Company, Limited.

The following report, for the year ended December 31st last, is issued by the Directors of this company, and will be presented to the shareholders at the meeting to be held at the Central Station, Draycott Place, Chelsea, S.W., on Tuesday next, at 12 o'clock:—

The net profits of the year on the ordinary business of the Company, after payment of interest on debentures, amount to £4,004. 4s. 6d. This sum, together with the balance from the sale of the South Kensington district,

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gives a net balance of £6,605. 2s. 7d. To meet the wishes of the Board of Trade, the sum of £4,674. 3s. has been deducted from the item of "preliminary expenses" in capital account, and transferred to a suspense account, which account it has been decided to reduce by writing off £2,500. A further sum of £1,000 has been placed to renewals and depreciation fund account, leaving a balance of £3,105. 2s. 7d. available for distribution. The Directors recommend the payment of a dividend on the Ordinary shares of five per cent. for the year, and that the balance of £619. 4s. 3d. be carried forward to next account.

In the month of May last, the purchase of the works, machinery and mains of the Cadogan Electric Light Company was concluded. The generating station, situated in Manor-street, Cheyne-walk, is of sufficient dimensions to contain plant to meet a large increase in the demand. Extensive improvements and additions are in progress at this station.

During the year about 20,000 yards of new conductors have been laid. The increase in the number of lamps connected to the service during the year is 10,665; and, deducting the number of lamps transferred with the South Kensington district, the total number on the Company's mains on December 31, 1893, was 40,665.

The transfer of the South Kensington District, authorised at the extraordinary general meetings held last year, was completed in June.

The satisfactory reduction made in the last few years in the working cost is shown in the following statement of the cost per Board of Trade unit sold:—

Year.	Coal.	Stores and water.	Wages.	Maintenance.	Rent, rates and taxes.	Management.	Renewals and depreciation fund.	Total.	Capital expenditure.	Board of Trade units sold.
	d.	d.	d.	d.	d.	d.	d.	d.	£	
1891......	2·22	0·74	1·11	0·93	0·21	1·56	—	6·77	74,721	290,458
1892......	1·63	0·59	0·95	0·71	0·21	1·26	0·67	6·02	81,364	357,162
1893......	1·11	0·35	0·80	0·53	0·48	1·17	0·59	5·03	99,483	402,848

The retiring Directors are Mr. J. Irving Courtenay and Mr. Nugent Daniell, who, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Brothers and Co., also offer themselves for re-election.

Westminster Electric Supply Corporation (Limited).

The following is the Directors' report to be presented to the meeting to be held at the offices, Eccleston-place, Eccleston-street, Belgravia, London, S.W., on Wednesday, the 21st inst., at 11 a.m.:—

The Board of Directors, in presenting their report and the accounts for the year 1893, are pleased to state that the business of the Corporation continues to make steady and satisfactory progress.

The Directors have again thought it desirable to reduce the price of current, from 7d. to 6d. per unit, and this change came into effect on April 1st last.

The supply of current which on December 31, 1892, was being provided for an equivalent of 98,686 lamps of 8 c.p., had increased by December 31, 1893, to the equivalent of 131,565, and at the present time there are on circuit the equivalent of 134,268 lamps of 8 c.p., and applications have been received for a further 9,451.

The length of roadway along which mains have been laid now exceeds 35 miles, making about 140 miles of ways, into which upwards of 106 miles of copper (strip and cable) have been drawn.

The plant and machinery have been working satisfactorily throughout the year, and have been fully maintained from revenue. In the manufacture and distribution of electricity, and in the general expenses, a considerable reduction has been effected in the cost per unit.

Since the last meeting, owing to the rapid increase in the Corporation's business, the Directors found it necessary to issue the balance of £30,000 Four and a-Half per Cent. Mortgage Debentures. The issue having been largely over-subscribed by the shareholders, the Directors regretted they were unable to allot in full.

The net revenue of the year amounts to £12,830, out of which £4,370 in payment of an interim dividend at the rate of 3 per cent. per annum for the half-year ending June 30, 1893, has already been distributed. The accounts now show a balance of £8,460 to the credit of net revenue, from which the Board recommend the payment of a dividend at the rate of 5 per cent. per annum for the half-year ending December 31st last, carrying forward a sum of £1,190.

In accordance with the Articles of Association two of the Directors, Lord Suffield and Mr. Hayes Fisher retire, but, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Brothers, also retire.

City of London Electric Lighting Company (Limited).

The following report of the Directors of this Company is to be presented to the shareholders at the ordinary general meeting to be held at Winchester House, E.C., on Thursday, the 22nd inst., at 2:30 p.m.:—

Capital.—The expenditure on capital account during the year ended December 31, 1893, amounted to £260,757. 18s. 1d. Details of this further outlay are given in the Capital Account No. III., the whole of which is rapidly becoming revenue-earning. During the year the remainder of the Preference shares have been issued, and all are now fully paid up. An official quotation for the second issue of £200,000 has been applied for and will no doubt be shortly granted. In order to provide for the additional expenditure which will be necessary to complete the undertaking, the Directors propose to issue debenture stock from time to time, as required. A first issue to the extent of £100,000 will be made immediately, and applications received from holders of the Ordinary and Preference shares of the Company will be preferentially considered.

Revenue.—The gross revenue for the year was		£38,556 10 3
From which must be deducted the following items charged against revenue:—		
Expenses of generation and distribution...	£18,374 14 8	
Repairs and maintenance of plant, machinery, mains, lamp-posts, &c.	2,285 18 4	
	20,660 13 0	
Rents, rates, taxes, and general charges were	2,431 0 8	
		23,091 13 8
Leaving a net revenue of.......................		£15,464 16 7
To which must be added other receipts		1,475 18 3
" " " balance brought forward from 1892		434 6 7
Making a total of		£17,375 1 5

Of this sum £5,333. 6s. 8d. was distributed in July last in payment of an interim dividend on the first issue of £200,000 Preference shares at the rate of 6 per cent. per annum for the half-year ended June 30, 1893, and the Directors recommend a further dividend of 6s. per share on the first issue of £200,000 and of 3s. per share on the second issue of £200,000 Preference shares, both payments being at the rate of 6 per cent. per annum for the half-year ended December 31, 1893. This will absorb £9,000, leaving a balance of £3,041. 14s. 9d., which the Directors propose to carry forward to next account.

After careful consideration the Directors have decided to establish two depreciation reserve funds, the first (Nos. 1 and 1A in the accounts) for the plant and running machinery, engines, boilers, dynamos, &c., and the second (No. 2 in the accounts) for the mains, meters, transformers, and other items from Nos. 2 to 10 in the capital account. For this purpose, out of the premium of £40,000 received from the second issue of Preference shares, £30,000 has been set aside for the first fund, and £9,152. 19s. 3d. for the second.

Owing to the delay on the part of the Local Authority in giving its consent, as required by the Telegraph Act, 1892, to the use of certain tubes for telephonic purposes, the further steps necessary could not be proceeded with, and therefore it has not been possible to include in the accounts the sums payable by the New Telephone Company (Limited) under the agreement. Negotiations are, however, still proceeding, and it is hoped that the consent of the Local Authority will shortly be given.

The working expenses for the year, including repairs and renewals, were 54·2 per cent of the earnings. In view of the exceptionally fine and bright weather, which adversely affected the receipts, and the prolonged coal strike, which seriously increased the expenses, the Directors consider this result satisfactory.

The revenue shows a steady increase, the estimated rate at which it is now being earned being £64,000 per annum gross. This, it is hoped, will be largely increased as soon as the remaining transformer stations are at work.

The Directors were successful in obtaining an Act of Parliament amalgamating the three City districts into one for the purposes of the accounts, and for defining in a clearer manner certain other matters in connection with the Company's Provisional Orders.

Lands and Buildings.—The greater portion of the main buildings is now practically finished, and the remainder is expected to be completed in March next. The pumping station, switch-rooms, and engineers' offices are also in a forward state. Twenty-two transformer stations have been constructed, of which eight are in operation, and every effort is being made to have all the others ready for work during the current half-year. These twenty-two stations when fully equipped will be equal to supplying at least 400,000 8-c.p. lamps installed.

Generating Plant.—The plant already in position is of a capacity of 100,000 8-c.p. lamps, and further machinery is in course of construction by the contractors. The arc-lighting plant has worked satisfactorily throughout the year. The total number of units sold was 1,741,099.

Street Work.—This work is now approaching completion. On February 1, 1894, 580 miles of "ways" had been laid in the City in 55½ miles of streets, into which 105 miles of cables have been drawn. Sufficient "ways" have been laid down to supply a demand of 400,000 8-c.p. lamps installed. Conduits have been laid in all the compulsory streets in the Southwark district.

Private Lighting.—Nearly 1,300 private consumers, representing a total of 72,000 8-c.p. lamps, are being supplied with current from eight transformer stations, and during the current half-year it is expected that the whole twenty-two stations required for the entire City will be at work. Applications continue to come in satisfactorily, the total received to date being equal to the supply of current for 100,000 8-c.p. lamps.

Public Lighting.—The lighting of the main thoroughfares of the City with arc lamps was virtually completed early last year, only a few lamps, for which positions have not been assigned, remaining to be fixed, but the Commissioners of Sewers have not yet given the order for the lighting of the lesser streets with glowlamps. The Company is prepared to carry out the lighting of these streets immediately upon receipt of the order to proceed, the necessary plant for this purpose being already in position. Two of the Directors, Sir David L. Salomons, Bart., and the Hon. Alan Charteris retire, and Sir David L. Salomons, being eligible, offers himself for re-election, but Mr. Charteris, owing to continued ill-health, resigns his seat. The Directors do not recommend that any steps be taken at present to fill the vacancy thus created. Messrs. W. H. Pannell and Co. (the auditors) retire, and, being eligible, offer themselves for re-election

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Charing Cross and Strand Electricity Supply Corporation (Limited).

The following is the report of the Directors, to be presented at the annual ordinary general meeting to be held at the Town Hall, St. Martin's-in-the-Fields, Charing Cross, W.C., on Tuesday next, the 20th inst., at 2 p.m. :—

The Directors have to announce to the shareholders with very great regret the death of their Chairman, the late Mr. Spencer Chadwick. Mr. George H. Brougham Glasier, the Deputy Chairman, has been chosen to fill the office of Chairman, and Mr. Richard Chadwick (brother of the late Mr. Spencer Chadwick) has been elected a Director until the Ordinary General Meeting.

The Corporation was on December 31, 1893, supplying energy to 34,570 eight candle-power lamps, an increase of 17½ per cent. on the number supplied at the end of the year 1892.

With the mains added during the past year there are now upwards of 19¼ miles laid.

Two actions were brought against the Corporation for injunctions and damages, both of which resulted in judgments in favour of the Corporation on all points with costs.

The Directors have given special attention to the question of maintenance, renewals and repairs, and have expended a considerable sum in keeping the station in all respects in a very high state of efficiency ; they have also written £200 off preliminary expenses, made provision for bad debts ; carried £700 to depreciation account, £200 to reserve fund, and carried forward £43. 0s. 1d.

The net earnings during the past year have amounted to £8,654. 8s. 4d.; £2,675. 8s. 5d. has been paid in respect of interest on debentures up to December 31, 1893, and £3,648. 7s. 11d. was distributed in payment of an interim dividend for the half-year ended June 30, 1893. A sum of £2,955 10s. 1d. now remains, which the Directors propose to deal with as follows : To payment of a dividend of 4½ per cent. for the year 1893 (less tax), £6,560. 17s. 11d. ; interim dividend paid August, 1893, £3,648. 7s. 11d.—£2,912. 10s. ; carried forward £43. 0s. 1d.—£2,955. 10s. 1d.

Mr. Agostino Gatti and Mr. Stefano Gatti, the Managing Directors, are the Directors who retire by rotation, and being eligible, offer themselves for re-election. Mr. Richard Chadwick being eligible also offers himself for re-election as a Director. The auditors, Messrs. O. R. Johnson and Son, also retire and offer themselves for re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

BRISTOL PHOENIX ENGINEERING AND FOUNDRY COMPANY (LIMITED). This Company has been registered, with a capital of £5,000, in 2,000 £7 per cent. cumulative Preference and 3,000 Ordinary shares of £1 each, to carry on business as mechanical engineers, boiler and tank makers and repairers, iron and brass founders, &c.

JAMES EDWIN ROSS (LIMITED).—This Company has been registered, with a capital of £1,000, in £1 shares, to carry on business as Engineers, manufacturers of patent fuel economisers, iron and brass founders, machinists, &c.

YORKSHIRE STEAM VALVE COMPANY.—Registered as an unlimited Company, with £40,000 capital, issued as paid up, to carry on business as manufacturers of and dealers in valves for steam, hydraulic, gas, and other purposes, mechanical engineers, machine and engineering tool makers, and manufacturers of boilers and boiler mountings, engine fittings and valves, &c.

GENERAL ELECTROLYTIC PARENT COMPANY (LIMITED).—The statutory return of this Company, made up to November 28th, has been filed. Out of a nominal capital of £24,000, in £1 shares, 22,507 have been taken up, and 18,000 issued as fully-paid. Upon the remaining 4,507 shares a call of 13s. 4d. per share has been made, resulting in the payment of £1,500, and leaving £1,504. 13s. 4d. in arrears.

LEEDS AND LONDON ELECTRICAL ENGINEERING COMPANY (LIMITED). The annual return of this Company, made up to November 27th, was recently filed. The capital is £100,000, divided into 250 Founders', 9,750 Preference, and 10,000 Ordinary shares of £5 each. 250 Founders', 734 Preference, and 5 Ordinary have been taken up, and the full amount called on the Founders', 634 Preference, and the 5 Ordinary shares, while a call of £1 per share has been made upon the 100 other Preference Shares. The calls paid amount to £4,545.

LITHANODE AND GENERAL ELECTRIC COMPANY (LIMITED).—The first annual return of this Company, made up to January 3rd, was recently filed. Out of a nominal capital of £100,000, in £1 shares, 20,642 have been taken up, and 17,720 of these have been issued, with 16s. per share considered as paid. Upon these shares a call of 4s. per share has been made, and the full amount has been called on the remaining 3,917 shares. The calls paid amount to £6,286. 17s., leaving £175. 3s. in arrears.

MORECAMBE ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return of this Company, made up to December 6th, has been filed. The nominal capital is £15,000, divided into 14,950 Ordinary and 50 Founders' shares of £1 each. All the Founders' and 5,855 Ordinary shares have been taken up, and 851 Ordinary issued as fully paid. The full amount has been called and paid on the Founders' and the remaining 5,004 Ordinary shares, resulting in the payment of £4,766. 15s. (which includes a sum of £11. 15s. paid on two Founders' and 116 Ordinary shares which have been forfeited), leaving £299 in arrears.

MULHOLLAND, MAUGHAM AND COMPANY (LIMITED).—The annual return of this Company, made up to December 28th, was recently filed. The nominal capital is £5,000, divided into 120 Founders' and 380 Ordinary shares of £10 each. All the Founders' and 177 Ordinary have been taken and the full amount called on the former, while a call of £5 per share has been made on the latter, resulting in a total payment of £2,085.

NORTH-EASTERN TELEPHONE COMPANY (LIMITED).—The statutory return of this Company, made up to November 13th, has been filed. The nominal capital is £1,000, divided into 500 Preference and 500 Ordinary shares of £1 each. 15 Preference and 452 Ordinary shares have been taken up, and the latter issued with 14s. per share considered as paid. Upon the Preference shares a call of 5s. per share has been made, and upon 28 Ordinary shares, 6s. per share has been called. The calls paid amount to £12. 3s.

PACIFIC AND EUROPEAN TELEGRAPH COMPANY (LIMITED).—When the annual return of this Company was filed on December 30th, the whole nominal capital of £100,000, in £10 shares, had been taken up and paid in full.

CITY NOTES, &c.

BABCOCK AND WILCOX (LIMITED).—The Directors have declared an interim dividend for the six months ended December 31st, at the rate of 6 per cent. per annum on the Preference, and 10 per cent. per annum on the Ordinary shares, payable on February 16th.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY (LIMITED).—As announced in our last issue, it is the intention of this Company to invite fresh capital, to enable it to carry out the extension of its tramway system to Kingswood, the extension to be worked by electricity. At the meeting of shareholders held at Bristol last week the proposal was carried unanimously.

BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED).—Notice is given that the transfer books will be closed, both for Debenture stock and Preference and Ordinary shares, from February 20th to March 5th inclusive.

CENTRAL LONDON RAILWAY.—A special general meeting of the above Company was held on Friday at the offices, 30, St. Swithin's-lane, for the purpose of submitting to the proprietors a proposed Bill, entitled "A Bill to extend the time for the purchase of lands and for the completion of the Central London Railway and for other purposes." Mr. F. A. Lucas presided, and said that the meeting was purely a formal one for the purpose of submitting a Bill to the proprietors for the extension of the time for the purchase of lands and for other purposes. He concluded by moving the resolution as above. Mr. W. Morris (the solicitor) said that by the first Act of 1891 the construction of the railway was authorised from Shepherd's Bush to Cornhill, with a terminal station at Cornhill. By the second Act, 1892, the terminal station in Cornhill was abandoned, and the construction of a central station appointed in the space opposite the Royal Exchange and the Mansion House, while the extension of the line to Liverpool-street was authorised, and powers given to construct a terminal station under the existing Great Eastern station at Liverpool-street. In consequence of having two Acts, the times for acquiring the lands and completing the works expired at different periods, which was found to be a great inconvenience, because the whole line from Liverpool-street to Shepherd's Bush was now one complete line, and not two sections. There yet remained a considerable time for the acquiring of the lands and the completion of the works, but as a measure of precaution, and, as a matter of convenience, it had been thought desirable to apply to Parliament to extend the respective times, and make the time for the acquiring of the lands and the time for the completion of the works apply to both sections of the undertaking. According to the Bill now under consideration, it was proposed that the time for the purchase of land in respect to the whole undertaking should be extended until 1897, and for the completion of the whole works until 1900. In consequence of a paragraph which had appeared in one of the newspapers a little while ago, he wished to state that there was nothing whatever in the Bill to alter the mode of traction intended to be adopted on the railway. The only traction power alluded to was electricity, and it was intended to adhere to that. The resolution was seconded by Mr. H. Smith, and carried.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended February 11th, were £937, as against £952 for the corresponding period of last year, being a decrease of £15. The total receipts for the half-year amount to £5,727, as against £5,862 for the corresponding period of 1893, a decrease of £135.

GAS LIGHT AND COKE COMPANY.—At the 164th half-yearly meeting of this Company, held on Friday last week, Col. W. T. Makins, who presided, pointed out that they had suffered from a considerable diminution in their receipts, owing to the reduced quantity of gas consumed, and that many would, no doubt, assume that the spread of the electric light had brought about this decreased consumption. He, however, thought otherwise, as, in the district south of the Thames served by the Company, where there was little or no electric light, the reduced consumption had been at the same ratio as on other parts of the Company's system, and that this would indicate that, as a competitor, the electric light was not likely to do them serious harm.

GREAT NORTHERN TELEGRAPH COMPANY.—The coupons falling due on March 1, 1894, on the Debentures of 1883 (Series B) should be presented for payment between the hours of 11 and 2, at the office of Messrs. C. J. Hambro and Son, 70, Old Broad-street, where lists may be obtained. Coupons must be left three clear days for examination.

HOBART ELECTRIC TRAMWAY COMPANY (LIMITED).—Traffic receipts for the month of December, £1,488 ; January receipts, £1,682.

NORTH STAFFORDSHIRE RAILWAY.—At the meeting of the Company held in London last week, Mr. T. Salt, the Chairman, stated that by the

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introduction of the electric light at Stoke station they would be enabled to carry on their work of loading and unloading at night, which would prove a good advantage in the carrying on of the Company's work. The work had been carried out by their own staff, and was giving every satisfaction.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the week ending February 9th (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,007.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price, Feb. 7.		Price Wednesday, Feb. 14.		Rate per Cent. Yielded (£ s. d.)	Dividend Due	Business Done During Week Ending Feb. 14: Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	13/6	Anglo-American	42	44	43	45	5 13 4	Jan., Apr., July, Oct.	43¾	..
£2,932,680	Stock	27/0	Do. Preferred	79½	80½	80½	81½	6 2 9	" "	81¼	80
£2,932,680	Stock	5/0	Do. Deferred	7¼	7¾	7½	7¾	..	..	7⅝	..
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	100	103	100	103	3 17 8	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	11½	12	11½	12	5 10 8	Mar., June, Oct., Dec.	11 11/16	–
£18,700	£100	5%	Do. 5 per Cent. Bonds	99	102	99	102	4 18 0	January and July	..	–
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	..	–
10,000,000	$100	7%	Commercial Cable Capital Stock	135	145	135	145	4 16 7	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	11½	12½	12	13	6 3 1	February and August	–	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2	3	5 6 8	April and October	2½	2½
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	..	..
60,710	20	3/0	Direct United States Cable, 1877	10	10¼	10¼	10⅝	6 2 8	Jan., Apr., July, Oct.	10⅝	10¼
400,000	10	2/6	Eastern	14⅞	15⅛	14⅞	15⅛	4 5 11	" "	15⅛	14⅞
70,000	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16¼	3 13 10	" "	16⅛	15⅞
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	115½	..
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	106	109	106	109	4 11 9	February & August	..	..
250,000	10	2/6	Eastern Extension	15½	15¾	15½	15¾	4 8 11	Jan., Apr., July, Oct.	15⅝	15⅝
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113	116	114	117	3 8 5	February & August	115½	115
£62,700	100	5%	Do. 5 p. c.(Austln. Gov. Sub.) Debs 1900	101	104	102	105	4 15 2	January and July	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	101	104	102	105	4 15 2	" "	102¾	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	102	105	102	105	3 16 2	February & August	104½	103
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	106%	109%	106%	109%	3 13 5	May and November	..	..
180,227	10	1/3	Globe Telegraph and Trust	8⅜	8⅝	8½	8¾	5 2 10	Jan., Apr., July, Oct.	8 11/16	8½
180,042	10	6%	Do. 6 per Cent. Preference	15½	15⅞	15½	15⅞	3 18 [illegible]	" "	15⅝	15½
150,000	10	5/0	Great Northern	21½	21¾	21¾	22¼	3 16 7	Jan., April, and July	22	21¾
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	..	..
17,000	25	12/6	Indo-European	41	44	42	45	5 11 1	May and November	43	42
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	3 6 8	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	106	109	107	110	5 9 1	March & September	..	..
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red 1942	101	104	102	105	3 16 2	..	103½	102½
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	..	..
3,881	£100 Cert.	25/0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	" "	..	..
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July	..	..
£249,900	100	5%	Do. 5 per Cent. Debentures	100	103	100	103	4 17 1	March & September	101½	101
30,000	10	2/0	West Coast of America	2	2½	2	2½	..	January and July	..	..
£150,000	100	8%	Do 8 per Cent. Debentures, 1902	97	101	97	101	7 18 5	June and December	..	..
88,321	10	1/0	West India and Panama	1	1¼	1	1¼	..	..	1 3/16	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	9½	10	9½	10	6 0 0	May and November	10	9¾
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 7	June and December	..	..
64,242	15	4/6	Western and Brazilian	6½	7	6½	7	..	May and November	6 11/16	6¾
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5½	6	5½	6	..	..	–	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¾	2¼	1¾	2¼	..	..	2	1⅞
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	102	105	103	106	5 13 2	February & August	..	–
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	102	105	103	106	5 13 2	" "	–	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	105	102	105	5 14 3	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	–	–	–
224,850	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
220,000	£1	4·76d.	Oriental Telephone and Electric (11s. paid)	¼	⅜	¼	⅜	5 6 5	Yearly	..	..
484,597	5	2/6	National	4¾	5	4⅝	4⅞	5 2 7	June and December	4⅞	4 11/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½	15½	14½	15½	3 17 5	" "	..	..
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	14	15	14	15	4 0 0	" "	14⅝	14 7/16
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¼	5½	5¼	5½	4 10 11	..	5⅜	..
925,017	£100	4½%	Do. Deb. Stk. 4½%	112	114	113	115	3 18 3	January and July	114	112¾
58,000	5	1/0	United River Plate	1½	2	1½	2	–	" "	–	–
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	–	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11	11½	10½	11½	–	..	11⅜	11
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	12¾	13¼	12¾	13¼	..	–	13⅛	12⅞
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	–	–
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	–	–	–
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	–	–
8,322	£5	..	House to House Electric	..		..		–	–	–	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		–	..	–	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	–	–
30,000	£5	1/9	Liverpool Electric Supply (£3 10s. paid)	5¼	5⅝	5¼	5⅝	..	–	–	–
15,000	£5	2/6	Do. (fully paid)	6⅛	6⅝	6⅛	6⅜	..	–	..	–
111,000	5	..	London Electric Supply	¼	¾	¼	¾	–	..	..	..
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	8	8½	8	8½	2 5 7	..	8⅜	8¼
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	104	108	104	108	4 12 7	June and December	..	–
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	–	–	5	–
19,980	£5	4/6	St. James' and Pall Mall	5¾	6¼	6¼	6¾	..	–	6⅜	6 1/16
20,000	£5	7%	Do. 7 per Cent. Preference	7¾	8¼	8	8½	4 2 4	–	8 3/16	8 1/16
59,900	5	1/6	Westminster Electric Supply (fully paid)	5½	6	5½	6	2 18 4	–	5 11/16	5⅝
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	2/1	Brush Electrical Engineering	2⅝	2⅞	2⅝	2⅞	6 5 4	–	2 13/16	2 11/16
90,000	2	6%	Do. 6 per Cent. Preference Non-Cumulative.	2⅛	2⅜	2⅛	2⅜	5 1 1	–	2 3/16	..
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	104	106	104	106	4 4 11	March & September	..	–
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	3	4	3	4	..	January and July	..	–
12,139	5	..	Edison and Swan United	–		–		–	–	–	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	–	–	–
120,000	2	..	Electric Construction	¼	¾	¼	¾	..		..	–
12,845	2	..	Do. 7% Cumulative Pref.	1½	1¾	1½	2	..	..	1¾	⅝
91,195	2	10/0	Elmore's Patent Copper Depositing	⅜	⅝	⅜	⅝	–	–	1 1/16	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	–	..	..
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	23	24	24	25	5 0 0	February & August	24 5/16	23½
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	–	–
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	–	–	–
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	–	..
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/16	5/16	3/16	5/16	..	–	–	–
78,949	5	3/6	Swan United (£3. 10s. paid)	2	2½	2	2½	–	May and November	..	..
37,350	12	12/0	Telegraph Construction and Maintenance	42	44	42	44	4 1 9	March and July	43	41½
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	..		–		..	January and July	..	–
37,514	£5	–	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		–		..	–	–	–
41,098	£5	–	Do. Preference (fully paid)	–		–		–	–	–	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	5%	City and South London Railway xd	28	33	27	32	4 5 11	May and November	30	–
87,500	£10	1%	Liverpool Overhead Railway	4⅝	5⅛	4 13/16	5 1/16	–	–	–	–

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THE ELECTRICIAN:

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NOTES.

After several more or less private meetings, one of which formed the subject of two "Notes" in these columns three weeks ago, the triangular duel between electric traction, telephones, and miscellaneous vested interests, opened on Wednesday last. Some thirty-five members were present, and Sir Courtenay Boyle, assisted by Major Cardew, Sir Thomas Blomefield, and Mr. Hopwood, plunged into the Draft Regulations and the observations made upon them by the different bodies. These observations, printed in a slightly different arrangement, to save space, will be found elsewhere in our present issue. The sitting was adjourned after the much-discussed Regulation 14 had been dealt with. We withhold our report of the proceedings and comments thereon until next week, when we shall be able to deal with the whole of this important conference. Meanwhile, we would remark that, so far, all has gone very well, and the edge of No. 14 was taken off by the voluntary suggestion from the Board of Trade to insert after "shall" the words "take all reasonable precautions to."

Careful inspection of manhole boxes is, at present, the only sure preventive of explosions. The onus of making such inspection, as well as the responsibility for explosions, should they occur, might be thrown on the real culprits, the gas companies, who ought to be thankful for the opportunity thus afforded them for obtaining warning of the escape and waste of their wares. It is the practice of the Notting Hill Company to send a man round to all the manholes on the higher parts of their district, where gas would naturally tend to accumulate, to lift the covers, and to search for gas by smelling. It seems a pity to break the joints of the cover so often, and were it not that these explosions, though apparently alarming, seem to be fraught with but little danger, the safety of the inhabitants might be endangered if the soil were of a deodorizing nature or if the official tester caught a cold. But even this mode of testing is a great advance upon no testing at all, and no accident has occurred in this district.

To give a more sure test, an instrument might easily be constructed to measure the percentage of hydrogen present in the manhole, and this without lifting the cover. Fire-damp and gas indicators have been made by taking advantage of the high rate of diffusion of light gases through porous partitions. A thin tube of unglazed earthenware might be mounted at the end of a staff, and be connected with a gauge, the readings being indicated on a dial by means of an aneroid movement, or by mercury in a thermometer tube. Such an instrument could be graduated to show percentages and the limits of explosive mixtures. If temperature errors were found to be appreciable, two similar tubes should be used, but one rendered non-porous; the tubes should be connected by a glass thermometer tube, and the displacement of a mercury index would measure the amount of hydrogen. A 1in. hole in the manhole cover, closed by a lock-flap or screw-plug, would suffice for the test.

The conclusion to which Mr. Schultz has been led by his researches on iron in armatures, an account of which he published in a recent Paper in the *Elektrotechnische Zeitschrift*, is not likely to be accepted by the general body of electrical engineers and dynamo builders without further confirmation. Briefly stated, this conclusion amounts to a denial of the utility of insulation between the laminæ of armature iron; and it therefore practically asserts that it is futile to laminate this iron. Mr. Schultz constructed four armatures, two with thin plates of 0·5mm. (19·69 mils), and two with plates 1mm. thick (39·37 mils); in one of each pair the plates were insulated from each other with paper, while in the other there was no such insulation; the external dimensions of the armature core were the same in all; these were revolved in a field, being driven by an electric motor; the power required for each could be measured accurately; the results of the tests and calculations are given in detail, allowances being made for the different cross-sections of the iron. Mr. Schultz then applies Steinmetz's formula for the loss of energy in a cubic centimetre of iron per period, and arrives at the two following curious results: (1) that in armatures with paper insulation between the laminæ the loss is not less than, but may be as much as 20 per cent. greater than in armatures without such insulation, and (2) that the thickness of the plate has a very important effect on the magnetic losses, the eddy-current waste of power being five times greater in the case of the thick than in the thin plates.

What, in the light of these two dicta, we are to understand is meant by "the thickness of the plate" it is not easy to surmise. Take a very thick slab of iron, and the eddy currents, we are told, will be enormous. Slice the slab into a great number of thin sheets, and place them side by side under sufficient pressure to ensure that the adjacent laminæ

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are not the least insulated from one another, and we shall find—so we are informed—that the eddy current losses will have wonderfully decreased. Lastly, place an innocent sheet of insulating material between each pair of metal sheets, and, wonderful to relate, the eddy current-losses will be found to have increased as much as 20 per cent. It reads like magic!

From the "advanced" prospectus issued to the "trades interested and users of chemicals," it will be seen that the large-scale experiments which have been going on for some time past at Snodland, Kent, under the auspices of the Electrolytic Caustic Soda and Chlorine Trust, are about to have their natural sequel in the formation of a limited liability company, with a capital of £200,000, divided into 26,000 £5 10 per Cent. Preference shares and 14,000 £5 Ordinary shares. For the patent and all other rights of the Vendor concern £70,000 worth of Ordinary shares, and £30,000 in hard cash or Preference shares is to be given, the "users of chemicals" being invited to take up the remainder of the preferential capital.

The electrolytic method of obtaining caustic soda and bleach from a solution of common salt has undoubted theoretic advantages over the offensive and cumbersome processes at present in vogue, and the vendors have certainly done much to overcome those troublesome little defects which have hitherto barred the way to commercial success. By the use of common gas-retort carbon anodes cast in a lead frame, and costing for renewals but a few shillings per ton of caustic soda turned out, the unattackable and unobtainable anode has been given the go-by. The porous and fragile diaphragm, compounded somewhat after the manner of the Macbethian hell-broth, of parchment, asbestos, and coagulated blood albumen, has been done away with. Finally, the employment of a copper cathode covered with a superficial film of copper oxide has brought down the volts per vat from 6 to 4, the theoretical minimum voltage being 2·02.

On the other hand, the huge profits which are predicted by the experts, even if the estimates of the cost of production upon which they rest are sound, depend firstly on the validity of the patents; secondly, on the surpassing excellence of the process; and, thirdly, on the judicious use of the commercial leverage afforded by the ownership of a superior process protected by valid patents. The validity of the patents, it is stated, has been thoroughly well ascertained, and we have independent reasons for believing them to be good ones; but the protection afforded by the thin armour of a patent, especially where "prodigious profits" are concerned, is about as illusory as it is on board a modern ironclad. But assuming that the Holland and Richardson patents are indefeasible, unless the process is beyond comparison the best that human ingenuity can devise, it may be predicted with certainty that human ingenuity, urged thereto by "enlightened self-interest," will not be long in evolving something similar. Again, assuming both patent and process to be unassailable, "prodigious profits" will not be realised unless the present market price of caustic soda and bleach is maintained. If the Electro-Chemical Company and its licensees take to turning out sufficiently large quantities of these chemicals, prices are bound to come down, but the appetite of the manufacturing community for caustic soda and bleach is almost insatiable. The success of the process owned by the Electro-Chemical Company would, however, give an immense impetus to the electrical industry, and on that account we wish it all good fortune.

It is interesting to note that this electrolytic process has been the cause of three careful estimates of the cost of the electrical horse-power hour when the plant is running continuously the year through. Mr. Swinburne, in his Paper on "Problems of Commercial Electrolysis," which was discussed at the Institution of Electrical Engineers in November, 1892, gave the figure ·1875d. Messrs. Cross and Bevan, in a Paper read about the same time before the London Section of the Society of Chemical Industry, gave ·178d. Dr. John Hopkinson, in a recent report to the Electrolytic Caustic Soda and Chlorine Trust, gives ·2461d. In all three cases much the same sized plant is assumed, and coal, labour, stores, and depreciation are included.

Personal.—Mr. Henry D. Wilkinson, M.I.E E., who has lately returned from Chicago, was married, last Tuesday, to Miss Morgan, of Cape Town, at Christ Church, Crouch End, London.

A Disadvantage of Using Water-Power.—In the early part of the winter the electric lighting station at Toulouse had to stop working for a time on account of a fall in the level of the River Garonne.

Royal Society.—The Bakerian lecture, "On the Relations between the Viscosity (internal friction) of Liquids and their Chemical Nature," by Prof. Thorpe and J. W. Rodger, was delivered yesterday.

The "Drehstrom" at Dresden.—It may interest our readers to know that the "drehstrom" plant for the Dresden Railway station has been built, and is now ready for erection on the site. The generating station has already been constructed.

Scientific Teaching.—Lord Playfair has select d "The Modern Needs of Scientific Teaching" as the title of his address to the students of the London Society for the Extension of University Teaching, at the Mansion House, on Saturday, March 10th.

Edison Lamp Decisions.—We have received from the General Electric Company, of New York, a handy file containing the various legal decisions on the Edison filament lamp patents of the United States, Canada, and Great Britain, together with copies of the injunction orders issued by the United States courts up to the present time.

Telegraphy without Wires.—The Paper on "Electric Signalling without Wires," which was read before the Society of Arts last Wednesday by Mr. W. H. Preece, has attracted considerable attention from the daily Press. Our readers will already have been informed as to our views about the experiments which were described in that lecture, for we have several times commented upon them on previous occasions.

Insulation of House-wiring in the City of London.—The City of London Electric Lighting Company gives notice that it is prepared to enter into agreements with consumers to examine their fittings, &c., at stated intervals on payment of an annual fee of 10s. The men who make the test will hand the consumer a signed report specifying the insulation resistance, with a note on the general condition of the wires and fittings at time of inspection.

Electricity Supply of Berlin. A Correction.—In the abstract on p. 417 of our last issue of the report of the Berliner Elektricitätswerke a serious error crept into the figures relating to capital expenditure on land, mains, and plant; these should respectively be £305,000, £340,000, and £190,000, and not

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as stated. The indebtedness to the Allgemeine Elektricitäts Gesellschaft should have been stated as £358,000, not £35,800. It may be mentioned that the average price obtained in Berlin for the kilowatt-hour is no less than 7·8d.

Cable Interruptions and Repairs:

	Date of Interruption.		Date of Repair.
Constantinople-Odessa.........	Jan. 31st, 1894	...	Feb. 17th, 1894.
Maranham-Ceara	Feb. 12th „	...	Feb. 22nd, 1894.
Cayenne-Paramaribo	Oct. 15th, 1893.	...	—
Bissao-Bolama	Nov. 24th „	...	—
Garachico - Santa Cruz de Palma	Dec. 27th „	...	—
St. Thome-Loanda	Feb. 5th, 1894.	...	—
Malta-Pozzala	Feb. 21st „	...	—

Nottingham.—Prof. W. Robinson has hardly been doing yeoman's service in the cause of electric lighting in this town, by giving a popular lecture at the University College on the subject of the so-called electric explosions and fires. The lecture was suggested, we understand, by recent occurrences in London, Glasgow, and Manchester electric light conduits, as well as by the fact of the forthcoming introduction of the electric light into Nottingham. We hope that the edification and amusement of the Nottingham people will not deter them from adopting the electric light in their homes and streets.

Electrically-Lighted Lifebuoys.—According to *Industries and Iron*, some trials have just been made at Kiel on board the German war vessel "Wörth" with an electrically-lighted lifebuoy, the invention of Capt. Melter. The buoy was thrown overboard when the vessel was proceeding at a speed of about sixteen knots. For a space of about twelve seconds it was lost in the eddy currents caused by the screws of the vessel, but then reappeared. The new lifebuoy will be found useful at night-time, and the experiments resulted so successfully that it is probable that it will be adopted generally in the German navy.

Dangerous Car Speeds.—The limit of speed for electric train cars in the City of Brooklyn, according to *Engineering*, is fixed by the municipal regulations at 10 miles an hour, which is, of course, a substantial increase on our Board of Trade maximum of eight miles per hour. In spite of this, however, it seems that the 10-mile limit has not been at all strictly observed in Brooklyn, the cars running faster in every part of the town save the most crowded streets. Unlike the cable system, in which the maximum speed is fixed by that at which the engines of the central station are run, the electric system leaves the question of speed very much under the control of the motor man on the car, who can vary it within wide limits. In the steam tramcars in this country it was, and is, the practice to fit a governor, which applies the brakes if the speed exceeds the Board of Trade limit. When, however, this governor was driven by a belt, the engineman not unfrequently removed it, and could thus run at almost any speed he liked.

Boiler Incrustation.—In his address before the Railway Association of Berlin, Herr Bork observed that petroleum has been, of late, a good deal used in Germany as a means of removing boiler incrustation. The boiler is first cleaned out with hot water and allowed to dry; and then the deposit is sprayed with petroleum, which it absorbs. The boiler is then filled with water and the work is gone on with in the ordinary way. Before the boiler has been long at work it is found that the scale has chipped and crumbled off, and loosened so much that there is no difficulty at the next cleaning in getting it completely removed. It is as if vapour of petroleum had been formed in the interstices of the scale, and as if this had blown the scale to pieces, by minute expansions here and there. Of course, care must be taken not to bring a lamp flame too near the boiler after spraying the scale with petroleum. There are, however, some particularly hard and compact scales in which the above treatment has no effect; they absorb no petroleum, and they can, accordingly, not be broken up by it.

Wire Thieves.—For some time, says the *Western Electrician*, the Chicago Telephone Company has been troubled by the loss of wire. Frequently as much as six or seven miles had been removed from one place. The operations of the thieves were not confined to overhead wires, but service wires in conduits were also stolen, and it is said that fully forty miles of telephone wire have been lost by the Company in the last three months. A month or so after the telephone Company began to suffer, the South Side electric railways also began to lose wire. Once or twice every week a raid would be made on one of the electric lines, and an aggravating delay would follow until the break could be repaired. The loss of the companies soon ran into hundreds of dollars on traffic alone. One fine Sunday afternoon two young men were seen winding up half-a-mile of wire on Lake-street. They were arrested, and it is thought that the leaders of a gang engaged in this work have been secured. Other arrests have been made, and it is to be hoped that the telephone and railway companies will now be allowed to give uninterrupted service.

Electrical Communication with Lighthouses.—In the estimates recently submitted to Congress there is an item of $50,000 for establishing electrical communication between lightships and the shore. A note accompanying the estimates states:—"The House of Representatives Committee on International and Foreign Commerce on 6th December, 1892, asked the views of the Treasury Department as to the Bill appropriating $50,000 to provide communication from light ships and outlying lighthouses to the shore. Favourable reply was made on December 8, 1892. Since then the Lighthouse Board has experimented, and is now satisfied that it can establish electrical communication between lightships and the shore. It is proposed to commence with an important lightship quite near shore, then take a more important one more distant, and then, if need be, another still further away, and thus acquire by successive effort the experience needed to successfully lay an electric cable to connect with the shore the most distant and important lightship, that on the New South Shoals, some thirty miles off Nantucket, Mass."

Bi-Metallic Telephone Conductors.—Concerning bi-metallic telephone wires, says Mr. A. E. Kennelly, in the *Electrical Engineer* of New York, it appears that any proposition which asserts that a combination of two metals in a conductor is superior for telephonic purposes to a similar conductor of either metal alone, seems to be entirely new, deserves to be considered with circumspection, and lays the burden of proof entirely upon experimental evidence. In the case of iron, however, it is orthodox to suppose that the inductance possessed by an iron wire is advantageous in long distance telephony within reasonable limits if the resistance of the conductor were at the same time capable of being sufficiently reduced. Also that when a definite adjustment between inductance, resistance, and capacity of the conductor has been attained, it is consistent with present recognised views to suppose that a comparatively low insulation can be permitted. In this connection lies the possibility for a superiority of a compound iron-copper wire over one wholly of copper or of iron, but even then the advantage, if due to these reasons, should attend definite relations of composition and disposition in the wires and not iron-copper wires indiscriminately.

The Pacific Cable.—Under date February 18th, the Ottawa correspondent of *The Times* states that it has been definitely decided that the Intercolonial Conference to consider matters relating to the Australian trade and to the proposed Pacific cable shall meet at Ottawa on Thursday, June 21st. The Imperial Government, all the Australasian colonies, and Fiji will be invited to send representatives; and it is probable that Hawaii will also be asked to take part. The Canadian Government, it is stated, are not wedded to any particular route for the cable. They only stipulate that it shall begin and end on British territory, and that it shall be under British control. At a meeting of the London Chamber of Commerce last week, a Paper, entitled "Reciprocal Trade with Australia," was read by the Hon. Robert Reid (Victorian Minister of Defence). In the course of the discussion that followed, Lieut.-Gen. Sir Andrew Clarke said he intended to ask the London Chamber of Commerce to help him in approaching the Government on the subject of establishing communication between Canada and Australia by means of a cable line and a fast line of steamships in the Pacific. That would give England an alternative route, and would be a source of immense strength to her.

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The Electricity of Drops.—At a meeting of the Cambridge Philosophical Society, on January 27th last, a Paper on "Electricity of Drops" was read by Prof. J. J. Thomson. The experiments and observations of Lenard were first referred to. No electrification is detected in a free falling drop, but if drops after falling be arrested by coming in collision with a plate or wire, the droplets generated in the splash are found to be electrified. The electrification of a free falling drop is masked by the opposite electrification of the air surrounding it, till by some sudden blow the drop is broken up. Special observations show that the blow does not generate the electricity, but merely separates already existing opposite electrifications. The effects produced by various liquids have been studied, and it appears that there is an obvious connection between the nature (reducing or oxidising) of the liquid used and the kind or amount of electrification detected. A very small amount of impurity in water is enough to produce a marked change in the electrification observed. The most remarkable case is that of phenol; this substance is only moderately soluble in water, but if only 0·2cc. of water saturated with phenol is added to 100cc. of pure water, the increase in electrification is obvious; and when 2·5cc. of solution are added to 100cc. of water, the effect on the electrometer is nearly seven times that due to pure water. The sign and magnitude of the electrification depend on the nature of the gas through which the drops fall before breaking up, hydrogen producing effects opposite to those produced by air. No electrification can be detected when drops of water fall through pure water-vapour, but the smallest addition of air brings about electrification.

Large Electric Power Transmission in Norway.—The large number of unused waterfalls in Norway is, says our Scandinavian Correspondent, attracting more and more attention, since the electric transmission of power has come to the fore, and there is every reason to believe that several large installations of this kind will ere long be realised. The latest and one of the most sensible plans of this kind refers to the transmission to Christiania of some 20,000 H.P. from two waterfalls, the distance of which from the capital is in both cases less than 25 miles. Although there is an available water power of 20,000 H.P., it is only proposed to convey 10,000 H.P. for the present. The current will be transmitted at a pressure not exceeding 20,000 volts, and the idea is to use bare wire. The lines will be railed in the whole of their length, and watchmen will be placed at every three miles, and where the lines pass through forests a belt 33ft. in breadth will be cleared, and altogether every conceivable precaution will be taken. On the outskirts of Christiania a distributing station will be placed, which will be common to both lines; the pressure will there be reduced, and the current will be distributed to the various parts of the town by means of underground cables, at a pressure of 100 to 400 volts. It is proposed to apply this considerable power to a number of varied purposes: power will be supplied to the different industrial establishments, both large and small; it is also proposed to use it both for tramways, local railways, and local steamers; further, the syndicate is prepared to light the town, either the whole of it, or only the part which is outside the area of the already existing central station. An application for the necessary concession has already been made, and the authority of Lord Kelvin's name is mentioned in support of the scheme, which is well thought of, and it is considered possible to complete it before the end of 1895. The estimated cost is about £300,000.

Institution of Civil Engineers: The Education of Students. The main idea of the amended regulations as to the education of engineering students, issued by the Council of the Institution of Civil Engineers is, we are told, "to make the regulations more consistent in themselves, and to allow an elasticity formerly wanting, without lowering the standard of general education previously demanded." The hope is expressed that no corporate member will receive as a pupil, or as an apprentice, any one failing to possess the limited qualifications required by these regulations. The following are the new regulations:—(1) No person will be admitted as a student unless he produces evidence of a competent knowledge of the subjects specified in the following list:—(1) English, comprising Grammar, Composition, History and Geography. (2) The elements of Mathematics, comprising (*a*) Arithmetic, including Vulgar and Decimal Fractions, (*b*) Algebra, including Quadratic Equations with one unknown quantity, (*c*) Geometry, including the fi st three books of Euclid *or* Trigonometry, including the solution of plane triangles. (3) Two of the following subjects, not more than one of which shall be a language:—(*a*) Latin, (*b*) Greek, (*c*) French, (*d*) German, (*e*) Italian, (*f*), Spanish, (*g*) Elementary Mechanics of Solids Fluids, (*h*) Elementary Geology, (*k*) Elementary Physics, (*l*) Geometrical Drawing, (*m*) Elementary Heat, (*n*) Elementary Electricity and Magnetism. (2) The evidence required in the above regulation shall be furnished by certificates to show either—(A) That the candidate has obtained any one of the educational distinctions, or has passed one of the qualifying examinations included in Schedule No. I.; or (B) That the candidate has passed examinations in the qualifying subjects, by one or more of the recognised Public Examining Bodies contained in Schedule No. II. (3) The Council may from time to time extend, alter, or otherwise amend the Schedules Nos. I. and II. (4) The Council reserve to themselves power to accept special qualifications of practical work in lieu of certain educational qualifications; or to waive any of the above-named requirements under special circumstances as they may think advisable.

Solidified Petroleum as a Fuel.—The high thermal value and cheapness of petroleum, and the inconvenience of burning it in furnaces in the fluid state, have led to many attempts to solidify it. The method of making fuel bricks of crude petroleum, adopted by Signor Maestracci, of the Italian Navy, is given as follows by the *Revue Scientifique*:—The bricks are of similar form and size to the coal briquettes extensively used in France and Germany. The mixture is made in the proportion of 1¾ pints of petroleum, 10 per cent. of rosin, 5¼oz. of powdered soap, and 11½oz. of caustic soda. The mixture is heated and stirred at the same time; solidification begins in about ten minutes, and the operation must then be carefully watched. If there is a tendency to remain liquid a little more soda is added. The mixture is stirred until the mass becomes nearly solid. The thick paste is then poured into the moulds, which are placed for 10 or 15 minutes in a drying stove. The briquettes are then cooled, and are ready for use in a few hours. Signor Maestracci recommends the addition of 20 per cent. of wood sawdust, and 20 per cent. of clay or sand, which will make the briquettes cheaper and more solid. In trials made at Marseilles on several tug-boats the petroleum briquettes furnished about three times as much heat as coal briquettes of the same size. They were burned in the ordinary boiler furnace, without any special preparation, and gave out very little smoke, leaving also little or no ash. The advantages claimed for the petroleum briquettes are the absence of smoke and a large reduction in bulk of fuel which must be carried, as compared with coal, while the risks attending the carrying of liquid fuel are avoided. The question as to whether it is more economical to burn petroleum than coal turns entirely on the relative cost of the two fuels, coupled with the comparison of their respective evaporative values. For the purpose of firing steam boilers the use of the higher qualities of petroleum, such as that used for illuminating purposes, is altogether out of the question on the score of price, as the process of rectification to which the crude petroleum is subjected very much enhances the cost. One of the simplest methods of burning the crude oils in steam boilers is that adopted by Messrs. Nobel at their well-known oil works at Baku. It consists of a series of shallow trough burners, arranged in a series one above the other, thus exposing a large surface. As the oil trickles down it flows from one stage to the other, and is thus vaporised and completely consumed by the time it reaches the lower tier of troughs. With this system of trough burners, it is stated, a practical evaporation of 14½lb. of water per pound of petroleum refuse has been obtained, as compared with an evaporation of 7lb. to 8lb. of water per pound of coal under similar conditions. The more common and practical method of burning these oils, however, is to spray them into the furnace tube or combustion chamber with a jet of superheated steam by an injector, which draws in the air supply at the same time.

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ELECTRIC MOTIVE POWER.*

BY ALBION T. SNELL.

(*Continued from page 88.*)

Advantages and Disadvantages of Alternate Currents.

The special points in favour of the alternate-current systems may be summarised as follows :—

(*a*) High-pressure machines are permissible, since the currents are not commutated, and, therefore, sparking difficulties are entirely obviated.

(*b*) Power is readily divided into units of any size and at any pressure, by suitable transformers—either step-up or step-down.

(*c*) The regulation of pressure over a large area of supply is facilitated by parallel high-pressure primary circuits.

(*d*) The power in any of the branch circuits can be regulated by choking coils without serious loss—thus the pressure of a feeder, or the light of a single lamp, can be graduated without using a wasteful resistance.

(*e*) Alternate currents are generally more easily handled than continuous currents, and the sparks at breaking circuit are less virulent.

(*f*) Synchronous motors of large sizes have a high all-round efficiency, and necessarily run at constant speed.

(*g*) Asynchronous motors can be made without collecting rings and brushes, and are of very simple construction.

(*h*) Separately driven alternators will run perfectly in parallel if the self-induction of the armatures be of suitable amount —too much or too little self induction lowers the plant efficiency, renders the condition unstable, and the load will not be proportionately divided between the several machines.

(*i*) Two alternators of unequal pressure may be coupled in parallel, and will give an intermediate pressure.

The chief drawbacks to alternate currents are :—

(1) Transformers, especially small ones, are not efficient with low load factors, and therefore transformer substations are advisable.

(2) Synchronous motors are not self-starting, and will stop if temporarily overloaded.

(3) Asynchronous motors will not start against the designed average torque, and are only efficient at high loads.

(4) The lag between current and pressure in an inductive circuit, such as one loaded with motors, is productive of wasteful current in the copper circuits. This is specially the case when the total useful power is small.

(5) Synchronous alternators are more costly to build than dynamos of equal output.

(6) Alternate-current transformers fed with the primaries in series at constant current require the secondary circuits to be also fed with constant current.

(7) Free-running synchronous alternate-current motors will not work in series.

(8) Alternate currents are not suitable for electrolytic purposes.

(9) There is some difficulty in regulating the pressure of supply in circuits containing induction and capacity.

In these sections only single-phase currents are considered, and hence the term alternate current will be limited here to this meaning.

Series Working not possible: Single Alternator and Motor.

It was shown in a previous portion of this series that the simplest case of transmission of power with continuous current is that in which one dynamo and one motor are run in series with each other. The same is the case with alternate currents ; but series working is strictly limited to two free-running synchronous machines. Properly speaking series working is impossible with synchronous machines. A reversed alternator runs perfectly as a motor when driven off a similar generator if it run in synchronism with it. The term synchronism usually implies that the periodic time of the alternations of the two machines is the same, and not that they are co-phasedly equal. Theoretically, it is sufficient that the frequency of one machine either coincide with, or be equal to a small multiple of that of the other, but in practice only the first case has been hitherto realised.

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It has been already shown that the frequency is equal to the number of pairs of poles in the field-magnets multiplied by the number of revolutions of the armature (or field-magnets) per second. Therefore, if the machines be similar the speeds must be the same when synchronism obtains ; and if the numbers of poles in the two machines differ, the revolutions will vary inversely as the relative numbers of poles. From these considerations it is seen that a synchronous alternate-current motor is *not self-starting ;* and that the moving part must be started and revolved until it falls into step with the generator. This is most readily accomplished by running the generator slowly until the motor has got into step with it when the speed of the dynamo may be gradually increased, and the motor speed will follow it with considerable persistence. This will be comprehended by reference to the following diagram.

In Fig. 83 let V be the curve of pressure of the alternator running as a generator ; *v*, the curve of counter pressure of a similar machine running as a motor, and assume that by means of suitable adjustment of both field-magnet excitations, V is greater than *v* by an amount sufficient to drive the current *i* through the combined circuit. Then the work given out by the generator at any instant is equal to the product of the corresponding ordinates of V and *i*, as N L × M L ; and the work absorbed by the motor at the same instant is – L N_1 × M L. The sign is taken as positive when either of the curves is above the time line and negative when below it. The total work done by either machine in one complete cycle can be obtained graphically by dividing the time line into any number of equal parts, when,

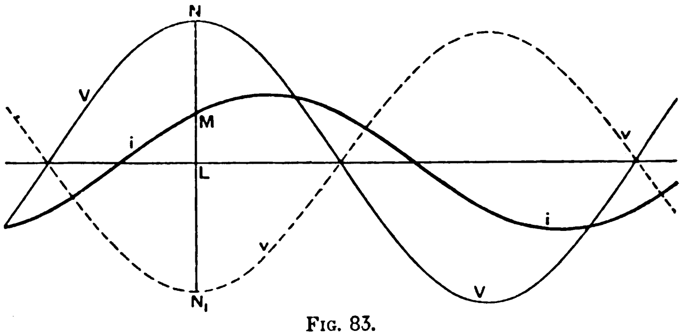

Fig. 83.

if the time of one-half period be equal to T, then the several values of $V\,i\,\frac{T}{n}$ and $v\,i\,\frac{T}{n}$ can be readily found and plotted in new curves whose areas will be proportional to the respective outputs. Care must be taken to use the right signs, and to recollect that the algebraic product of two negative quantities is reckoned as positive ; hence the values of V *i* in the second half of the generator curves are positive, although each of the factors are negative. The negative sign before the product V *i* implies that the machine is *receiving power* from the circuit, whilst the contrary shows that the machine is *giving power* into the circuit. The displacement of the current curve, *i*, with reference to the resultant pressure V – *v*, is called the lag. The amount of the lag is usually measured in degrees and is determined by the self-induction of the circuit.

Parallel Working with Alternate Currents.

Alternate-current working is seen at its best when the alternators as well as the transformers are coupled in parallel. The term "parallel working," indeed, is usually held to imply this particular arrangement of the generators, and does not refer to the transformers, although these are generally coupled in parallel as well. The ordinary practice is to drive each alternator separately. In Continental practice two alternators are frequently coupled, one at each end of a turbine shaft, the whole forming one unit. Machines of unequal size work perfectly in parallel, dividing the load in proportion to their capacities, if the excitations be properly adjusted and the armatures have a suitable amount of self-induction. And alternators of even widely different pressures may be coupled parallel without risk of damaging either, the resultant omnibus pressure being intermediate between the two. But the load

will not be necessarily divided according to the capacities of the two; and the machine with the higher internal pressure will do work on that with the lower pressure during a portion of each period. Therefore, the power absorbed will be greater than is necessary, and may be excessive. In fact, the difficulty with parallel working is to proportion the load according to the several capacities of the generators. It is necessary to measure, by means of a *wattmeter*, the power given out by each machine, and to adjust the excitation and the steam admission until the load is properly distributed. An ammeter is of no use, since it gives no indication of the lag between the current and pressure, and, of course, the omnibus pressure is necessarily the same for all the machines. As previously mentioned, the engines (or turbines) should not have separate governors, but the throttle valve of each should be first properly adjusted, and then fixed. The main supply of steam (or water) being controlled by a single governor, affecting all the prime motors. Further adjustment of output must be made by the field excitation, the safest condition of working being given, not by the minimum current, but by pushing the excitation beyond the lowest point of the volt-ampere curve, so that a slight rise of speed will increase the *armature* current, and the converse will bring it to its normal value. This is technically known as giving the alternator "backbone," and permits of small variations of speed without sensibly altering the omnibus pressure.

Alternate currents are adapted for—

(*a*) Simple parallel and reverse parallel systems, either direct or with transformers.

(*b*) Two-wire feeder systems, direct or with transformers; and

(*c*) Multiple-wire feeder systems, direct or with regulators or transformers.

It is in the transformer systems that they compare most favourably with direct currents, for dynamotors cannot seriously compete with transformers either in prime cost, efficiency, or durability. It is important to examine carefully the use of transformers, since they are likely to play a leading part in all large power plants in the future.

It is sufficiently clear that high pressure is essential in the transmission mains from economical considerations; and it is also evident that the distributing pressure must not exceed about 500 volts. It has already been shown how these two conflicting conditions are met in continuous-current working by means of regulators, dynamotors, and other devices, all, however, having moving parts, and, therefore, requiring attention more or less continuously, being always liable to breakdowns from mechanical defects, and subject, also, to wear and tear from mechanical friction. It would be unfair to the continuous-current systems to lay too much stress on these points, but they undoubtedly must weigh heavily in the judgment of engineers when comparing these two great classes of electric machinery.

In alternate-current working the connecting link between the feeders and the distributors is the transformer. Reference has already been made to the structural details and to the fundamental features of design. It remains to investigate the functions of the transformer, and to see how admirably it meets the many and varied requirements of power and lighting work. It was shown that the construction is of the simplest character involving no moving parts, and comprising merely a laminated iron core and two separate windings of copper wire, the cable being protected by an iron case commonly filled with resinous oil. From the engineering point of view, it is as near perfection as possible, a machine of the highest efficiency without moving parts, and requiring no attention. If properly designed for the work expected of it, there is no reason why it should not last for an indefinite period without repairs of any kind.

In parallel working, the transformers may be banked at sub-stations, and any number may be coupled up to the distributors according as the load varies, the necessary connections being made by an attendant on the spot; or the switching may be controlled by magnetic devices worked automatically or from the central station. The load factor of each transformer must be kept as high as possible, though the load factor of the station may vary largely. To attain this end it is necessary to select the transformer unit so that the minimum load is about 75 per cent. of the maximum output of one transformer. As soon as the full load of one transformer is reached, a second is switched in. With this arrangement no transformer will run with a load factor of less than 50 per cent., at which the efficiency is about 95 per cent. If the maximum load obtains for only short periods it may be advisable to have some larger transformers in addition to the small ones, but this is a matter of detail which must be settled on the merits of each case.

Another method, which was largely practised in the early days of alternate-current working (and is still now in commencing a new plant), is to place a transformer in the premises of each consumer. It has several disadvantages. In the first place, the prime cost of small transformers is necessarily more per unit of output than that of large ones; and secondly, the size of the transformer must be chosen with reference to the maximum, and not to the average, load; and hence the all-day load-factor will of necessity be small in most cases, often in lighting plants not averaging more than 10 per cent. When this system is carried out on a large scale for lighting, the result is disastrous as regards coal consumption, which may reach as high as from 20lb. to 25lb. of coal per kilowatt-hour at the terminals of the lamps (one Board of Trade unit delivered). Whereas the best continuous-current three-wire systems consume from 6lb. to 8lb., and sub-station alternate-current plants not more than from 10lb. to 15lb. This disparity is due to the efficiency of transformers being comparatively small at low loads, and also because the exciting currents must be supplied whether the secondary circuits are closed or open. Hence the primary circuits carry large idle currents, which are wasted in heating them and the transformers. The power thus lost has been variously estimated at from 10 to 15 per cent. of the total station power. This difficulty, however, is not likely to be so serious in the case of power work, for with large motors the load-factor will generally be high, and the transformers can always be switched out of circuit when the motors are standing, lamps (if used) being supplied from a separate transformer. And in the case of a number of small motors, such as a manufacturing town or a large factory, a transformer sub-station can be easily arranged to deal with both light and power work.

(*To be continued.*)

THE NEW TELEGRAPH CABLE IN THE ST. GOTTHARD TUNNEL.

The first telegraph cable in the St. Gotthard Tunnel was laid in the year 1882 by the firm of Felten and Guilleaume, of Mulheim-on-Rhine, and although supplemented by a three-core telegraph cable and a concentric telephone cable only a couple of years ago, soon afterwards the installation was found inadequate to cope with the rapidly increasing demands upon it, so that the Swiss telegraph authorities decided to lay yet another cable, and this was accordingly done in September and October, 1893.

The peculiarities of this tunnel telegraph line made it inevitable that in laying the first cable many unexpected difficulties would present themselves and have to be overcome, thus the greatest care had to be exercised by the manufacturers in only employing materials offering the greatest resistance to the chemical influences to which the cables are exposed in the tunnel. It must be borne in mind that even the iron superstructure of the railway has suffered from the water and fumes in the tunnel, the water containing sulphuretted hydrogen and sulphides and the fumes carbonic acid, sulphurous acid, and ammonia. The uncommonly high temperature of the tunnel (73°F. at times) also influences the choice of material.

A special feature was the provision of an effective sheathing for the cable, the danger of mechanical injury being very great. This is explained by the fact that work of some kind or another is almost continually going on in the tunnel, and what with the darkness, the high temperature, the impurities in the atmosphere, and other circumstances, it is extremely difficult to prevent mechanical injury to the cable. The presence of sharp stones in the tunnel of itself made a good sheathing imperative.

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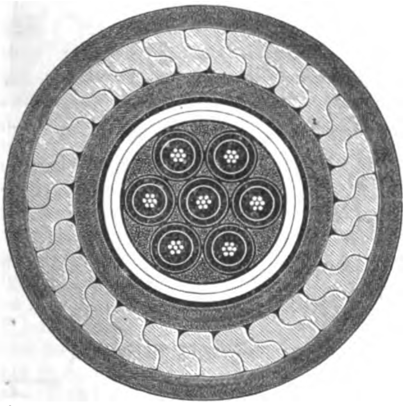
To effectively meet these difficulties was by no means easy. After minute examination of the question by the Swiss telegraph authorities, the Felten and Guilleaume cable, the section of which is shown in full size in the accompanying illustration, was adopted. The conductors are each composed of seven No. 22 copper wires, the strand being insulated with alternate layers of Chatterton compound and gutta percha to a thickness of 0·236in., and then taped. Seven such gutta percha cores are stranded together and the whole taped and tarred. To protect the cores from the gases and water in the tunnel they are encased afterwards in a double lead-covering. The latter is served with insulating material, chiefly compound, and packing, and over this are placed 25 peculiarly-shaped wires which interlock and form an extremely firm and close sheathing; finally the cable is served with asphaltum, the diameter over all being about 2in. The total length of the cable is about eight miles. In addition to the seven-core cable a quantity of cable of the same construction, but having five and four cores, was supplied for special connections.

The next consideration was the laying of the cable. This was done under the supervision of Dr. V. Wietlisbach, of the Swiss Telegraph Administration. It was determined to have the cable laid in the same trench as the former cables, but as there was no space left at the same depth beneath the ground, and it being no longer possible to widen the trench, the only alternative, in order to avoid the difficult and costly work of constructing another trench, was to lay the new cable above the previous ones, and the new cable has been laid in this way, separated from the others by sand, and covered by a



Cross-section of the St. Gotthard Telegraph Cable, Full size.

layer of sand and stone slabs, the trench being then filled up with stones or pebbles. The laying of the cable was carried out as on former occasions, that is to say, the rotating wheel on which the cable was carted was placed on an open truck drawn by a locomotive, thus allowing the cable to slowly unwind from the reel. The laying of the cable, as well as the conveyance of material, could only be done in the evening between seven and nine o'clock, on account of the immense traffic on the line. The jointing, however, was done at night. The jointing was an exceedingly difficult task, as in consequence of the atmosphere being so damp, and besides impregnated with coal and ash-dust, it was almost impossible to keep the hands and tools clean, even for a short time. The damp and trickling water moistened the ends of the cores, often causing small faults in the insulation, in spite of the utmost care. However, by means of a sensitive mirror galvanometer placed at the Göschenen entrance, these faults were detected and eliminated. It will be readily understood that work of this kind in such an atmosphere (made worse by the flickering torches and the high temperature) was exceedingly difficult. The joints were enclosed in iron joint boxes specially designed by the contractors to protect them both from mechanical and chemical injury.

The cable is connected up at the Göschenen and Airolo stations, and there provided with lightning arresters. The electrical tests specified for the cable by the telegraph administration are as follows:—

Copper resistance, 7 ohms max.	Per kilometre at 60°F.
Insulation resistance 1,000 megohms min.	
Capacity 0·25 microfarad max.	

The tests after the cable was laid gave the following far more favourable results, viz.:—

Copper resistance, mean, 6·35 ohms	Per kilometre at 60°F.
Insulation resistance, mean, 7,500 megohms...	
Capacity, mean, 0·193 microfarad	

SOME NOTES ON THE ELECTRIC LIGHTING OF THE CITY OF LONDON.*

BY MAJOR-GEN. C. E. WEBBER.

(Continued from page 427.)

What was probably one of the most difficult parts of the task was the description of the details of the adaptation of portions of the plant to sites and buildings still under design, so that no extras on the contracts should arise, and thus the equipment of the stations and sub-stations should be of the most complete and up-to-date description, and fully equal to the requirement of the capacity which the contractors had undertaken to provide. Both sites presented exceptional features, and the designing of the building structures for each differed entirely. That for the Wool Quay (since abandoned)† required a building in which the floor of the basement would have been 20 feet below high-water mark, and the station plant should be placed on floors one above the other; the generators to be in the basement, the boilers over (on a Hobson's steel girder floor), and the coal above. The site at Meredith's Wharf, although the essential features of the first design have been retained, has been so enlarged that any description of it that might be attempted in this paper would not be sufficient.‡

The estimate of the load-factors of the *public* lighting of the City may be here made with some interest. Adopting Mr. Crompton's figure, which allows 25 per cent. for extra or reserve machinery, in the case of the public lighting the capacity of the plant is 890 − 222 = 668 kilowatts, or 5,851,680 kilowatts per annum. The 515 arc lamps represent 257,500 watt hours, and the 906 glow lamps—half being 100 watts and half 50—represent 67,950 watts more, or a total hourly consumption of 325·45 kilowatt hours, which, with 4,030 running hours in the year, gives a load of 1,311,562 units per annum. But, in fact, the amount of the above plant that is spare, or available for arc lighting in public buildings or elsewhere, is very large, and it is better to regard the actual capacity of the plant exclusively devoted to public lighting, including reserve, as represented by sixteen 50 (500-watt) light machines, with an annual total capacity of 3,504,000 kilowatts. This will give a load-factor of 37·4.

DISTRIBUTION.

Outside the Postal Telegraph and the City Engineer's office there was no one who could form any accurate idea of the condition of things below the surface of the City streets. The subways in Queen Victoria-street, in Arthur-street, and in the Holborn-viaduct, although suitable for through mains of supply of any kind, were eminently not so for electric distribution conductors, which have to be tapped at frequent intervals for the supply of current for public and private lighting. Although forced to use them, the cost of such mains and services to a supply company is higher than if the lines were laid under the footway on either side. In March, 1890, the London County Council, with the approval of the Board of Trade, and the confirmation of the Home Secretary under the terms of the Metropolitan Subways and Government Acts of 1868 and 1888, had published by-laws for regulating the use of subways. These, while in force in the Queen Victoria-street subway, are not so in those under the Holborn Viaduct and Arthur-street. Anyone who has used street subways for electrical conductors, in common with gas, water, and other companies, will understand that, except for primaries, the

* Paper read before the Institution of Electrical Engineers, February 8, 1894.

† This site had to be taken over by the City company under the "concessionaire" contracts.

‡ The Institution will be better served if I leave it to the gentlemen who were selected by me as my assistants for that part of the work, and who have actually since carried it out—namely, Colonel Seddon (late R.E.), and Mr. C. Thompson. The meeting will, I hope, understand that in refraining to give any detailed description of the equipment of the stations I am influenced by the wish that such should be undertaken either by the engineers of the respective contractors who designed and erected them, or by Mr. J. H. Jackson (one of my assistants), who is still superintending the same. As regards the building structures, I may, however, add that of three chimneys designed, and specified and contracted for under me, one—*i.e.*, that now to be seen close to Bankside—has been erected. There are features of its construction, especially with reference to the bond, that I should like to have time to describe. Its cost was £2,075, its height 150 feet, and its internal diameter 12 feet.

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electrical engineer would much rather remain outside. The by-laws are excellent for the regulation of this user, but the panacea which excellently-intentioned persons believe exists in street subways falls short of theirs and the public's expectations. The law allows the local authority to oblige us to use them where they exist, and to charge us a rental for that use; but, as the word "pipe" in the Act includes a "tube for wires," and as the rental, irrespective of the number of wires, is £16 per annum for a 3-inch pipe for the 1,200 yards of the Queen Victoria-street subway, and £49 per annum for one under 18in. diameter for the same length, the way-leave is not very costly, but the cost of using it is extremely so.

Sections of some of the subways, with the conduits placed in each for lectric light conductors, are shown. In each case the obligation

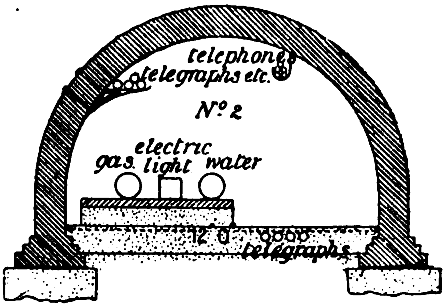

FIG. 1.—Holborn Viaduct Subway.

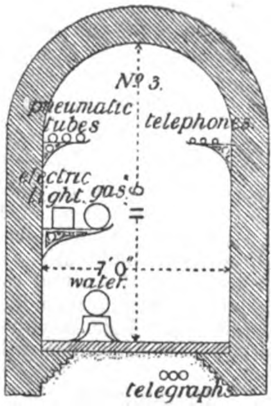

FIG. 2.—Holborn Viaduct Narrow Subway.

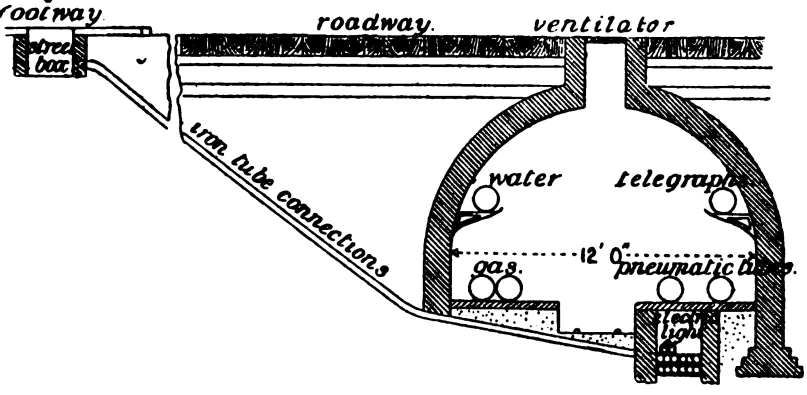

FIG. 3.—Subway, Charterhouse-square, with Street Box.

to use the subway instead of the ground under the footways entailed one excessive expenditure common to both—namely, the works in breaking through the massive arches and deep cuttings in the roadways to get at the street lamps, and, in many places, to obtain access to the houses, in some places 30ft. away. In the Arthur-street and Holborn Viaduct subways a large number of "ways" in Callender-Webber casing have been secured at a very little cost.

In the Queen Victoria-street subway cast-iron troughing on wall brackets, as first designed, proved an awkward and costly arrangement in many ways; the weight of the structure was nearly 3cwt. per yard. Lighter troughing designed by me was adopted, of which follow sections.

The trough contains cables—six of 1·9" external diameter, three of 1·5" external diameter, and four of 0·7" external diameter; with a carrying capacity in section of copper available at 2,000 volts =0·09", at 200 volts=2·1". Weight of trough per yard=90lb.; cost of trough, fixed, 16s. per yard—with conductors, high-insulation bitumen, £4. 2s. per yard run. The essential objections to working in such subways (apart from maintenance) are—(1) The difficulties, physical and otherwise, of access to them, both for *personnel*, material, and plant; (2) the delays to work, due (*a*) to defective lighting, (*b*) time required to communicate with the authority and other occupiers, (*c*) to foul atmosphere; (3) the engineering obstacles due to the works of previous occupiers, and to the cutting in and out where necessary to reach side streets.

My own Postal Telegraph experience in 1871 and 1872 had been in the difficult ground in thoroughfares like Cornhill; and although in 1891 and 1892 places were come upon where hardly a single conduit could be laid, the task, owing to the system adopted, proved, on the whole, less difficult than was anticipated; and, as was expected, generally, the thoroughfares running north and south were easier than those east and west, for the reason that most water, gas and telegraph mains, tend from the City towards outside centres in those directions. The pioneer work included the opening of certain main thoroughfares, so that the arc lighting might be got forward. In these, the most thronged streets of the City, it was essential not to have to repeat the inconvenience of opening the ground. Whatever was laid down at the first operation had to form a portion of, and suffice for, the completed scheme.

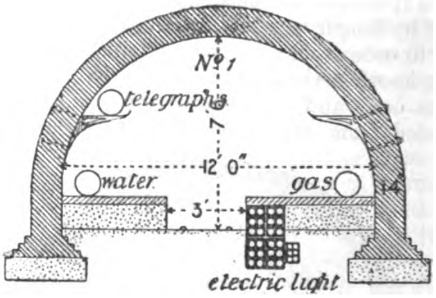

FIG. 4.—Subway, Arthur-street.

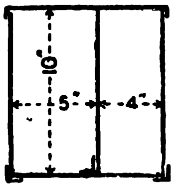

FIG. 5.—Section of Square Trough.

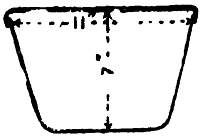

FIG. 6.—Section of Rolled-Iron Trough.

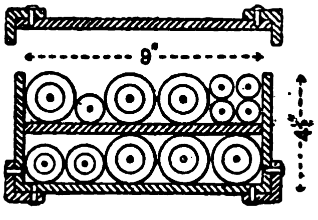

FIG. 7.—Section of Trough with Cables laid in.

In a matter so long under my own consideration I had no hesitation in recommending that sufficient conduit accommodation should be provided and that it should take the following form, viz.:—* (*a*) Iron pipes for concentric high-tension mains from the generating to the transforming stations. (*b*) Iron pipes for continuous-current high-tension mains for the public arc lighting. (*c*) Bitumen concrete casing for three ways, to accommodate the conductors of a low-tension distributing system, both feeders and distributors. The future needs of the great whole had, as I shall describe further on, to be thought out before March of 1891, so that each part of the work, however preliminary, should eventually fit into the permanent system. The future need for

* The entire responsibility of thus advising the Pioneer Company rests with me. As the pioneer contracts (with the making of which I had nothing to do) had only provided conduits sufficient for the cables from the pioneer generating stations, and had specified nothing as regards the underground conditions, it was necessary, in order to prevent the consequent waste of having to excavate the same ground twice, to make additional provision. And as the isolated areas treated by these pioneer contracts had to be considered as forming a part of the great whole, the whole of the details of the completed work had to be gone into.

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spare conduits, possibly for telephones, had also to be thought of, and it was provided for as far as the very limited space under the footways of those thoroughfares which were first treated would permit.

The question of interference, through the neighbourhood of alternating-current working, with telegraph and telephone circuits was at that time under public discussion. I had very little time, and had to be satisfied with one experiment having the object of observing the screening effect which was anticipated would exist through the interposition of what might be called "faggots" of iron pipes, lying in the same trench as the non-conducting conduits, into which the low-tension distributing mains were to be drawn. For the experiment, conduits and pipes were laid on trestles under nearly the same conditions as in the trench, and a 200-volt current with 100 frequency (obtained by transformation) and 100 amperes was passed through two of the three ways of a bitumen concrete conduit, in conductors having a sectional area of copper of about one-tenth of an inch. Telephone circuits with metallic* returns laid parallel were tried. The iron tubes were placed at various distances and in various numbers. Imperfect as the trial was, it gave us security that at a distance of 12in. from the Callender-Webber casing, twin telephone circuits in iron pipes would be fairly secure from trouble. But, as an additional precaution, it was decided to sheath the casing with iron. Within a distance of about 6in. a very slight disturbance could be still heard. The choice was further justified, because the Duke of Marlborough, with his usual foresight, asked several practical engineers to meet him in a friendly way soon after this advice had been given and adopted, in order to discuss the whole question. From my notes of that meeting, held on March 23 and 24, 1891, I find the conclusions then come to coincided with the system above referred to, which was already in course of execution. Those present at this meeting were the Duke of Marlborough, Messrs. T. Callender, Gordon, Gray, Heaviside, Mavor, Raworth, A. Siemens, Wharton, and Major-Gen. Webber. It is not to be assumed that unanimity on matters of detail was expected or arrived at. As regards anticipated electrical troubles, the avoidance of interruption of telegraph and telephone circuits was the only thing dealt with at those consultations. Those present had till then had, I must presume, no practical experience of the resistances due to skin effect, or self-induction, in the case of single conductors of over one-third of an inch section of copper used to convey alternating currents at *low* pressure. The use of concentric lead-covered cables laid in the earth, with iron split-tube protection where joints have to be made, was discussed with the advocates of that system as used in Germany, and its advantages, both as to reliability, manageability, and first cost, in comparison with two or more highly-insulated conductors in one iron pipe, were weighed, especially in view of the claim that, wherever laid, it is everlasting. The question of influence on telegraphs and telephones, and the means of screening or damping down the magnetic field, was discussed, and various experiences at Bath, Newcastle, and in London were quoted.

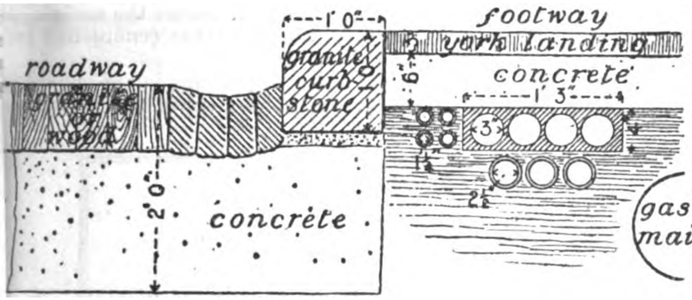

FIG. 8.—Sections of Road.

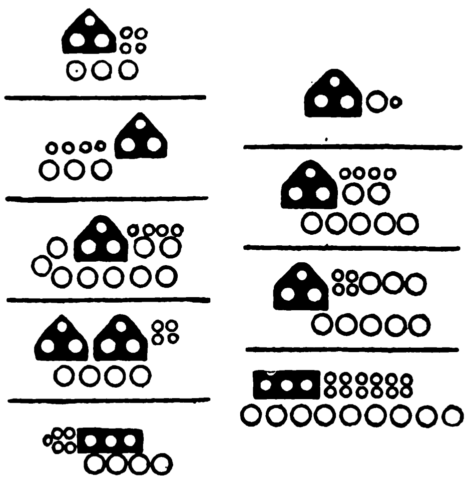

FIG. 9.—Various Typical Sections of Conduits.

The following recommendations were formulated, with general concurrence:—(1.) That a separate way should be provided for each separate conductor, for the purpose of drawing in and out between flush-boxes. (2.) That the high-tension primary alternating currents should have concentric conductors with vulcanised rubber dielectric, and be drawn into iron ways. (3.) That the arc lighting continuous-current conductors should be concentric, and drawn into an iron way, except in the lengths where the circuit is connected with lamps, when the 7/16 conductors should be separate, so as to avoid joints.

In connection with the secondary distributing conductors, the use of the three-wire system having been admitted, various means of laying were examined—such as large iron pipes, with and without interior separate ways for the cable; the use of paper tubes in iron cases; iron tubes lined with bitumen; and earthenware cases, with ways similar to the Callender-Webber bitumen concrete cases. After carefully considering the conditions of the City streets, and all the circumstances of difficulty that were being met with and known to exist, the use of bitumen concrete cases with separate ways; and, in view of the experience and evidence of its efficiency, the use of Callender's bitumen insulation for the secondary distributors, met with approval. After hearing all that was to be said as to the conditions for providing drawing-in and joint boxes in the City streets, no doubt remained as to the necessity for using a common box in most situations for all main circuits and their joints, and of making them as large as the space below the surface would permit.

The justification of the adoption of these resolutions was, both from the engineering and financial point of view, as follows:—The use of footways wherever possible had been prescribed by the Commissioners. In spite of having to keep six inches under the lower side of the paving-stones, it entailed less labour in excavating. In the lines where they had to be carried under roadways, the conduits had to be below paving and concrete, sometimes 2ft. in thickness, and with a surface subject to such traffic the numerous draw, service, and other flush boxes would have been impossible.* The space available below the surface was occasionally entirely occupied by cellars, areas, and other pipes, and the work had to be carried out in the presence of officials representing—(1) The Commissioners of Sewers, (2) the Postmaster-General, (3) the Gas Company, (4) the Water Company, (5) the Hydraulic Main Company, (6) the District Surveyor.

The condition, exacted rigorously—namely, that no pipe or conduit should be placed vertically over, or within 6in. horizontally of, an existing pipe—was a most arduous one to fulfil. My procedure in the most difficult streets was as follows:—Having decided on the maximum number of "ways" that should, and if possible be, laid under the footway, I began by examining it personally, having first obtained from the authorities I have named all possible information as to their pipes—information that was sometimes very imperfect. I then measured carefully all cellars, arches, and areas, and had trial holes opened wherever exceptional difficulty was anticipated. In many cases, such as in King William-street, so contracted was the space that several ways which were actually necessary had to be omitted and taken another way, and occasionally a deviation under the roadway was obligatory. The intricacies of the trench opened under such conditions could not, I believe, have been followed with any other system of ways, namely, the combination of Callender-Webber casings and wrought-iron tubes. Both these are capable of being bent on the ground to any reasonable curve—in the case of the iron pipes by the ordinary means, and in the case of the bitumen concrete cases either by warming the case and bending it when soft, or by laying short lengths and setting them at an angle to one another with mitred ends; the length of the short pieces and the angle of the mitres being, of course, dependent on the radius of the segment of the curve that has to be followed.

* Experiments made in 1880 with telephone circuits with and without earth returns, between Paddington and Westbourne Park Stations, laid in the same wooden troughs as 40 or 50 working single and double-current telegraph circuits, saved me from having to make any trial with earth return for the telephones.

* The following figures give an idea of the traffic in the City:—By bridges, streets, railway stations, landing piers, and subways there are 81 means of public access. By these the *daily* traffic was—

		1881.	1891.
Vehicular—	During 16 hours	66,909	85,286
	During 8 hours	4,984	6,546
Pedestrian—	During 16 hours	739,640	1,100,636
	During 8 hours	57,923	85,458

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The difficult problem that faced the Company in August, 1891, was the obligation to lay down their mains and complete the public lighting in all or parts of 53 streets by February, 1892, requiring approximately 17 miles of trench; and that the Commissioners were likely to be very stiff as to punctuality. A careful consideration of the case in its various aspects had led me, when acting (up to and before 1890) as technical adviser to the Brush Company, to regard the adoption of alternating currents, delivered at high pressure and distributed at low pressure, as the service most suitable for private lighting in the City. There was no hesitation on the part of all concerned to adopt it, particularly as in the case of the contractors the Mordey and Thomson-Houston systems had in 1890 reached considerable perfection. The conditions which emphasised this view in my mind were geographical and local as regards the City. Whatever may have been the ultimate practice, they were paramount during the preliminary stage. They were, first, on account of cost of ground, that the generating stations should be at a distance; second, on account of the exceptional difficulties in the streets for laying mains, the desirable frequency of converting stations might be impossible to achieve. When the concessionaires (*i.e.*, the contractors) had the matter in their own hands, the sites already named for the generating stations were secured in, or in close proximity to, the City. Although this was a reversal of conditions, the selections were easier to have first found sites for the sub-stations and then arranged the areas to be served by them; but, as the main thoroughfares traversed the City throughout in all directions, there was no area that was not touched by the work requiring immediate completion, so that, to be able to get the above-named 17 miles done, all had to be considered in advance.

The combination of casings with 1¼in. and 2¼in. pipes required a minimum sectional area of trench varying according to locality, and if the soil below the footways had been comparatively free there would have been little difficulty in arranging the position of the ways relatively to one another, so as to suit all requirements. It was essential—(*a*) To place them so that the relative positions of the ends should coincide at any rate between box and box, no matter what might be their vagaries in the interval. (*b*) That, where the trench was opened alongside of a line of pipes enclosing telegraph conductors, the mass of the iron pipes should be laid between the alternating low-pressure conductors and the same, to aid in screening the inductive effect on the smaller currents. (*c*) That the ways destined to be used for the arc lighting, and for the distribution in the street itself, should be nearest the surface. As it was, the fulfilment of these and all other conditions I have mentioned was often absolutely impossible.

The obligatory positions of boxes for drawing in and out and for access to the cables (exclusive of house service and street lamp

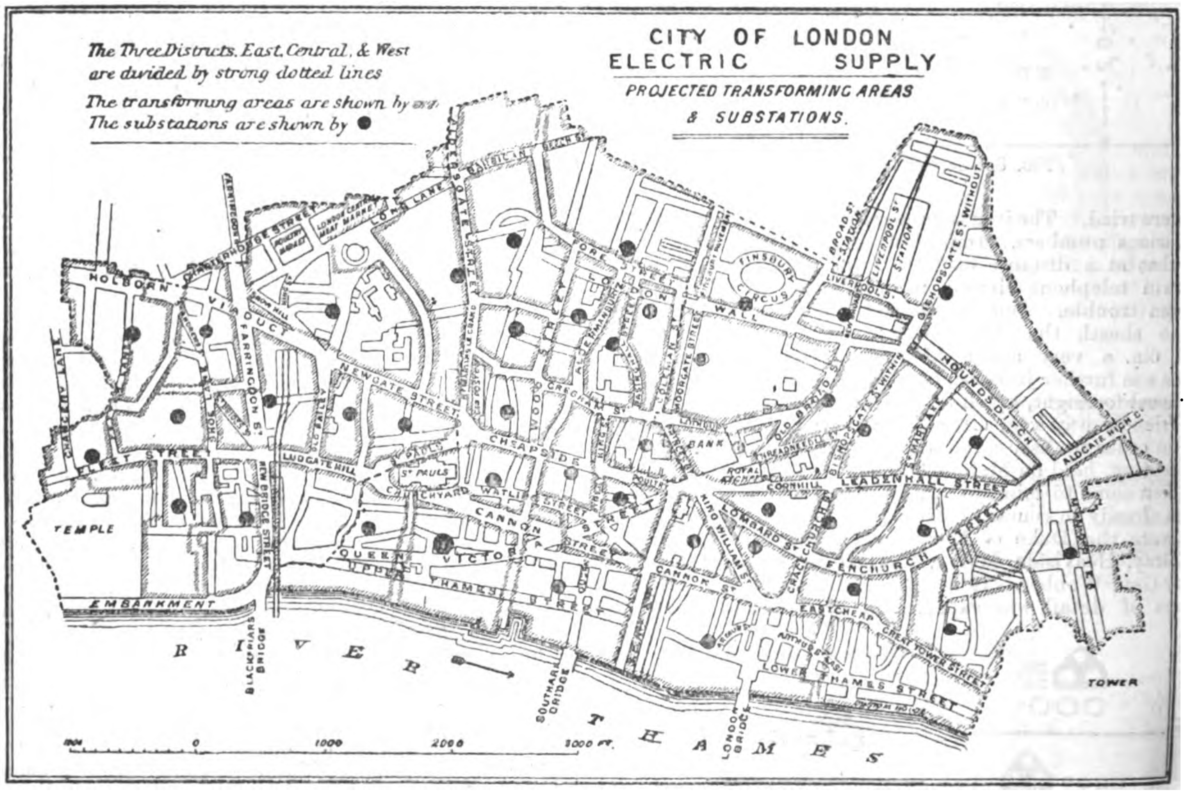

FIG. 10.—Map of City, showing Transformer Sub-stations.

probably wisely influenced by question of facilities for sea-borne coal and condensing water, and largely controlled by the difficulty created by the Electric Light Acts in getting way-leaves through the areas of neighbouring local authorities.* The facility, or otherwise, of obtaining sites for transforming stations could not be fully gauged during the preliminary stage, and space underground to be found for large conductors could only be expected to a very limited degree. If we had only known as much as experience has since shown, it is quite possible that a continuous-current system of distribution would have had as good a chance of being adopted as the alternating system.

Distribution with low pressure from transforming stations entailed a network on the well-known lines, with distributing service mains and feeders. When the time arrived for the City to be divided into areas, each to be served by a transforming station, with all the stations, if not the areas, intercommunicating, the areas and points for the stations had to be approximately assumed, and the number of ways estimated that would be required under each footway throughout the whole City. It would have been, of course, boxes, which were only for access to the cables required) were numerous, as it was necessary to place one at every street corner, and wherever a serious change of direction occurred. Still, the lineal space of line of main occupied by boxes was, on an average, only about 2 yards in every 100. These boxes were made as large as possible, which is not saying much; I aimed at making them large and deep enough for a man to get entirely inside, but this was rarely possible. Owing to the obstruction underground, they are of every conceivable size and shape.

Drainage, and access of gas from the surrounding soil, are conflicting conditions. The drainage had to give way unless some nearer outlet was evident, and the boxes were made as gas-tight as cement and glazed or impervious bricks could make them. The question of the presence of explosive mixtures in street boxes has, as my audience knows, been several times brought to notice by explosions—one lately in the Western district, on Ludgate Hill. My own view of this particular condition of danger has been to do everything to prevent the coal-gas getting into a box, and I believe this can be secured with proper precautions, apart from the occasional possibility of being able to ventilate by in-draught and out-draught ducts. The precautions are—(*a*) Good joints between case and case, ensured by finally passing the red-hot "mouse" through each joint after the casing has been laid; (*b*) absence of air space between the cases and the iron sheathing; (*c*) careful sealing

* For instance, negotiations extending over three years, with that object only, that I had conducted for the Brush Company with some local authorities on the Surrey side, ended in only obliging the Company to seek and obtain a Provisional Order for the St. Saviour's district.

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in round the iron tubes and bitumen cases where they pass through the wall of a box ; (*d*) careful plugging of all "ways" not in use, and caulking with tarred yarn round the cables where they emerge from the "ways" ; (*e*) the use of drainage only where the pipes are sure not to become ducts for gas ; (*f*) ordinary care in the use of lights until gas is clear.

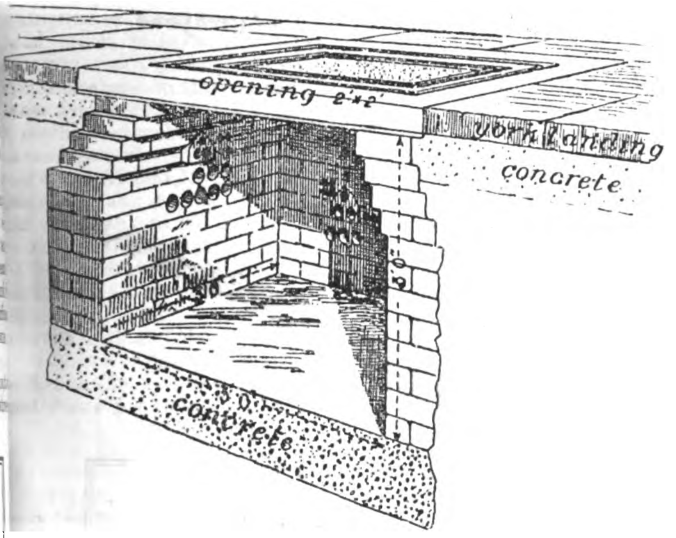

Fig. 11.—Example, Street Box.

The nature of the material in, and shape of, the frames of the iron covers were the outcome of some experience. Nothing is better than a wide rim to the frame, roughed to prevent slipping, filled in with fine Portland cement concrete, made with very hard material, and allowed some weeks to set. The bad ones—and I see there are some—were the result of the want of care and bad material. The wide rim provides spaces for letters indicating the ownership of the box.

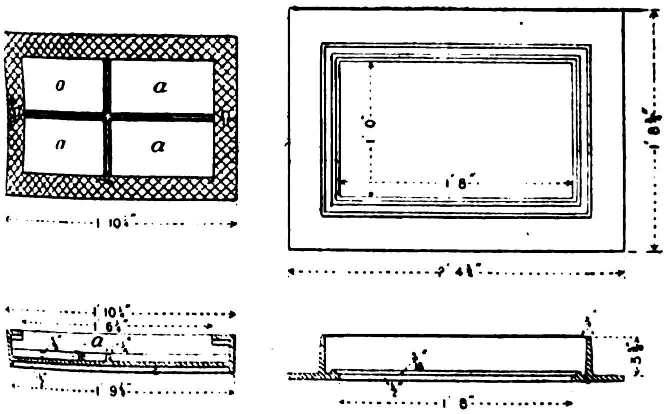

Fig. 12.—Example, Cover to Street Box.

In the trenches opened for that purpose all the conduits for conductors, the need for which in the future could be foreseen, had to be provided—(*a*) For the public lighting high-pressure conductors, concentric in some lengths, separate in others. (1¼in. pipes.) (*b*) For the private lighting primary high-pressure concentric conductors from the central to the converting stations, and between the latter. (2½in. pipes.) (*c*) For the three-wire feeding mains to points in the network. (Casing.) (*d*) For the three-wire distributing low-pressure conductors of the network. (Casing.) (*e*) For the pilot or signal wires for the service of the Company—one in each trench. (*f*) For spares and the future use of telephone conductors—as many in some places as 23—as the probable future demand indicated.*

As an under-estimate of the number and size of these meant a waste later on, in having again to open the streets, and as an over-estimate would be also wasteful, it was imperative, as I have said, to make a careful study of the whole. This was done with an accuracy only diminished by the following :—(*a*) The number of existing lights that might be expected within a given number of years to be replaced by glow lamps. (*b*) The selection of the boundaries of the areas, and, approximately, of the points for the transforming stations. (*c*) The desirability, though not an essential, of arranging the areas so that the difference between the consumption in each should not be too great. To the difficulties in finding sites for stations, and to the unforeseen obstructions to be encountered underground generally, all these became subordinate.

Careful canvassing of the City in various typical blocks of buildings (a "block" meaning all buildings situated between the nearest streets which meet one another) showed that they might be roughly classified in three, and that the number of existing lights, or lamps, averaged as follows, per square yard of ground space, was—

——	Central.	Eastern.	Western.
First-class blocks, per square yard	0·254	0·275	About the
Second-class „ „	0·171	0·171	same as the
Third-class „ „	0·067	0·100	Central.

Another canvass led to the conclusion that the proportion of those existing lamps that might be expected to be replaced by glow lamps was—

In the first-class blocks	0·75
„ second-class „	0·50
„ third-class „	0·33

The above figures were applied, and the blocks being all classified, and grouped in areas, so that each area might, as has been stated, have approximately the same number of lamps, the following results were obtained ; and, although it will be very a long time before its general accuracy can be tested, I feel sure that, so far as the number of lamps is concerned, it is not very far from the truth, although the number of areas may vary very much from the estimate.

For the three districts the following figures were arrived at :—

Glow Lamps.

—	Eastern.	Central.	Western.	Total.
18 areas..........................	139,900	—	—	—
14 „	—	100,750	—	—
12 „	—	—	99,547	—
Total, 44 areas...	—	—	—	340,197

If these are 8-c.p. lamps of 33 watts, this will give a load at the lamp terminals of 11,226·5 kilowatts. With 96 per cent. in the transformers at full load (the efficiency specified under the contract), and 5 per cent. loss in the mains, primary and secondary,* the output of alternating current of the three stations—namely, 12,100 kilowatts—is not far short of 12,236 demand the maximum possible load, so that with 80 per cent. of the lamps alight there would be nearly 20 per cent. spare generating plant. If it may be assumed also that each 8-c.p. (33 watt) lamp uses 18 units =6,123,546, with 20 per cent. spare, the load-factor comes out =13·8.

The design of 44 converting points in those districts required that, including spares, each transformer station should have, on an average, 275 kilowatts capacity. The three first permanent sub-stations, the sites of which were secured by, and the structures designed by, myself, were :—(1) Pancras-lane (Bene't Sherehog), with space for transformers having a capacity of 450 kilowatts ; (2) Nicholas-lane (St. Thomas Acorn), with space for 480 kilowatts ; (3) Queen Victoria-street (St. Nicholas Cole Abbey). This is a double station, and has space for 648 kilowatts.

Of these, I only show the design of the first, it being situated under exceptionally difficult conditions. (*See* Plan No. 13, &c.)

Transformation.

As has been said, little progress could be made with the selection of sites for permanent transformer stations before July, 1891, as the general scheme, upon which their relative positions much depended, was still under consideration.

To distribute the current generated in the pioneer stations, three temporary transforming stations were improvised, viz., one in Queen Victoria-street, in the basement of No. 47 ; one in the basement of the Mansion House ; one in St. Swithin's-lane, under a restaurant. In no case were these suited to become afterwards permanent stations, both on account of size and circumstances of surroundings. In the transformers first delivered the secondary windings gave a pressure of 1-20th that of the primary ; and, as the current is delivered at an E.M.F. of about 2,050, and it had to be distributed in the three-wire mains with an initial pressure of about 205 volts, they had to be coupled two in series—an arrangement which would disappear with the delivery of the contract transformers.

* On this subject, from the point of view of the telephone service of London, I hope to be permitted to read a Paper before the Institution at a future date.

* It is quite certain that this ideal condition of efficiency can only be achieved when a completed system is at full work ; at lower loads it will often go down to 76 per cent.

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It early became evident that the price, by way of rent, that would be demanded for adequate space in, and access to, existing buildings, was prohibitive in the more costly areas. For instance, in Lombard-street, where every square yard is said to be worth £1,000, it can readily be conceived that £500 a year was asked for a small room in the basement. With this in view it behoved us to look for what we required to the space under those portions accessible to the public, or not available for building purposes. Careful searching showed that many engineering and financial difficulties existed. For instance, at some points where there was evidently ample space below the surface a prohibitive price was asked for the means of access to it through private property; and, again, at many such points, space for access within the area used by the public could not be obtained, for various reasons of public convenience and safety. In time our attention was turned to the old City graveyards, and, after long negotiation with the parish

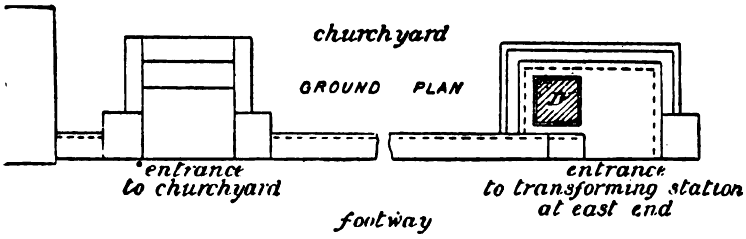
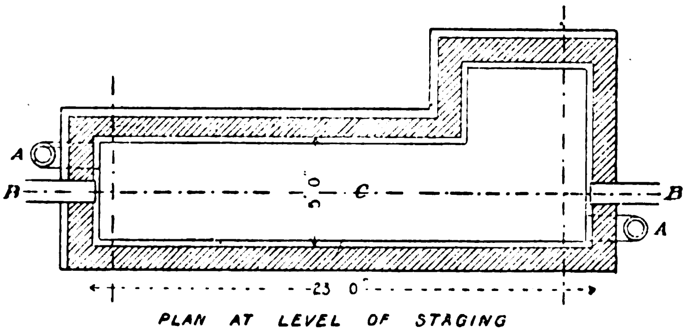


Fig. 13.



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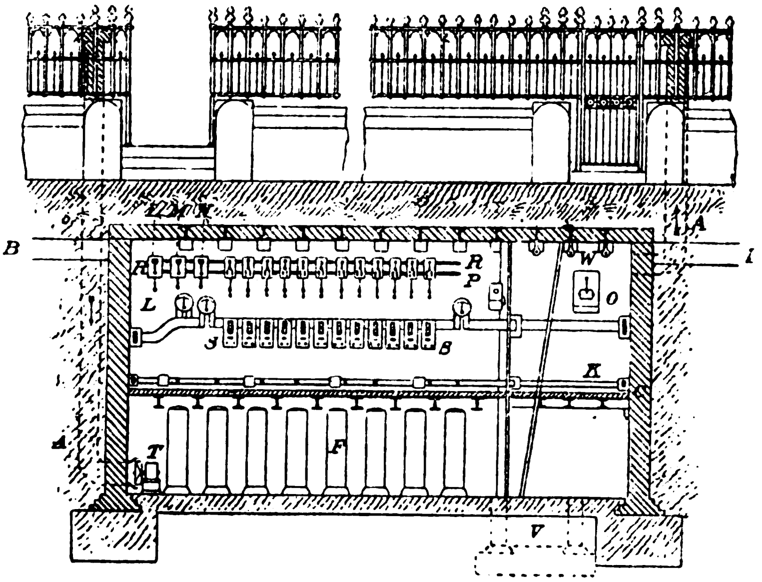

Fig. 15.

authorities, and with the Consistory Court and the Commissioners, leave was obtained at a fair cost to use a small portion of two of these open spaces in Pancras and Nicholas-lanes, so as to provide shafts for descent to the contiguous chambers to be constructed by leave of the Commissioners under the foot or roadways. But, even with this facility, the space below was in one case—namely, Pancras-lane—extremely limited, through the existence of large main sewers and water and gas pipes. In excavating, large quantities of human bones were met with, which had all to be transported carefully for extramural re-burial.

The drawings show the structure and the conditions of housing the transformers and switch-boards and connections. Under such circumstances every inch was important, and it was to the suggestion of my chief assistant, Mr. Nisbett, that the plan of placing

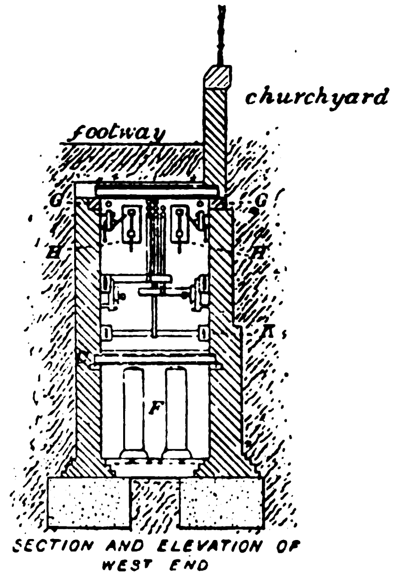

Fig. 16.

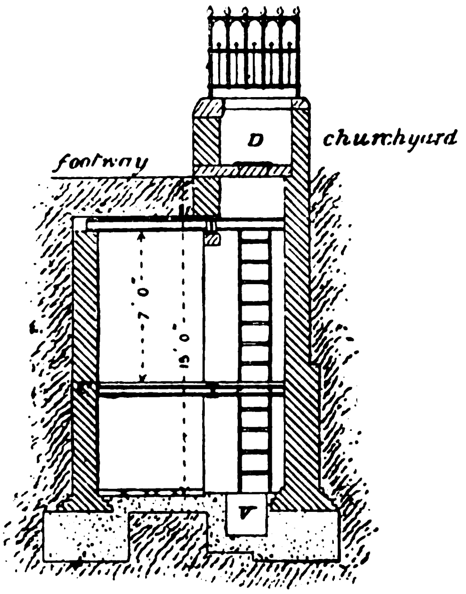

Fig. 17.

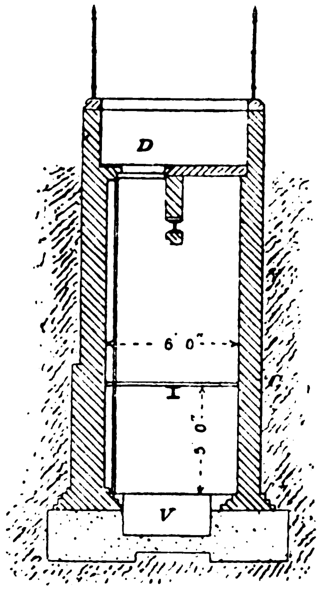

Fig. 18.

the transformers, F, below the floor was adopted in that station. Height was the most elastic dimension, and it will be seen that

the attendant standing over the transformers on a stage, C, has sufficient headway to stand up and attend to the board, S, one on the north, another on the south side. The floor of this stage is made of wooden squares, each of which can be taken off independently, and the top end of the transformer underneath exposed. When required to be removed, it is lifted by tackle suspended to a ring (as at W) in the arched roof, and being received on to a hand truck, it is moved along the floor to the bottom of the entrance shaft, and there, by other tackle, carried by a tripod standing above on the dwarf walls, lifted up to the surface, where it can be lowered on to a suitable trolley and taken away.

B (Figs. 14 and 15) shows where the conduits enter the station at the east and west ends.

D (Figs. 17 and 18) is the entrance for access to the descent by ladder into the staging.

F (Figs. 15 and 16) indicates the 18-kilowatt transformers.

G (Fig. 16) the position of the primary 'bus bars on each side.

H (Fig. 16) the main primary switches.

K (Fig. 16) the low-tension middle bar which runs round the tension.

L and N (Fig. 15) are switches for connecting at high tension with other transforming stations.

M (Fig. 15), a switch to divide the station in two for repairs.

O (Fig. 15), a recording voltmeter.

P (Fig. 15), the telephone to the generating station.

R (Fig. 15), one pole of high-tension bar, with a switch to every two transformers, and Brush-Mordey fuses.

S (Fig. 15), low-tension switches on 'bus bar, with a switch to every two transformers, and separate fuses.

T (Fig. 15), motor and fan for ventilation.

Drainage by a sump, V (Fig. 15), and ventilation by large upcast and downcast shafts, A A (Fig. 15), are provided, as well as means of telephonic communication, P. The cost of the builder's part of the structure, when completed, is about £430, with an annual charge for the way-leave of about £5. The honeycomb space under the staging floor should be able to receive 45 10-kilowatt transformers, of which 40 may be assumed to be in full use, the rest spare. The cost may be considered inthe following way:—

The present value of £5 a year for 21 years, at 5 per cent.	£64
Cost of building construction	430
„ transformers and fittings, as per contract	...
400 kilowatts, at £7 per kilowatt	2,800
Add 5 per cent. for supervision and contingencies	182
Total cost of a transforming station (having a maximum space for 450 kilowatts)	£3,476

To arrive at the capital of cost of the plant between the generating stations and the low-pressure feeders, it is necessary to add the cost of two concentric mains; and this I have taken from a table that I prepared which enables me to appropriate with very fair accuracy between the conduits for various purposes the cost of the underground work.

In this case the distance is about 1,200 yards.

Carried down	£3,476
Two 2½-in. wrought-iron conduits, at 4s. 4d. per yard	520
Two 0·154-in. concentric high-insulation 1,200-yard cables drawn in and connected	1,150
These figures give a total Capital outlay of	£5,146,

which will be repaid, interest and principal, at 4 per cent. in 21 years by, per annum, £161; to which should be added at least 2½ per cent. depreciation and repairs—say £136—and £70 for attendance and small stores: total, £367. Again, assuming a total consumption of about 18 units per 33-watt lamp fixed, and 12s. the gross earnings per lamp per annum, and allowing 96 per cent. efficiency as before, and the equivalent of 15,000 8-c.p. lamps connected with this one station, or say £9,000 per annum, the above annual charge will represent 4 per cent., being a standing charge on every unit sold.*

* A useful comparison may be drawn between the cost of these 2,000-volt mains and low-tension mains at 200 volts from the generating station to the same distributing centre. A loss of 2 per cent. in the high-pressure mains, and of 4 per cent in transforming—total, 6 per cent.—in the former, may be fairly balanced by a loss of 15 per cent. in the latter. The additional size of the low-tension plant is counterbalanced by its lower price. The low-tension main, required to carry 400 kilowatts at 200 volts pressure through 1,200 yards of distance with a loss of 15 per cent., would be about 4 square inches of copper in each outer conductor, and 2 square inches in the middle wire. Such a line, using the largest insulated cables made, and drawing them into 10 3in. "ways" of casing, would cost more than £15,660, representing an annual charge of £490, or 5·4 per cent. on each unit sold. Mr. Crompton will, I hope, give us the cost of the same sections of bare copper strip laid in culverts on his system, if he can keep his culvert within 160 inches sectional area.

(To be concluded.)

MEASUREMENT OF THE CAPACITY OF CONDENSERS UNDER ALTERNATE CURRENTS.*

BY J. SAHULKA.

The author has found that condensers having a solid dielectric have a smaller capacity when used with alternating currents than is given by a measurement by direct-current methods. He considers that the reason for this phenomenon lies in the construction of the dielectric. Even if it has a very high electrical resistance it absorbs energy in the process of charging, which energy is partly returned to the circuit in the discharge and partly converted into heat; for this reason, if a measurement of charge or discharge is made the galvanometer deflection is too high, for it is a measure not only of the quantity of electricity passing on to or out of the coatings, but also of that taken up or returned by the dielectric. Now it is well known that the dielectric takes an appreciable time to take up this quantity of electricity, and since in alternate-current working charge and discharge occur successively with enormous rapidity, it follows that the dielectric has not time at every charge to take up as much electrical energy as it would on direct currents measured by a galvanometer of a period perhaps a couple of hundred times as long, and similarly it gives up less energy in the discharge. This explains completely the difference in capacity for alternating and direct currents. It is necessary, then, says the author, to define what is meant by capacity, where alternating currents are concerned, and he proposes the following definitions. The capacity of a condenser in an alternate current circuit is equal to the reciprocal of the product of $2\pi n$ and its inductive resistance, the latter being equal to the quotient of the potential difference at the condenser terminals caused by the charge, divided by the strength of the current flowing into it.

The author mentions an experiment on a condenser with paraffined paper as dielectric, having a capacity of about a microfarad when measured on direct currents, which was found on an average of several experiments with alternate currents to have a capacity about 14 per cent. lower. Steinmetz's law, according to which condensers having solid dielectrics should absorb under alternating currents an amount of energy proportional to the square of the potential difference within a large range, was found by the author's experiments to be very approximately true.

* Abstract of article in Wiener Sitz.-Ber., Vol. 102.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, February 23rd.

PHYSICAL SOCIETY.

5 p.m. The following Papers are down to be read: (1) "A Method of determining Refraction Indices," by W. Littlewood. (2) "A New Electrical Theorem," by T. H. Blakesley. (3) "The Attachment of Quartz Fibres," by Prof. C. V. Boys.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting at 25, Gt. George-street. The following Paper is down to be read: "Ship Slipways," having special reference to the Dover Slipway, by Walter Beer, Stud.Inst.C.E.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Ladies' Night. Concert at the St. James' Hall Restaurant (Banquet Room), Regent-street, W.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Transformations of Electric Currents," by Prof. Silvanus P. Thompson, F.R.S.

SATURDAY, February 24th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture on "Light," with special reference to the Optical Discoveries of Newton, by the Rt. Hon. Lord Rayleigh, F.R.S.

TUESDAY, February 27th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be read, with a view to discussion: (1) "The Liverpool Overhead Railway," by J. H. Greathead and Francis Fox, M.M.Inst.C.E.; (2) "The Electrical Equipment of the Liverpool Overhead Railway," by Thomas Parker, M.Inst.C.E.

WEDNESDAY, February 28th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper to be read: "Rainfall Records in the British Isles," by G. J. Symons, F.R.S.

FRIDAY, March 2nd. INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting at 25, Gt. George-street. The following Paper will be read: "Efficiency and Economy of Elevators," by Herbert W. Umney, Stud.Inst.C.E.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Theory of the Cochlea and Inner Ear," by Prof. John G. McKendrick, M.D.

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The Electrician.

(The Oldest Electrical Journal, 1861—1878.)

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STREET LIGHTING.

Street lighting by glow lamps must be accepted as one of the problems of the near future, and it has been rather hastily assumed that if electric lighting by this means is superior to gas for some purposes it can replace it under nearly all circumstances. General WEBBER's remarks on this subject in his recent Paper on the lighting of the City of London seemed to have been interpreted by some of his hearers to imply that such a mode of street lighting is impracticable, but he did nothing more than give a warning against badly designed plans. In his Paper at the Society of Arts last week, Prof. H. ROBINSON observed that it is often stated that the cost of public lighting by electricity is greater than by gas, but that if the same standard of illumination had to be obtained by gas as by electricity the statement would not hold good. He thought that it was entirely a question as to whether or no the standard of lighting does not require to be raised. This is equivalent to stating

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that to light a street with glow lamps at the ordinary degree of illumination is more expensive than with gas. Under ordinary circumstances this is undoubtedly true, and as a starting point it is necessary to inquire at what point the cost of the two systems is the same, and then the effect of an increase of the illumination on the cost of each system.

Among the gas burners of which we published tests some three months ago, were several burners used for street lamps, and of these one of the best known gave results almost exactly identical with the mean of 22 burners. The mean cost of lighting, as deduced from the report, was 22·8d. per candle per year, at four hours a day, this being the basis assumed by Prof. AYRTON in his Royal Institution discourse. We showed, on page 143 of our issue for December 8, 1892, that the cost of a 16-c.p. glow lamp, at 3 watts per candle, renewals at 6s. for 1,460 hours, and current at 4d. per unit, comes to 22·02d., or almost exactly the same as gas. We have given a very liberal figure for renewals, as we have no definite information on the subject. Whatever be the total number of hours of lighting in the year, or the number of lamps used for a mile of streets, this equality between the cost of gas and the cost of electric light will be maintained. To provide and maintain special mains and switches would, of course, far exceed the cost of a lamplighter, and the only difference would be a slight, but hardly appreciable, saving in cleaning. Where electric supply can be provided at a profit for less than 4d. per unit, and where gas is 2s. 6d. per thousand, or in this proportion, competition with gas becomes practicable. To attempt to reduce the lamp renewals by increasing the candle-power, and decreasing the number of lamps, although a very useful expedient in the case of large halls or public buildings, would only aggravate the bad distribution of the light in street work.

The extent to which uniform distribution of illumination for street lighting is necessary, convenient, or agreeable, is very difficult to decide. It is possible both by experiment to determine, and by calculation to predetermine, the distribution of illumination due to any given arrangement of lights, but these results, after all, tell us nothing. It is necessary to go to the street thus lighted, and to form a judgment of the quality of the illumination; and it is difficult to separate this from the intensity of illumination or total quantity of light. It has been found that the arc lighting in the City of London is less uniform than the gas lighting in Whitehall. If 100 square yards of each of these streets be divided into the best lighted 25 square yards, the worst lighted 25 square yards, and 50 square yards of mean illumination, the first and last of these are best provided in the City, but the 50 square yards of mean illumination are better in Whitehall. Two years ago, perhaps, before the City lighting had settled down, and while the lamps and perhaps the carbons allowed room for improvement, the illumination just after a lamp had fed was often considerably below the Whitehall standard. The City lamps cost £26 a year, and illuminate from 90 to 100 square yards. The gas lamps in Whitehall light between 10 and 11 square yards for one cubic foot of gas. There is a special contract for the Whitehall and Parliament-street lighting, the cost being £307 17s. 10d. per annum for the district lighted by the 45 special Sugg's lamps, the light being reduced after midnight. But at 3s. per thousand cubic feet the cost of lighting 1,000 square yards in this fashion would be about 2·7d. per hour. Taking 4,400 hours to the year, which is probably under the mark, arc lighting at the City rate would cost about 1·62d. for the same work. Taking these arcs at 500 watts (probably above the mark) the cost per unit is about 2¾d. per unit; this includes carbons and trimming. This low price is of course exceptional. From the very beginning of negotiations for lighting the City the obligation to carry out the street lighting was the condition on which the supply for private lighting would be granted. This price is probably little more than the "sheer cost" of the lighting. Allowing half a watt per candle for an arc, a very liberal allowance, and three watts per candle for a glow lamp, and setting carbons against lamp renewals, and trimming against lamp lighting, the cost of the latter is, roughly, six times that of the former, light for light.

We do not believe that the total light remaining the same, a really uniform distribution of light like moonlight would be appreciated, for the mean illumination would be on the whole less convenient than occasional well-lighted spaces separated by darker portions. We should not like our meals in ten-minute mouthfuls 144 times a day. But this question of distribution becomes very important when a rather lower standard of illumination than that of the City lighting is attempted. Only two remedies are possible, optical devices, or smaller and more numerous lamps. The former are unsatisfactory on account of the trouble and expense of cleaning the prisms, but we do not think that the latter has been given a fair trial. Six ampere, or even five ampere lamps, with a positive carbon as large as can be used without tunnelling or burrowing of the crater, and long negative carbons as slender as can be carried and handled without breakage, run in series of five on the outer conductors of a three-wire system have yet to be tried on a fairly large scale. The lighting of the City being confessedly better than that which most Corporations or Vestries could afford, the decreased illumination might with advantage be obtained by using such lamps on posts as high, or nearly as high as those in the City, and placed as far, or nearly as far apart. The glass might be less obscured, as the lights would be less dazzling. We should like to find some grounds for recommending the adoption of street lighting by glow lamps at a price profitable to the contractor, but even with the great saving of copper by a well-designed series system, running up to, say, 800 lamps on a circuit, the sixfold decrease of efficiency is a serious drawback. It is, however, as we have said, a problem of the near future, and the adoption of electric lighting by municipal authorities will afford many opportunities for experiment in this direction.

REVIEWS.

A Text-Book of Electro-magnetism and the Construction of Dynamos. Vol. I. By DUGALD C. JACKSON, B.S. (New York and London: Macmillan and Co., 1893).

This book makes no claim to special originality; it is a compilation from the works of Ewing, Hopkinson, and S. P. Thompson, in which it is sought to present in a condensed form the researches of these scientists on electro-magnetism and the theory of the dynamo. The present volume, which deals with continuous-current machines, is to be supplemented by a second volume in which alternators will be discussed. The standard of mathematical treatment in this work is too advanced, not to say prolix, for it to be of much value to elementary students; while, for advanced students and engineers, the treatment is on the one hand too abridged and on the other hand too unpractical and *doctrinaire*. The author has made the mistake of selecting a purely elementary scope, and subjecting it to very complicated treatment. For example, in Chapter V., on "The Magnetic Circuit of the Dynamo," instead of finding something which the beginner might understand or the engineer profit by, we discover such pure pedantry as the determination of the magnetic reluctance between two

parallel cylinders, one cylinder being supposed to be at one uniform magnetic potential and the other cylinder being supposed to be at another uniform magnetic potential, and no poles, yokes, or disturbing masses of iron being assumed to be within any less than an infinite distance. Now all this may be very interesting to the abstract mind with a taste for problem involving Laplacian and other functions; but, we need scarcely say, it is utterly useless from the dynamo point of view. Again, wherein lies the benefit in entering on a complicated series of armature calculations, on pages 113 to 121, based on purely abstract assumptions, if we are to be told at the end of it all that "this is an unwieldy method of determining the relations . . . and would usually give results of little value"? Unwieldy, indeed! but it is all the reader is offered.

We are informed in the preface that the book "treats the subject from the American standpoint and represents American practice." Yet we fancy that both American and English dynamo builders will be astonished to learn, on page 110, that the limit of safe current density in ventilated armature conductors is not greater than "about 2,500 amperes per square inch." This may be safe practice, but it is certainly not the safe limit. In the account of Hopkinson's magnetometer it is suggested that, instead of cutting the test piece in two and separating the parts under constant magnetic force, the magnetising current should be reversed, as in the Rowland's ring, "in which case the test piece need not be divided." This would be to defeat the whole purpose of the Hopkinson magnetometer, and to introduce the error which is inseparable from the Rowland ring method as recommended by the author.

The book seems to have been printed in America, and the illustrations are numerous, instructive, and very well executed, consisting as they largely do of curves showing various electromagnetic properties. But the book is not a safe one in the hands of any person who does not thoroughly understand all that it attempts to teach.

Theoretical Elements of Electro-Dynamic Machinery, Vol. I. By A. E. Kennelly. (London: E. and F. N. Spon. New York: D. Van Nostrand Co. 1893.)

This volume is a collection of a series of articles recently published in the *Electrical Engineer* of New York.

It professes to set forth, for students of electrical engineering, "the applied or arithmetical theory of electro-magnetism, as distinguished from the purely mathematical theory." It is difficult, and it would be manifestly unfair, to pronounce a final judgment on a treatise solely upon the evidence of the first volume. And this difficulty is rendered much greater when one is kept in ignorance of whether the complete treatise is to appear in two or two hundred volumes, and as to the scope of the whole work in relation to the "groundwork" which is "completed within the limits of these covers." Judging tentatively, then, we can only pronounce an opinion on the groundwork before us. And we are obliged to confess that it is disappointing. To us it seems that the author has abandoned entirely "the applied or arithmetical theory," and has given himself over to a series of elaborate discussions of the mathematical niceties of hypothetical and unpractical problems. Diagrams of equi-potential lines and of lines of force, in the neighbourhood of points, thin plates, bars, infinitely isolated circular currents, &c., &c., pervade the book, and are sandwiched between mathematical discussions of their conditions. Thus, for example, the most elaborate set of curves in the whole volume, namely that occurring on the plate between pages 80 and 81, represents the conditions of stress and of rate of change of stress when little iron spheres are suspended in various magnetic fields. All these things are instructive, useful, and interesting in their proper relation; and, though we might perhaps prefer a more elegant mathematical treatment than Mr. Kennelly has adopted, we feel that the volume would be a very good one in the hands of the purely scientific student. But it is surely a little out of place to offer a work of this kind to the electrical engineer, as a treatise on the theoretical elements underlying his machinery. In any work dealing with the theory or practice of machinery of any sort, imaginary and unpractical cases are only admissible when the argument based on them leads to some really practical conclusion which could not as well have been deduced from the consideration of truly practical cases. But perhaps Mr. Kennelly means to come down to the practical level in the sequel.

Electricity in the Service of Man. By R. Wormell, D.Sc. M.A. Third edition. Revised and enlarged by R. M. Walmsley D.Sc. (London: Cassell and Co. 1893.)

This popular treatise on the applications of electricity to the fulfilment of some of the numerous needs of mankind was originally a translation from the German of Dr. Von Urbanitzky. Since the issue of the first edition, however, the work has undergone a process of such extension and alteration that it may practically be regarded as having little in common with its German embryo. In Dr. Walmsley's hands, this latest edition has been brought well up to date, having been stocked with a vast amount of new and well-illustrated matter, dealing with recent advances in electrical engineering and technology. A great amount of obsolete matter has been removed, in order to make room for this new material, in spite of which the volume has now expanded to one of nearly a thousand pages, illustrated by an almost equally large number of popular pictures. We cannot, of course, recommend this work as in any way supplying the needs of a student of electrical science; neither, we are sure, would its translator and reviser expect us to do so. But, taken as a clearly-written, popular *exposé* of the development and present state of every important branch of electrical technology, it is an admirable production. We notice, however, with regret that among the things which have been cleared away from the original matter is the "Introduction" which was written for the first edition by Prof. John Perry, and which formed a very valuable introduction indeed, and which it was a pity to part with.

Elementary Manual of Magnetism and Electricity. By Prof. Andrew Jamieson, M.I.C.E. Third edition. (London: C. Griffin and Co. 1894.)

This manual has been written expressly for elementary or "first-year" students. It is designed to cover the requirements for examination in the elementary stage by the Science and Art Department. We may say, however, that the ground covered is more extensive, more practical, and less hampered by obsolete phrases than the official syllabus and examinations of that examining body. This is the third edition of Prof. Jamieson's useful little work, and we find that in many places it has been brought up to date. The matter is arranged in the form of a course of some 28 lectures; though we fancy that the majority of elementary classes would require to take their instruction in smaller and more numerous doses. It is always to be regretted when a lecturer and author allows the local phraseology of his lecture-room to be introduced into his text-book. What benefit, for example, can the general reader be expected to derive from the concluding sentence in this book:—"When we commence our Advanced Series of Lectures we will reverse the order of treatment. . . because it will be fresh in your memory. . . There is not the same excuse for avoiding the November fogs, because in the Advanced Course the treatment is of necessity more mathematical!" Why is the prospect of an advanced treatise to be advertised as a reversal of the elementary one, and what is the cause why a "mathematical treatment" in it is to be considered an antidote to the dread November fog? Careful reading of the proof sheets is the best antidote to this unnecessary type of literature. Nevertheless, we can strongly recommend Prof. Jamieson's little book to elementary students of electricity, who will find it a safe guide and an intelligible instructor.

A Pocket-Book of Electrical Rules and Tables. By John Munro, C.E., and Andrew Jamieson, M.I.C.E. Tenth edition. (London: C. Griffin and Co. 1894.)

This well-known pocket-book, which has been for so many years appreciated by every branch of the electrical profession, has now reached its tenth edition. In its latest form it resembles its predecessors, both in shape and size; but care has been exercised in careful revision of its contents and in the choice of new material. The additional features in this latest edition are:—An abstract of the decisions of the International Congress of Electrical Engineers at Chicago in

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1893, in regard to nomenclature and units; Lloyd's rules for ship lighting; several tables of constants for electrical properties of copper, &c.; besides descriptions of some of the latest methods of electrical testing. In a work of this sort, which appeals to so many branches of a widely-extended technical science, it is inevitable that each branch will find much that it fails to see the direct use of; so that we are prepared to admit that complaints of the inutility of any part of the work may arise from shortness of sight. Still, we do not quite perceive any advantage in the retention of, say, the three or four whole pages devoted to a description of the secohmmeter—an instrument which has not only been robbed of its purpose, but also of half its name.

Annuaire pour l'An 1894, publié par le Bureau des Longitudes. (Paris: Gauthier-Villars et Fils.)

In addition to the usual astronomical, physical, chemical, electrical, magnetic, and geographical data the Annuaire for 1894 contains an interesting note by M. Poincaré, entitled "Light and Electricity according to Maxwell and Hertz," in which it is pointed out that Hertz's brilliant success in what M. Poincaré terms his "veritable synthesis of light," was due to the simple fact that he succeeded in his oscillator in devising an electrical starter of electromagnetic vibrations. At the end of his notice M. Poincaré calls attention to the various points connected with the Maxwellian theory that still refuse to submit to experimental proof; such, for instance, as the obstinate non-compliance of transparent bodies with the Specific Inductive Capacity = $\sqrt{\text{Index of Refraction}}$ law. Admiral Fleuriais contributes a note on the compass, M. Janssen one on his four days spent at the top of Mont Blanc, and the volume concludes with the speeches delivered on the occasion of the unveiling of Arago's statue in June last. It is a pity, however, that no room was found amongst the 800 pages of the Annuaire to put on record the decisions of the Chicago Electrical Congress; they were surely sufficiently mature to find a place even in a semi-official publication.

Laxton's Price Book, 1894. (London: Kelly and Co.)

Three sections of this annual publication are this year devoted to electrical matters. Two pages are devoted to lightning conductors; solid copper tape being, as was the case last year, recommended as the best form of conductor. Telephones take up a single page, occupied solely by the quotations of the Consolidated Telephone Company and the General Electric Company. The electric lighting section is far more extensive than last year, but is not on that account less likely to lead to misapprehensions. The labour of wading through a large number of price-lists and deducing a table of average prices would no doubt be severe, and the result perhaps not commensurate with the effort. But failing some such heroic device, the prices of at least half-a-dozen of the leading firms should be given in the case of each important piece of apparatus, so that the unsophisticated purchaser, for whom presumably such things as price books are compiled, may not have his attention too forcibly confined to a single or it may be to a couple of makers. A page is devoted to electric lighting engines: the names of plenty of makers are given in this case, it is true, but that of Willans and Robinson is omitted; perhaps it is too well known to require mention. Omissions of this kind are, however, as we have said before, likely to lead to misapprehensions.

Lockwood's Price Book, 1894. Edited by FRANCIS T. W. MILLER, A.R.I.B.A. (London: Crosby Lockwood and Son.)

This price book contains three sections devoted to electrical matters, viz., Lightning Conductors, Phœnix Rules, and Electric Lighting, the latter of which should prove fairly useful as a guide to an intending purchaser of electric lighting apparatus, the names and prices of several makers being given in the case of dynamos, arc lamps, glow lamps, and accumulators, whilst the prices of accessories are not taken from a single firm's catalogue, but are fairly average ones. Under the heading "Steam Engines for Dynamo Driving," however, the only engine given is that made by the Brush Company.

IMPROVED SWITCHES AND SWITCHING GEAR.

A number of switches and other appliances have lately been invented and patented by officers of the Brush Electrical Engineering Company. These inventions have for their object the simplification of central station working and the reduction of risk of accidental stoppages, which sometimes occur through carelessness or nervousness on the part of the attendants or from disablement of some part of the plant. Among these are automatic switching gear for continuous-current dynamos or exciters, interlocked switching gear for alternators working in parallel, interlocked switching gear for main feeders for continuous or alternate currents, return current fuse for use on the leads connecting an alternator with the omnibus bars, universal perfect contact switch, automatic transformer switch, automatic rocking gear for Brush dynamos, water type Brush automatic regulator. The first five of these are the invention of Mr. Raworth, the last is a modification of the Brush-Geipel regulator, and the remaining two are the invention of Mr. W. M. Mordey.

The return-current fuse is intended to render the parallel working of alternators perfectly safe, because the fuse will melt only with return current; that is to say, the fuse cannot be melted whilst energy is being transmitted from the alternator to the mains, but should the alternator from any cause fail to give its full volts the fuse will immediately act and cut it out of circuit. For instance, if three alternators be working in parallel, and one of them fail, then the other two have to supply current for the outer circuit, and sufficient additional current to burn the fuses of the disabled alternator. Under these conditions all the fuses would go

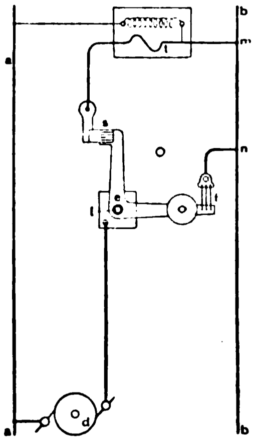

FIG. 1.—Diagram of Connections of the Return-Current Fuse.

simultaneously, or the fuses of the two working alternators might melt without cutting off the disabled alternator. Referring to the diagram (Fig. 1), *a* and *b* are the omnibus bars, *d* the alternator, *e* a weighted lever, *f* the fuse. The accelerator, which is a small transformer, is shown at *t*. It will be seen that the current enters at the joint, *l*, from which point there are two paths open to it to the omnibus bar, *b*—one through the switch, *s*, and the accelerator, *t*, and the other through the fuse, *f*. The accelerator has the effect of slightly increasing the pressure by something under half a volt, which is sufficient to induce the current to select that path in preference to the path by the fuse, but in the event of the current returning upon the alternator the accelerator acts as a retarder, and forces the current through the fuse, which as it melts liberates the switch, *s*, and cuts off the alternator.

The automatic switching gear, is applicable in all cases where two or more continuous-current dynamos or exciters are arranged to work in parallel on a common circuit. The switch closes automatically when the dynamo attains a voltage equal to that existing in the station mains, and opens automatically when the dynamo ceases to generate current. It is claimed that this automatic switching gear entirely prevents accidents from closing the switch when the dynamo is unexcited or not giving full volts; closing the switch when the polarity of dynamo is reversed; the current coming back on the dynamo and burning the fuses.

The interlocked switching gear is intended to facilitate the working of alternators in parallel; the gear is arranged so that the main switch cannot be closed until the field switch is closed and the field fully excited, also not until the synchroniser switch is closed. When the main switches are closed the field switch cannot be opened, and the main switches are locked by shutting off the synchroniser switch. The main switches break through water and oil, and are practically sparkless under all conditions. It is claimed that the interlocked switching gear prevents accidents from closing the main switch when the alternator is unexcited or not giving full volts; and from opening the field switch when the main switch is closed.

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The interlocked switching gear for main feeders, continuous or alternating current, takes the form of a cast-iron pillar which carries the main switches, fuses, ammeter, and voltmeter, regulating gear, and interlocking machinery. In the base of the pillar, where the leads enter, there is a switch for disconnecting the upper part of the pillar and for establishing the circuit, in order that the instruments, fuses and switches may be examined and repaired without cutting off the feeder. There are three fuses fixed on the top of the pillar, any one of which may be put in circuit by turning the right-hand handle, but this handle cannot be moved unless the main switch be open. Double-pole switches are fixed below the fuses, and are actuated by the central handle, which is locked by a trigger, which must be released before the switch can be opened or closed. The handle on the left actuates the disconnecting switch, but it cannot be moved unless the main switch be open. By means of the disconnecting switch any part of the gear can be examined and repaired without any possibility of shock. It is claimed that no mistakes can be made, as the handles are all interlocked.

THE DRAFT ELECTRIC TRACTION REGULATIONS.—SUGGESTED ALTERATIONS.

Regulation observed upon.	Body making Observations and Observations made.
Definitions	**By Institution of Electrical Engineers.** In the last paragraph but one after ampere insert : The expression "line" or "lines" means an insulated conductor or conductors used for transmitting energy from the generator or generators to the trolley wire or other conductor from which the current is taken to the motor or motors by a rubbing contact. The expression "return" or "returns" means the conductor or conductors, uninsulated or otherwise, used for completing the circuit or circuits between the motor or motors and the generator or generators.
Definition 6.—The expression "current" means an electric current exceeding one-thousandth part of one ampere.	**By London Chamber of Commerce (Traction Committee).** The Committee understand that definition 6 is not intended by the Board to apply to telegraphic, telephonic, and railway signalling currents.
Reg. No. 1.—Any dynamo used as a generator shall be of such pattern and construction as to be capable of producing a steady continuous current.	The Committee suggest that the word "steady" in line 2 (*here* 6*), be defined under the heading "definitions."
Reg. No. 2.—One of the two conductors used for transmitting energy from the generator to the motors shall be in every case insulated throughout its length, and is hereinafter referred to as the "line"; the other may be insulated throughout, or may be uninsulated in such parts and to such extent as is provided in the following regulations, and is hereinafter referred to as the return.	**By Institution of Electrical Engineers.** Omit and insert in its place— The line or lines shall in every case be insulated throughout its or their length or lengths. The return or returns may be uninsulated in such parts or to such an extent as is provided in the following Regulations. **By London Chamber of Commerce (Traction Committee).** Line 2 (*here* 6).—It is suggested that the words "from earth" should be inserted after the word "insulated." **By Imperial Tramways Company, Limited.** "One of the two conductors used for transmitting energy from the generator to the motors shall be in every case insulated throughout its length, &c." It is gathered from the context of this Regulation that by "the two conductors" is meant the outward and the inward wire, only one of which transmits energy "*from* the generator *to* the motor," the other afterwards correctly described as "the return" carrying the current back to the generator. Apart from this use of the doubtful expression "two conductors," my Directors desire a clearer and more explicit statement of what is here meant by "insulated throughout its length." If by this is meant the use of "insulated wire" in its usual acceptation, then the Regulation is simply fatal to the use of the overhead trolley system, which can only be worked with an uncovered wire. If the words mean that at the points of support, and at the junction of the trolley wire-arm with the standard, complete and full insulation must be provided, then this should be made perfectly clear. And my Directors desire me to point out that if the other and fatal interpretation of the words be intended, then the Regulation is directly opposed to the opinion of the Joint Committee of the Houses of Parliament, 1893, as expressed in their Report, where the opinion is clearly stated that it is not for the interest of the public to insist upon regulations "calculated to retard" the development of electric traction.
Reg. No. 3.—Where any rails on which cars run or any conductors laid between such rails form any part of a return, such part may be uninsulated. All other returns or parts of a return shall be insulated.	**By Institution of Electrical Engineers.** Line 1 (*here* 4) after "between" insert "or contiguous to." Line 2 (*here* 7), after uninsulated" insert "but the supports of all overhead wires, whether line or return, shall be electrically connected to the return circuit." Line 3 (*here* 9), after "insulated" insert "unless of such sectional area as shall satisfy the Board of Trade." **By Association of Municipal Corporations (Dr. J. A. Fleming).** The uninsulated conductor is to be laid *between* the rails. It might be convenient to lay it just outside one of them. Hence it would be desirable to ask that this regulation may read—"between such rails, or within two feet of the outside of either rail." **By London Chamber of Commerce (Traction Committee).** Line 1 (*here* 4).—As it may be necessary in some cases to lay conductors outside the rails, it is suggested that the words "or contiguous to" should be inserted after the word "between." It is thought that the last sentence of this regulation will introduce a question on which it is impossible to give a definite opinion in the present state of knowledge. Any regulation forcing the industry to adopt a partially insulated return in place of an uninsulated one of heavier section may defeat the objects the Board of Trade have in view, and it is therefore suggested that the sentence should be omitted.
Reg. No. 4.—When any uninsulated conductor laid between the rails forms any part of a return, it shall be electrically connected to the rails at distances apart not exceeding 100 ft. by means of copper strips having a sectional area of at least one-sixteenth of a square inch, or by other means of equal conductivity.	**By Institution of Electrical Engineers.** In line 2 (*here* 7), after the word "rails" insert "to the satisfaction of the Board of Trade," and strike out remaining words. **By National Telephone Company.** The Telephone Company is satisfied that induction and not leakage is the main cause of disturbance, and that that disturbance will be minimised by requiring "the return," whether insulated or uninsulated, to be placed parallel, and as near as may be, to the line. *Regulation* 13 provides for this where the return is insulated, whether run overhead or underground. The National Telephone Company is advised that there is no reason (either electrical, engineering, or financial) why a similar regulation should not apply to the case of an uninsulated return. Obviously this is simple where the line and return are both underground, and where the line is overhead it is easy also to carry the *return* overhead and within a reasonable distance of the line, connecting the return at each post with the rails by means of suitable copper conductors. In most cases this return might suitably be carried on the poles which carry the line from which the feeders are supplied with energy. *Regulation* 4 provides for an electrical connection between an uninsulated conductor laid between the rails and forming part of the return and the rails themselves, at distances not exceeding 100 ft. It is suggested that this regulation should be modified, so as to provide for the same electrical connection with an uninsulated return carried overhead in the manner suggested above, and that the connections should be not more than 50 ft. apart, or if the distance of 100 ft. is maintained that the connections should be alternately to each rail, so that there should be a connection between one or other of the rails and the return every 50 ft.

* These references are to the numbers of the lines as printed in *The Electrician*.

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Regulation observed upon.	Body making Observations and Observations made.

By London Chamber of Commerce (Traction Committee).

Line 1 (*here* 3).—It is suggested that this regulation should be amended in the terms suggested for No. 3, viz., by the insertion of the words "or contiguous to" after the word "between."

Reg. No. 5. — When any part of a return is uninsulated it shall be connected with the negative terminal of the generator, and in such case the negative terminal of the generator shall also be directly connected, through the current indicator hereinafter mentioned, to two separate earth connections which shall be placed not less than 20 yards apart.

Provided that in place of such two earth connections the Company may make one connection to a main for water supply of not less than four inches internal diameter, with the consent of the owner thereof.

Such earth connections shall be constructed, laid, and maintained, so as to secure contact with the general mass of earth, so that an electromotive force, not exceeding four volts, shall suffice to produce a current of at least two amperes from one earth connection to the other through the earth, and a test shall be made at least once in every month to ascertain whether this requirement is complied with.

Where any portion of either earth connection is placed within 6ft. of any pipe, and the Company are unable to obtain permission to metallically connect it with the earth connection, they shall provide by means of a non-conducting screen that no current can pass between the pipe and the earth connection, without traversing at least 6ft. of earth.

By Institution of Electrical Engineers.

First paragraph, last line, after "apart" insert "and close to the generator end of the uninsulated portion of the return."

Strike out paragraph 4 and bring down in its place paragraph 2.

By Association of Municipal Corporations (Dr. J. A. Fleming).

A more explicit definition should be asked for as to the nature of the "Non-Conducting Screen" which is to be provided in some cases. The regulation as it stands is difficult to interpret. The simple coating of the pipe with gas tar or pitch for 6ft. of its length might be asked for as a substitute for this "Non-Conducting Screen."

By Associated Railway Companies.

That an uniform system of joining up the generators be observed, whether the return wire be insulated or not, the object of this being to enable the block instruments to be joined up in such a manner that the traction current shall produce the "Train on Line" signal, and not the "Line Clear" signal.

By National Telephone Company.

Paragraph 3.—It is suggested that this paragraph should be re-cast, so that the test shall be the resistance of the earth measured in ohms, and that that resistance should not exceed one ohm.

By London Chamber of Commerce (Traction Committee).

Paragraph 2, line 2 (*here* 7).—That the diameter of the pipe be limited to "three inches" instead of "four."

Paragraph 3, line 1.—That the words "referred to in this clause" be inserted after the word "connections"; line 2 (*here* 4), that the word "electrical" be inserted after the word "secure."

Paragraph 4, line 3 (*here* 9).—It is suggested that all the words after "they shall" should be deleted, and that the following words should be substituted:—"if required by the owners, at their own expense coat such portions of the pipe as shall be within the distanceof 6ft. with a non-conducting 'material.'"

Reg. No. 6.—When the return is partly or entirely uninsulated the Company shall in the construction and maintenance of the tramway (*a*) separate the uninsulated return from the general mass of earth, and from any pipe in the vicinity; (*b*) connect together the several lengths of the rails; (*c*) adopt means for reducing the difference produced by the current between the potential of the uninsulated return at any one point and the potential of the uninsulated return at any other point; and (*d*) maintain the efficiency of the earth connections specified in the preceding Regulations, so as to fulfil the following conditions, viz.:—

(*i.*) That the current passing from the earth connections to the generator shall not at any time exceed 10 amperes.

(*ii.*) That if at any time and at any place a test be made by connecting a galvanometer or other current-indicator to the uninsulated return, and to any pipe in the vicinity, the direction of the current, if any, shall be from the return to the pipe, and not *vice versâ*.

(*iii.*) That under the conditions specified in (*ii.*) it shall always be possible to reverse the direction of the current by interposing a battery of three Leclanché cells connected in series.

In order to provide a continuous indication that the condition (*i.*) is complied with, the Company shall place in a conspicuous position a suitable, properly connected, and correctly marked current-indicator, and shall keep it connected during the whole time that the line is charged.

The owner of any pipe may require the Company to permit him to ascertain by test that the conditions (*ii.*) and (*iii.*) are complied with as regards his pipe.

By Institution of Electrical Engineers.

First paragraph, after (*a*) insert "so."

First paragraph, after (*b*) insert "so."

First paragraph, after (*c*) "adopt" insert "such."

First paragraph, after (*d*) insert "so."

First paragraph, line 8 (*here* 27), after "regulations" strike out word "so."

(*i.*) After "connections" insert "through the indicator"; strike out 10 amperes and insert "2 amperes per mile of single track without the consent of the Board of Trade."

(*ii.*) Strike out present clause, and insert "That if at any time and at any place a test be made by connecting a voltmeter to the uninsulated return, and to any pipe which the current can reach without traversing more than 6ft. of earth, the difference of potential arising from the working of the tramway between them shall not be greater than 4 volts if the return is positive to the pipe, or greater than one volt if the pipe is positive to the return."

(*iii.*) Strike out.

In last paragraph, line 1 (*here* 3), after "Company" strike out "to permit him"; in line 2 (*here* 4), after "that" strike out "the" and the s in conditions and "and (*iii.*) are" and insert "is"; and in the last line after "pipe" insert "and in the event of the test proving that the condition is complied with, he shall bear the cost of such test."

By Association of Municipal Corporations (Dr. J. A. Fleming).

Is a long regulation which reduces itself in effect to a provision that the Tramway Company must so far insulate the rails and uninsulated conductor that the integral earth leakage from all parts of the line back to the negative terminal of the generator shall never exceed 10 amperes, and that the uninsulated return, or partly insulated return, conductor shall be at a higher potential than any pipe in its neighbourhood by not more than four volts.

Since the pipe will always, or nearly always, be at zero potential, this is equivalent to saying that no point on the uninsulated rails or return conductor must be at more than four volts pressure above the earth under any conditions. I think that to carry out this regulation in practice over tramways of perhaps several miles in length will involve an expenditure in copper which may prove to require an unremunerative capital outlay. It must be borne in mind that in electric tramway working there arise occasionally demands for current far in excess of the normal working current, as, for instance, when a number of cars get stopped close together and have all to be started at once. Under these conditions the return line and feeders would be called upon to carry an abnormal current, and both the total leakage current and the potential of the return would be temporarily increased. I think that this maximum permissible leakage current should bear some proportion to the length of the tramline, because a leakage current which would be great for a short line would be small for a long one. I suggest that the request should be made to have the whole of Regulation 6 so altered as to state in sub section (*i.*) of Regulation 6 that the *average* integral leakage current passing from the earth connections to the generator shall not exceed five amperes per mile of tramway worked. This average can always be measured by a self-integrating ampere-hour meter. Also that in sub-section (*iii.*) of Regulation 6 it shall be permissible to take the maximum potential, by which the uninsulated return is allowed to be raised above the earth, as that which obtains when the cars are all in motion at about equal distances along the line, and that under these conditions six volts shall be the limit of potential allowable.

By National Telephone Company.

(*i.*) Ten amperes is, it is submitted, an excessive current to be allowed from the earth connections to the generator. There is no practical difficulty in keeping this below *five* amperes.

London Chamber of Commerce (Traction Committee).

That the word "so" be introduced before the word "separate" in line 2 (*here* 7), before the word "connect" in line 4 (*here* 12). That the word "such" be introduced after the word "adopt" in line 4 (*here* 14), and that the word "so" be inserted before the word "maintain" in line 7 (*here* 23). That the word "so" be in consequence deleted in line 8 (*here* 27).

(*i.*) It is suggested that the current permissible should be 3 per cent. of the total current output of the station.

(*ii.*) and (*iii.*). That the following clause be substituted for these:—"That if at any time and at any place a test be made by connecting an indicator to the uninsulated return and to any pipe in the vicinity, it shall always be possible to reverse the normal direction of the current by interposing a battery of three Leclanché cells connected in series or in the reverse direction by interposing one Leclanché cell."

Paragraph 6.—Beginning "the owner of any pipe," line 1. That the words "at reasonabler times and intervals" be inserted afte the word "Company."

Regulation observed upon.	Body making Observations and Observations made.
	That in case such test shows the conditions have been complied with the owner of the pipe be required to pay the expenses incidental to the test. **By Imperial Tramways Company, Limited.** This regulation appears in its details to be unnecessarily complicated, and in the final provision, enabling an outside owner to apply tests to the works of the Tramway Company, it is distinctly objectionable. It has yet to be demonstrated that the conditions *i.*, *ii.*, and *iii.* are practicable in the sense of being applicable to all cases and under all circumstances. In this connection my Directors would point to condition VII., as laid down in the Report of the Joint Committee, where it is expressly stated that the danger of electrolysis has arisen from faulty construction, and that with improved methods of construction (such as are contemplated by this Company), the danger may be made "practically negligible," assuming this opinion to be well-founded, the draft regulation now under consideration appears to be to a large extent unnecessary.
Reg. No. 7.—When the return is partly or entirely uninsulated its electrical resistance shall be tested by the Company at least once in every three months. If at any such testing it appears that the resistance has increased by more than 15 per cent. above the value recorded at the time the tramway was opened, the Company shall take immediate steps to reduce the resistance to the said recorded value.	**By Institution of Electrical Engineers.** In line 3 (*here* 10), after "increased" insert "permanently"; and in line 6 (*here* 17), before "the said" insert "within 5 per cent. of." **By Association of Municipal Corporations (Dr. J. A. Fleming).** This regulation appears on consideration to be difficult to carry out in practice, because of the difficulty of separating the true resistance of the partly-insulated return from that of the earth in parallel with it, and which last may vary from day to day. It would be more difficult to determine if the uninsulated return is laid in separate sections, each connected with the generator by insulated feeders. A careful inspection by eye would be preferable to an uncertain electrical test. I should prefer to see this regulation modified so that it should state that the uninsulated return is to be carefully inspected once in three months, or oftener, and such tests applied as shall be sufficient to show that it is not in any way deteriorated. **By London Chamber of Commerce (Traction Committee).** That for Regulation 7 the following be substituted :—"When the return is partly or entirely uninsulated, a record shall be kept by the Company of the extreme difference of potential reached during the working of the tramway measured between the most distant part of the system and the nearest home point of the uninsulated portion of the system, and if this record shows that at any time the recorded difference of potential exceeds 15 per cent. above the value the company shall take immediate steps to reduce the difference to the required value."
Reg. No. 8.—Every electrical connection with any pipe shall be so arranged as to admit of easy inspection, and shall be tested by the Company at least once in every three months.	**By Institution of Electrical Engineers.** In line 2 (*here* 5), strike out "inspection" and insert "examination." **By London Chamber of Commerce (Traction Committee).** The Committee are desirous of knowing whether the intention is that a manhole should be placed at each electrical connection. The cost of such construction would be unduly heavy.
Reg. No. 9.—Every line and every insulated return or part of a return shall be constructed in sections not exceeding one half of a mile in length, and means shall be provided for isolating each such section for purposes of testing.	**By Institution of Electrical Engineers.** Strike out and substitute : "The insulation of the cables forming the line and the insulated portion of the returns shall be tested apart from all connections, joint boxes, test boxes, &c., and shall not be permitted to fall below the equivalent of 10 megohms for a length of one mile, and for the purpose of testing such insulation these lines and returns shall be so constructed that they can be divided into sections not exceeding one half mile in length, and these tests shall be made at least once every three months." **By Association of Municipal Corporations (Dr. J. A. Fleming).** Provides that the line and insulated return shall be laid in sections not exceeding one half mile in length. There is no reason to impose this limit on insulated feeders, and it would be advisable not to have them so limited. Hence a request should be made that this regulation shall not cover insulated feeders. **By London Chamber of Commerce (Traction Committee).** That the following be substituted for Regulations Nos. 9 and 11 :—"The insulation of the cables forming the line and the insulated portion of the returns shall be tested apart from all connections, joint boxes, test boxes, &c., and shall not be permitted to fall below the equivalent of 10 megohms for a length of one mile, and for the purpose of testing such insulation these lines and returns shall be so constructed that they can be divided into sections not exceeding one half mile in length, and these tests shall be made at least once in each quarter."
Reg. No. 10.—The insulation of the line and of the return when insulated, and of all feeders and other conductors, shall be so maintained that the leakage current shall not exceed one-hundredth of an ampere per mile of tramway. The leakage current shall be ascertained daily before or after the hours of running when the line is fully charged. If at any time it should be found that the leakage current exceeds one-tenth of an ampere per mile of tramway, the running of the cars shall be stopped until the leak has been localised and removed.	**By Institution of Electrical Engineers.** Strike out and substitute : "The insulation of the line of the insulated portion of the return when both are coupled up ready for work shall be such that the leakage current shall not exceed one-hundredth of an ampere per mile of tramway. The leakage current shall be ascertained daily before or after the hours of running when the line is fully charged, and if at any time it exceeds one-tenth of an ampere per mile, the leak shall be localised and removed as soon as practicable. Provided always that where both line and return are placed within a conduit these leakage tests shall not apply." **By Association of Municipal Corporations (Dr. J. A. Fleming).** The leakage current from all the parts of the circuit which is insulated is not to exceed one-hundredth of an ampere per mile. It appears to me that this is a difficult standard to attain in ordinary practice when working at, say, 500 volts on the line. It will be an impossible standard for bare conductors in a culvert. I think that at least one-twentieth of an ampere should be allowed, and the limit beyond which leakage should be considered great enough to stop working should be put at one ampere as a minimum per mile of tramway worked. **By London Chamber of Commerce (Traction Committee).** That the following be substituted for Regulation 10 : "The insulation of the line and of the insulated portion of the return when both are coupled up ready for work shall be such that the leakage current shall not exceed one-hundredth of an ampere per mile of tramway. The leakage current shall be ascertained daily before and after the hours of running, and if at any time it exceeds one-tenth of an ampere per mile, the leak shall be localised and removed as soon as practicable. Provided always that where both line and return are placed within a culvert no such leakage tests shall be required." **By Imperial Tramways Company (Limited).** The Directors would draw attention to the drastic provision in the last sentence of this proposed regulation. Even were it a just and politic provision, which cannot in the meantime be admitted, the absence of any provision of authority or process by which such interruption in the running of the cars is rendered possible indicates a want of thoroughness in the drafting of the regulations.
Reg. No. 11.—The insulation resistance of all lines, insulated returns, feeders, or other conductors, laid below the surface of the ground, shall not be permitted to fall below the equivalent of 10 megohms for a length of one mile. A test of the insulation	**By Institution of Electrical Engineers.** Strike out. **By Association of Municipal Corporations (Dr. J. A. Fleming).** Provides that the insulation of all conductors laid below the ground shall not fall below 10 megohms per mile. I think a request should be made to reduce this to one megohm per mile. **By London Chamber of Commerce (Traction Committee).** *See Reg. No.* 9.

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Regulation observed upon.	Body making Observations and Observations made.
resistance of each part of the circuit shall be made at least once in each month.	
Reg. No. 12.—Where in any case in any part of the tramway the line is erected overhead and the return is laid on or under the ground, and where any wires have been erected or laid before the construction of the tramway in the same or nearly the same direction as such part of the tramway, the Company shall, if required so to do by the owners of such wires or any of them, permit such owners to insert and maintain in the Company's line one or more induction-coils or other apparatus for the purpose of preventing disturbance by electric induction.	**By Institution of Electrical Engineers.** In last line after "induction" insert: "Such apparatus to be approved by the Tramways Company subject to an appeal to the Board of Trade." **By Association of Municipal Corporations (Dr. J. A. Fleming).** This is a provision intended to prevent disturbance by induction on neighbouring wires. If these wires are telephone or telegraph wires, it is in accordance with the recommendations of the Joint Committee to ask that it shall be stated that the owners of such wires shall take such steps by the use of a metallic twisted return to guard themselves against inductive disturbance, and then, if unable to avoid it, shall be permitted to insert and maintain induction coils as stated in the Company's line. **By London Chamber of Commerce (Traction Committee).** Last line.—It is suggested after the word "induction" the following words be added, "provided nevertheless that the efficiency and cost of the line be not thereby affected." **By Imperial Tramways Company (Limited).** Even if the proposal here indicated were practically useful, my Directors would call special attention to this second introduction of a power of interference with a tramway company's installation plant and works on the part of irresponsible outsiders. As with the regulation already discussed, my Directors here notice the entire absence of any intervening public authority to protect the interests of a tramway company from unnecessary officious or malicious and interested interference. With reference to this regulation, my Directors would point out the absence of any provision for the erection of "guard wires" for the protection of the tramway electric line against accidents, contact, or interference by wires belonging to the telegraph, telephone, or other opposing interests. The interference with any existing wires on the part of a tramway company is fully safeguarded here and in regulation 14, but my Directors miss the insertion of any reciprocal obligation on the part of telephone or telegraph works yet to be erected. On this point it is submitted very careful consideration is required. **By London Chamber of Commerce (Traction Committee).** It is suggested that it is unnecessary to vary the distance permissible between the line and return in different systems.
Reg. No. 13.—Any insulated return shall be placed parallel to and at a distance not exceeding 3ft. from the line when the line and return are both erected overhead, or 18in. when they are both laid underground.	
Reg. No. 14.—In the disposition, connections, and working of feeders, the Company shall avoid injurious interference with any existing wires.	**By Institution of Electrical Engineers.** Strike out. **By Association of Municipal Corporations (Dr. J. A. Fleming).** As this regulation stands it would appear that the whole burden of avoiding inductive disturbance rests with the tramway companies. It would be in accordance with the recommendations of the Joint Committee to ask that this shall be modified to read as follows:—"In the dispositions, connections, and working of feeders the Company shall avoid injurious interference with any existing wires which cannot be prevented by the owners of these existing wires, providing a twisted metallic return for the circuits thus liable to be disturbed." **By London Chamber of Commerce (Traction Committee).** This regulation has had the most serious consideration at the hands of the Committee, and it is unanimously regarded by them as practically re opening points dealt with in the recommendations of the Joint Committee. It is felt that it is too general in its terms, and they would suggest its fuller definition or omission. **By Imperial Tramways Company (Limited).** The rule in its bald state as drafted may or may not be charged with deadly peril to the development of electric traction. In providing that "the (tramway) company *shall avoid* injurious interference," it is respectfully submitted that the draft regulation goes far beyond the condition proposed by the Joint Committee that the "undertakers shall *take all reasonable* precautions" not injuriously to affect existing works, and that the Board of Trade should have regard to expense involved and to the effect commercially of any rules proposed to be laid down. In its present bare condition this regulation appears to approve and enact all the extravagant demands of the telephone interest, which it was the express purpose and intention of the Joint Committee to restrain.
Reg. No. 15.—The Company shall so construct and maintain their system as to secure good contact between the motors and the line and return respectively, and they shall not allow sparking to occur at the rubbing or rolling contacts in any part.	**By Institution of Electrical Engineers.** In line 3 (*here* 8), after "allow" insert "more"; and in last line after "part" insert "than is considered reasonable by the Board of Trade." **By Association of Municipal Corporations (Dr. J. A. Fleming).** The word "unnecessary" should be inserted before "sparking." **By National Telephone Company.** Forbids in general terms sparking between the line and the trolley or between the wheels and the rails, but without specifying any precautions which are to be taken, and the tramway companies may contend that it is not possible always to prevent sparking at one or other of these contacts. It is suggested that the tramway company should be required to take all reasonable precautions by the use of brushes and other proper means to maintain effective and uniform contacts so as to minimise as far as practicable both sparking and irregular contacts at these points. **By London Chamber of Commerce (Traction Committee.** Line 3 (*here* 8).—It is suggested that this regulation, as well as No. 17, be merged together, and that the word "undue" be inserted after the word "allow" in the third (*here* 8) line of No. 15. **By Imperial Tramways Company, (Limited.)** The first paragraph of this regulation appears to be unnecessary, for unless good contact is secured the working will be almost impracticable and will certainly be unprofitable. The second part of the regulation, that sparking shall not be "allowed," is also superfluous, as a tramway company would never knowingly "allow" such a state of things to exist, although it can hardly be deemed reasonable or practicable that under all circumstances it should be rigidly prohibited. That this view is correct is proved by *Regulation* 17, in which a tramway company is required to "take all precautions to prevent the occurrence of *undue* sparking." On the rails, sparking is to be totally prohibited, or rather the company is forbidden to "allow" it, but in the generators and in the motors on the car, only "undue sparking" is to be "prevented" as far as "reasonable precautions" allow this to be done. The second part of Regulation 15 should, it is submitted, be deleted.
Reg. No. 16.—In working the cars the current shall be varied as required by means of a rheostat containing at least 20 sections, or by some other equally efficient method of gradually varying resistance.	**By Association of Municipal Corporations (Dr. J. A. Fleming).** The selection of 20 sections in the rheostat is perhaps somewhat too definite. What is really required is a means of varying the current continuously without sudden changes. It would be better to insist that the starting and stopping of cars shall be effected by a continuously varying resistance.
Reg. No. 17.—In the construction and use of their generator and motors the Company	Would disappear if Reg. No. 15 is revised as above.

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Regulation observed upon.	Body making Observations and Observations made.
shall take all reasonable precautions to prevent the occurrence of undue sparking.	
Reg. No. 18.—Where the line or return, or both, are laid in a conduit the following conditions shall be complied with in the construction and maintenance of such conduit :— (*a*) The conduit shall be so constructed as to admit of easy inspection of, and access to, the conductors contained therein, and of all insulators and supports. (*b*) It shall be so constructed as to be readily cleared of accumulation of dust or other *débris*, and no such accumulation shall be permitted to remain. (*c*) It shall be laid to such falls, and so connected to sumps or other means of drainage, as to automatically clear itself of water without danger of the water at any time reaching the level of the conductors. (*d*) If the conduit is formed of metal, all separate lengths shall be so jointed as to secure metallic continuity for the passage of electric currents, and where the rails are used to form any part of the return they shall be electrically connected to the conduit by means of copper strips having a sectional area of at least one-sixteenth of a square inch, or other means of equal conductivity, at distances apart not exceeding 100ft. Where the return is wholly insulated and contained within the conduit the latter shall be connected to earth at the generating station through a high-resistance galvanometer suitable for the indication of any contact or partial contact of either the line or the return with the conduit. (*e*) If the conduit is formed of any non-metallic material not being of high insulating quality and impervious to moisture throughout, and is placed within 6 ft. of any pipe, a non-conducting screen shall be interposed between the conduit and the pipe, or such material and dimensions as shall provide that no current can pass between them without traversing at least 6 ft. of earth.	**By Institution of Electrical Engineers.** In (*a*), line 1 (*here* 3), strike out "inspection" and insert "examination"; and in last line before "supports" insert "their." In (*c*), line 3 (*here* 7), after "water," strike out "at any time." In (*d*), line 2 (*here* 5), after "secure," insert "efficient"; and strike out "passage of." In line 3 (*here* 7), after "currents," insert "which may pass through it"; strike out "and," and commence new sentence. "Where," &c. In line 4 (*here* 10), after "be," insert "equally efficiently"; and after "conduit" strike out down to "feet," and insert "to the satisfaction of the Board of Trade." (*e*) Strike out paragraph, and substitute: "The leakage current shall be ascertained daily before or after the hours of running, when the line is fully charged, and if at any time it shall be found to exceed half an ampere per mile of track the leak shall be localised and removed as soon as practicable." **By Association of Municipal Corporations (Dr. J. A. Fleming).** Is a comprehensive regulation for conduit systems. A more complete definition should be asked for as to the means of carrying into effect the sub-section (*e*), which requires a "Non-Conducting Screen" to be placed between a neighbouring pipe and a non-metallic partly insulating conduit. **By London Chamber of Commerce (Traction Committee).** (*a*) A definition is desired of what is meant by "easy inspection." (*d*) It is suggested that it does not seem satisfactory to electrically connect lengths of conduit together, especially where a complete metallic return is used, on the grounds that a fault might cause a complete breakdown in the whole system if metallic continuity was insisted on, instead of only a partial one. (*e*) The Committee would wish to have an indication from the Board as to what material they would consider would satisfy the requirements of this clause.
Reg. No. 19.—The Company shall, so far as may be applicable to their system of working, keep records as specified below. These records shall, if and when required, be forwarded for the information of the Board of Trade.	The question has been carefully considered, and the Committee have nothing to add beyond the suggestion that it might be difficult in small lines to afford the services of an electrician of efficient ability to make the daily and periodical tests required of sufficient accuracy to be of any value. **By Institution of Electrical Engineers.** Last line, add "s" to "Regulation," and after "10" insert "and 16 (*e*)."
Daily Records .... Leakage current (*vide* Reg. 10).	
Monthly Records......... Insulation resistance of different conductors (*vide* Reg. 11).	Strike out last line and transpose it to "Quarterly Records," after line 2.
Quarterly Records ...... Conductance of joints to pipes (*vide* Reg. 8).	Line 2, strike out "Conductance," and insert "Resistance," and bring down line 2 of Monthly Records.
Occasional Records ..... Any tests made under provisions of Reg. 6 (*ii.* and *iii.*).	Line 1, strike out "and iii."

Additional Proposals.

Proposed New Regulations.

By Institution of Electrical Engineers.

Numbered 17: In any case where overhead lines are used, the Company shall erect and maintain in good order a guard wire in such a manner as to prevent any previously erected wire or wires from coming into metallic contact with the conductors carrying the tramway current.

By Associated Railway Companies.

That the most effectual means of preventing interference with the railway wires will be found in laying the "line" and "return" traction wires on insulated supports within a metal culvert, the joints and the section of the said culvert being of such a character and section as shall ensure a perfect return to the generating station for the traction currents should such from defective insulation, or other causes, pass into it

That where an overhead wire or wires are used for conveying the current to the tramcar, the pillar, pillars, or other supports carrying such wire or wires shall be so connected electrically with the return circuit of the said tramway as to convey to it without loss any and all such current as may escape from the insulator or insulators by which the conducting wire or wires are attached to the said pillars or supports.

That where two overhead wires are employed, the one for the outgoing and the other for the return current, the supports for the same shall be so electrically connected that any current escaping from the one shall be conveyed to the other without any portion of the same passing to earth.

That where the route of the tramway is circuitous the return wire shall be aided by insulated feeders.

That having regard to the fact that any failure in the electrical conductivity of the traction conductors, culverts, poles, or brackets, &c., may prove the occasion of interference with neighbouring block signals, the wires of such block-signalling instruments should be dissociated from the earth as far as possible, and that in common justice the cost incurred by the railway companies in consequence of these or other precautionary measures, in order to provide as far as possible against the incursion of the traction currents, should be borne by the traction authority concerned.

By Gas Light and Coke Company.

We observe that the regulations proposed do not contain any prohibition forbidding connections with gas pipes, and also contain an express permission to use, in lieu of two earth connections to the negative terminal of the generator, one connection with a water main.

The Company venture to suggest the advisability of inserting such a prohibition as above referred to, and in support of this suggestion they desire to refer the Board to the evidence given before the Joint Committee of both Houses on Electric Powers (Protective Clauses) by Major Cardew, Sir Frederick Bramwell, Dr. J. Hopkinson, Prof. Dewar, and others, which, in the view thereof taken by the Company, entirely justifies, if it does not do more, such a prohibition; the Company also hope the Board will, at least as regards the Metropolis, reconsider the advisability of permitting connections to water mains, and would refer to the same evidence in support of this proposition. In the Metropolis the confusion existing between water mains and gas mains and other subterranean works in the street is so great and the propinquity between water mains and gas mains is so close that the electrical use of water mains inevitably carries with it the use of the gas mains, and consequently great danger to the public.

The Company desire further to place before the Board the necessity of treating the Metropolis differently to the extra-metropolitan parts of the country, and, in particular, that the use of uninsulated returns should be entirely prohibited in the Metropolis, excepting places where the Board of Trade should, after a full investigation of the special circumstances, see fit to sanction the use of such returns.

In many, if not in most, streets in the Metropolis the subsoil is crowded with mains and works of gas, water, electric, hydraulic, and other companies and of sewage authorities. Amongst other inconveniences, too obvious to need comment, this state of things carries with it a very great liability to frequent subsidences, the formation of cavities, sometimes of great extent, and frequent leakage of gas mains; these subsidences, cavities, and leakages are, for the most part indiscoverable and not to be prevented

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by any possible precautions, and often are discovered only after injurious consequences have arisen; explosive mixtures are liable to be formed in these cavities and in sewers, particularly the numerous disused sewers, and frequently the gas travels long distances from the seat of the original mischief. Of these matters this Company has had only too frequent experience, as well as of the practical difficulty of coping with the dangers so created in an adequate and effective manner. The Company are, therefore, led to very earnestly deprecate the permitting of anything likely to intensify or increase the danger to persons or property in crowded centres, such as the Metropolis contains, and uninsulated or defective insulated conductors of electric currents cannot but be regarded, the Company are advised, as likely sources of danger. The Company desire to express the hope that the Board will take these observations into consideration, and reconsider the question of permitting uninsulated returns in the Metropolis.

The Company further observe that clauses (2 and 3) of the clauses to be inserted in all Bills and Provisional Orders limit the protections against injurious affection of gas and water mains, and the regulations to be made by the Board to fusion and electrolytic action. The Company venture to suggest the desirability of, in practice, extending the powers to provisions against other modes of injurious electric action. Clause 4 of these clauses imposes, in very sweeping terms, a single penalty, with a further daily penalty in case of a continued offence, for any breach of the Act, Order, or Regulations. The Company are advised that this clause would seem to defeat the object of the Joint Committee, inasmuch as unless the legal right to recover compensation in the shape of damages is expressly reserved to persons injured by the undertaker's acts, or neglects, the Courts might, on the authority of decided cases, hold that the sole remedy for, or consequence of, any breach of the Act, Order, or Regulation was the recovery of the penalty, and that the recovery of damages by an injured party was excluded. So that if the undertakers chose to risk the imposition of a penalty, and not necessarily the full penalty, they would enjoy a practical immunity and the most effectual deterrent, viz., the liability to suffer in damages would be excluded. The Company desire us to draw attention to this aspect of the clause with a view to the Board's future opportunities of action in the matter.

TELEGRAPHIC COMMUNICATION BETWEEN ENGLAND AND INDIA: ITS PRESENT CONDITION AND FUTURE DEVELOPMENT.

The following report of the discussion which followed the reading of Mr. E. O. Walker's Paper on the above subject before the Indian Section of the Society of Arts, on Thursday, the 8th inst., is taken from the last number of the *Journal of the Society of Arts*:—

Sir OWEN TUDOR BURNE, K.C.S.I., said that he was able, after a long official experience, to corroborate all that Mr. Walker had brought forward, as to the necessity for cheapening telegraph rates, and as to the quickness of communication between England and India, mentioning an instance, some years ago, of a telegram being despatched and a reply received within seven minutes.

Mr. MARTIN WOOD said the lecture of Mr. Walker afforded a comprehensive review of a truly Imperial subject, and, amongst other passages, he was glad to hear the references made in the Paper to the difficulties which some of the pioneers of telegraphic communication with the East had to go through. He remembered, for instance, the enthusiasm which the name of Col. Patrick Stewart always created among those who had been associated with him, and also some of Sir Charles Bright's staff in the Persian Gulf. He believed there was still a charge on the Indian revenue of about £18,000 a year for that early company, which only acted for about a week. He hoped some means would be found for relieving the taxpayers of India from that charge, though he did not know how this should be met, whether from future profits of Government lines, or what else, but it was too bad that India should be paying all these years, now nearly two lakhs and a-half, for no service whatever. He had been much interested in hearing the mention of the laying of the cable from Suez to Bombay, because it was his own fortune to be on board the "Great Eastern" when it was done, and as Captain Halpin, who then commanded that once noble vessel, had only recently died, it was only fitting to recall his memory. All on board the ship could testify to the great ability with which he carried out that important work. There was one practical object that might be furthered by the reading of this Paper, namely, some appreciable reduction in charges for telegrams to the East. This was no mere outside claim for cheapness, for Mr. Walker had shown good reasons for such reduction, based on his own intimate experience of the subject.

Mr. B. T. FFINCH said after this interesting and exhaustive Paper there was very little for him to add. With regard to the reduction of the tariff to India, he was not in a position to say what might eventually be done; but he knew the subject was one in which the Government of India took a great interest, and that they were constantly watching events. Tariffs were generally considered, and reduced or increased at the Telegraphic Conferences, which took place every five years. The next conference should have taken place next year, but had been postponed till 1896, so that he feared until it met no alteration could be expected. It must be remembered that the Eastern Telegraph Company had spent large sums of money on their line, and their capital was over £6,000,000. Submarine cables would not last for a very long period, especially when laid in such seas as the Red Sea and the Persian Gulf. Mr. Walker appeared to think that a land line was perhaps better than a submarine cable. It undoubtedly was cheaper; but it must be remembered that the land lines through a great part of the way between India and England traversed countries where there were no railways and no roads. The coast which extended 700 miles from Kurachi, was one of the most desolate and arid tracks of country in the whole world. When that line was first built, in 1862, the Beluchis were not so well known as they now are, and it was the object of the working parties to construct the line as near the sea as possible. They had the sea on the left hand and a range of mountains on the right, which eventually merged into the sea. As the line was being constructed they got nearer and nearer to the range of mountains, and eventually came to the foot of the cliff which ended in the sea, and the difficulty was how they should take the line on. It was decided to lay a submarine cable round the cliff, which was done, but the rocks very soon cut through the guards, and the cable was interrupted. A second cable was laid, which quickly shared the same fate. In the meantime a path up the mountain from the west side was discovered, and after improving it somewhat the posts and wires were carried to the top, but when they came to the east cliff it was found to be about 2,000ft. deep, down which they had to throw the wire. It used to take a Beluchi, accustomed to hill climbing, five days to go overland from the post at the bottom to the post at the top. This line, also, was very unsatisfactory, as rocks were constantly falling on it, and they next turned attention to another pass called the Buzi Pass in the native language, the Ass's Pass. He sent an assistant there, who got to the top of the mountain, but he told him that although he arrived late at night, and dead tired, he was unable to sleep, because all night long he was thinking how he should get to the bottom again. In other parts of the country there were salt plains which much interfered with the good working of an overland line. The cables on the other hand had their own peculiar difficulties, such as had been mentioned in the Paper. Although these lines were laid in such an unfavourable country there had been no total interruption in the Persian Gulf line since 1885. In Persia they had to go over four mountain passes to get to the plateau, and down another to reach Teheran, the elevations being from 7,700 to 8,800ft. Mr. Walker had told them what kind of country Persia was, but he would read a passage from a report by his former chief, Sir John Bateman-Champain, which would perhaps present the case in even more forcible colours:—"The heat in summer is nearly as distressing as in India, and the inspector on his urgent repairing trip can hope for no shady tree nor for a single stream of water. As a general rule, with few exceptions, his way lies over glaring salt or stony deserts, or under scorching barren rocks. In winter, the cold on the mountain ridges and elevated plains is as trying as, and perhaps more dangerous than, the heat of summer. In severe seasons the passes are occasionally so blocked with snow that no native traveller dreams of pursuing his journey, but the telegraph official is bound to force his way through obstacles which are an effectual bar to ordinary traffic. The wretched caravanserais, or hovels, where shelter can be found lie apart from one another 20 or 30 miles, and in many parts of Persia there are no intermediate villages. The inhabitants are not inclined to be hospitable, and the difficulty of procuring help, supplies, or lodging, is indescribable. The roads and tracks are generally as bad as possible, and wheeled conveyances are unknown. The risk to life in crossing snow drifts is great, and the privations which must be endured when, after struggling in a bitterly cold temperature all day, the nights have to be passed in some wretched hut, or even cave, with barely enough fuel or food to support life, can scarcely be imagined. It was after a week of such work that Mr. Hamilton, a clerk at Dehbeed, formerly a sergeant of the Royal Engineers, died from inflammation of the stomach brought on by cold and exposure." Since 1886, however, the Persian section of the line had only been interrupted once for nine hours. In his opinion they should devote attention more to the Turkish route, which was the easiest to the East, if they could only persuade the Turks to allow it to be put in good order, and have English clerks work it for them.

Lieut.-Col. H. L. WELLS, R.E., M.I.E.E., said he could perhaps give a little more information with regard to Persia. Mr. Walker had referred to the case of one of their officials being murdered, that was in 1872, and he must say in defence of the Persians that in that case it was the man's own fault. Two sergeants were shot, and in one case the Englishman was entirely to blame, and in the other a man died bravely defending his possessions. Being a soldier, he preferred fighting to parleying, though his opponents were six to one, and naturally he had to succumb. The wilful damage in Persia, which at first was very great, was now not worth serious notice. Since he had charge of that section there had been only one case of total interruption from that cause, and this was due to some person, who thinking he owed a grudge to the local governor, cut the wires. In another case, to which Mr. Walker referred, where the local governor from spite against the Government tried to damage the line. He only smashed three or four posts and forgot to cut the wires, which were only rendered unworkable because they were lying jumbled together in the muddy ground. Nowadays, thanks to Cardew's sounders, they could work through long distances even when the line was lying on damp earth and snow. In Sir John Champain's and Sir Robert Murdoch Smith's time the natives were very bigoted, but little by little the Telegraph Department had found its way into their affections. The officials, like all Englishmen, were hospitable, and they liked to speak and chat with their neighbours, and by degrees they became the confidants of the villagers, and even by the governors were much looked up to. When the tobacco régie came to an end, and a great feeling was expressed against all European institutions throughout Persia, the Indo-European telegraph was specially exempted by name. The lines were unprotected for hundreds of miles, but no fanatic interfered with them, or even smashed an insulator. Only last spring a typical case occurred, when a revolution took place owing to bad government in the province of Fars. The people, as usual, flew to the representative of the Indo-European telegraph, and sent messages to the Shah, knowing that in this way their com-

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plaints would be heard. The officials were sometimes placed in rather a difficult position in this way, having to represent rebels ; but still the truth did get to the Shah by these means, and generally had a beneficial effect. Governors had been spared from unjust punishment, and the population had been freed from tyrannical masters through the operations of the telegraph. The line from Shiraz to Jask would, he was sure, be welcome ; but before it could be undertaken with success, the Government must, as the Hon. George Curzon insists, be more strict than at present, for last year the whole of the Shiraz to Jask country was in revolt ; and the line, if made, would be subject to all sorts of difficulties, until the Persian Government took this district into its hands ; at the same time, making the line might conduce to that end. The Shah took interest in the telegraphs and electricity. He had the electric lights in his theatre for passion plays ; telephones were well known, and a network of telegraph wires ran throughout the country ; but, owing to mismanagement, the want of funds, and the peculation, which was chronic, they seldom worked satisfactorily. The Meshed line, to which Mr. Walker had referred, was now under the charge of the Indo-European Telegraph Department. Before he left the country, the Shah handed over to him 10,000 tomans (a toman being worth about 6s.), to be spent in three annual instalments on the line, in addition to the annual outlay. The Shah had lately started a second line, *via* Shiraz and Mohammera, making the connection with the Turkish lines. He was glad to find that Mr. Walker, as well as Mr. Ffinch, were in favour of land lines. He was quite sure that land lines were better than cables for commercial work ; notably, the speed on them is better, and they were so quickly repaired. The Indo-European system had continually taken up the work of the cables when they broke down. Year after year, until quite lately, as soon as the monsoon came round, a total interruption of the Eastern Telegraph system used to occur (until within the last two years), and when that occurred the land line came to their aid, and carried the whole traffic. In 1882, during the Egyptian campaign, when Arabi's men cut the line connecting Suez with Port Said, the only means of communication between General Wolseley, at Port Said, and Admiral Hewett, at Suez, was *via* Aden, Bombay, and Persia. Each morning they used to clear the line, and those two chiefs had a talk with each other. He was then temporarily in charge at Teheran, and remembered the bread riot which occurred at a small town 200 miles to the south, which looked as if it would be the cause of a total breakdown of communication between the Eastern and Western world. The rioters seized the telegraph clerk and held him to his desk, and insisted on an immediate reply to their petition to the Shah ; others climbed the post, and said if they did not get an answer within ten minutes they would smash the lines ; and it was only by the official's excellent knowledge of the language of the people, and the esteem in which he was held, that he was able at last to persuade them to wait until their petition could be forwarded to the Shah, who was away some distance from Teheran. Some years ago, when all the lines in England were interrupted by heavy snow storms, an inquiry came *via* Bombay and Teheran from Cornwall to know what London was about. Mr. Walker had referred to the ease with which a line could be carried through Afghanistan, but he feared there would be more difficulty than Mr. Walker anticipated, there were so many tribes at variance with each other, and he feared for a long time they would come and damage the line in the hope of the blame attaching to their neighbours this being a favourite trick with that sort of people. He was not so much in favour of a line *viâ* Meshed, Herat and Candahar, as of the Turkish lines being prolonged. The former would be essentially a peace line, for as soon as there was war, enemies to Persia or England could in 28 hours send a dozen horsemen across the frontier and cut up the wires and carry them off. The Cyprus, Aleppo, and Euphrates Valley route connecting with Baghdad, Jask, and Kurachi, through Southern Persia, would be the better route.

The CHAIRMAN (Sir Thomas Sutherland), in proposing a vote of thanks to Mr. Walker for his admirable Paper, said he had brought the history of telegraphic communication with the East up to date, and had made some most valuable suggestions which, no doubt, would be acted upon at no distant date, both with regard to the extension of the system and to the economy which would attend it. In reading his observations on this point, the idea occurred to him that it would be better if his friend Sir John Pender had been asked to preside, because he would be likely to bring more influence to bear on the main object which Mr. Walker advocated than any one else. Probably, if some gentleman came forward hereafter to read a Paper on cheap passage and freight to India, Sir John Pender would be asked to take the chair. Looking at the question of telegraphing from the point of view of a shipowner, he was amazed to find that, whilst it was possible to send a ton of merchandise from London to the uttermost ends of the earth for something like 50s., it cost 20s. to send a message of five words to India. It must have occurred to many who saw the wonderful manner in which the telegraphic system had developed, and the great improvements which had taken place through the opening of the Suez Canal, and the acceleration of steam communication to all parts of the world, how absolutely useless the telegraphic system would be if to-morrow they were relegated to the days of sailing vessels and the Cape of Good Hope route. In 1867 or 1868, when telegraphic communication was first opened with North China, through Russia, he happened to be residing in Shanghai, and should never forget the astonishment of the Chinese people on discovering that they could not only obtain news of the European markets in that way, but also remittances. The system of transacting business by bills had been almost obliterated by the system of telegraphic exchange which now existed. On the occasion of the Russian scare which took place in 1885, the Government and the Navy were, as usual, unprepared, and it was found necessary not only to engage in this country many of the fastest vessels connected with the Atlantic trade for the purpose of arming them as cruisers, but also to telegraph and engage vessels in Sydney, Hong Kong, and the Cape, and it was within his knowledge that the vessels in Sydney and Hong Kong were engaged and armed, and the men were practising their guns at sea, before the guns were placed on board the auxiliary vessels in Liverpool. That showed how dependent we were on the electric telegraph for the security of the empire. With regard to the suggestions made for the extension of numerous lines and additions *via* Persia, Russia, Central Asia, and so on, he thought it would never do for this country not to have an independent line of its own, solely devoted to its own service, for the purposes of peace or war.

Mr. CHARLES BRIGHT wrote as follows:—Though present at the meeting, I had no opportunity of taking part in the discussion. I would point out that Messrs. Bright and Clark were engineers to the Indian Government, in connection with the first Persian Gulf cable, and that this cable was laid in 1863, under the personal superintendence of the late Sir Charles Bright. The late Mr. J. C. Laws was his principal assistant, and he was further assisted by the late Mr. F. Lambert and Mr. F. C. Webb, besides several others. The first Persian Gulf cable of historic interest, in that it was the first cable which was a complete success from the outset, no hitch whatever occurring during the construction or laying of the same. Moreover, this was the first cable which underwent a proper system of testing during manufacture, the testing instruments being also more delicate than those previously used. Every joint was, for the first time, tested by the accumulation test of Mr. Latimer Clark, F.R.S. The copper conductor gave an average conductivity (or purity) of 90 per cent. ; in previous cables this had been as low as 40 per cent., and under. To the design of Messrs. Bright and Clark, the conductor (225lbs. per N.M.) was built up in a segmental form, with an outer surrounding tube, the whole being drawn down to a circular form, thus combining the electrical advantages of a solid wire with the mechanical advantages of a strand. Several practical difficulties were found in the construction of such a conductor, however, and the expense of a special wire of such a form was also very great. Messrs. Siemens Bros. have since adopted a conductor based on the same principles, having a large centre wire surrounded by small wires. It was in connection with the Persian Gulf cable that Messrs. Bright and Clark first made experiments with gutta-percha at different temperatures, which led to the logarithmic curve law for the variation of electrical resistance of such substances by temperature. This core (275 lbs. of G.P. per N.M.) was manufactured at the Gutta-percha Company's works, Wharf-road, and this was armoured at Messrs. W. T. Henley's works, that firm having obtained the contract for the same. In the manufacture of this cable the core was for the first time tested under hydraulic pressure with a view to the exposure of any incipient faults in the insulation due to airholes, and so forth. This plan has since formed a part of the system of Messrs. Siemens Bros.' Cable Works. In practice it is found, however, that besides being exceedingly expensive, the pressure tends sometimes to "mask" factory faults, as well as to divulge them. One speaker referred to the risk of interruption to a submarine cable. Surely it is acknowledged by now that this is infinitesimal, compared with the same risk in the case of an aerial line, running across a desert country, in a tropical climate, with heavy rainfalls.

LEGAL INTELLIGENCE.

McGeagh v. Elmore's Foreign and Colonial Patent Copper Depositing Company (Limited).

An action was brought in the City of London Court, this week, in which the defendant Company was unrepresented by counsel.

The Plaintiff stated that he was induced to take shares in Elmore's French Patent Copper Depositing Company by seeing a statement in the prospectus that a dividend of 10 per cent. would be guaranteed for the first year by the defendant Company, and that there would also be a participation in further profits. The guaranteed amount had not been paid. The Secretary to the French Company was Mr. J. Shurmer, who was also Secretary to the guaranteeing Company ; and the defence set up was that the prospectus in which the statement was made was issued without the authority of the guaranteeing Company.

Mr. SHURMER was examined, and stated that he was secretary to the Guaranteeing Company when the prospectus was issued, and it was quite true that the 10 per cent. had been guaranteed by the defendant Company.

The shares bought by the plaintiff were of an issue upon which the dividend had not matured at the time the 10 per cent. was paid by the guaranteeing Company upon other shares.

Mr. RICHARDS (who appeared for the plaintiff) stated that the case was a test one, and many of the other shareholders were awaiting the result before taking action.

Mr. COMMISSIONER KERR ordered Mr. Shurmer to bring the money claimed into Court ; and the case was then adjourned for a week.

Spencer v. The New Telephone Company (Limited).

In an action tried at Manchester for £14. 15s., for rents for permission to erect poles, &c., the New Telephone Company claimed that the wires were put up with the consent and at the request of the plaintiff's tenants, and the Judge said as the tenants were entitled to fit up the telephone in their premises there could be no trespass on the part of the company in acting at their request. The jury found for the defendants, with costs.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *February* 9, 1894.

Patent Litigation.—Almost the entire interest of the electrical public has been centred for some time on the various phases which patent litigation has been assuming. The state of the patent law has been growing more and more unsatisfactory, and at present it may be said to be little less than chaotic. The Edison lamp patent, for example, after years of constant and enormously expensive litigation, was finally awarded priority by the highest Courts; instead, however, of this resulting in the expected benefit to the patentee, it merely seemed to stimulate infringers, who have since been ceaseless in their efforts to overcome the patent. The celebrated Goebel defence was one of the first means adopted, but although it met with partial success in one Court, it has been overthrown by two others, and a decision from a fourth Court is soon expected. The most startling decision was that of Judge Ricks, who interpreted the blunder of an attorney in endorsing a wrong date on the Edison lamp patent as a dedication of it to the public, so that in this judicial district the patent is now void. The Novak case, in which it was claimed that the Edison combination is broken by the use of a bromine atmosphere in the bulb, has been argued and will soon be decided. Another important case, now on the list of a Federal Court, is in regard to whether the date of application or issue of a foreign patent shall apply in the determination of the life of a domestic patent, but it is not expected that the decision will reverse the law on the point now established. Finally, the United States Supreme Court has just decided against the practice of dividing an invention up among a number of patents by hair-splitting constructions, which may have an important bearing on the telephone and other electrical patents. The result thus far of patent litigation seems to show that our patent laws furnish little protection if an invention is of sufficient value to tempt infringers to continue a legal warfare that may in the end probably result in their favour through some technicality.

The General Electric and Westinghouse Companies.—The condition of the General Electric Company is still precarious, and reductions in *personnel* and contraction in scope still continue. On the other hand, as the fortunes of its great rival wane, those of the Westinghouse Company are on the ascendancy. More than 4,000 hands are now employed in the shops of the latter, and it has just commenced to build immense works covering acres of ground, in which all the valuable Pittsburg ideas in regard to economical processes of manufacture will have their full development.

CORRESPONDENCE.

IS THE HIRE WORTHY OF THE LABOURER?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to the article entitled "Is the Hire Worthy of the Labourer?" this is a subject which not only calls for support, but deserves it. Speaking from experience, I can endorse all that "Superintendent" has brought before the notice of yourself and readers with reference to the work and pay of "electricians in charge" or "superintendents," and it gives rise to a very natural question as to what steps are the most calculated to be attended with success. The organisation of a Union of some sort seems necessary, even though it were restricted to men of at least three or four years' practical experience. It seems to me it would be a great boon if amongst these men a small society could be formed where questions like this could be freely discussed. Your correspondent writes that the "electrician in charge" *may* have to undertake the duties of a driver or stoker in an emergency. I could cite cases from personal knowledge where the electrician had to perform these duties, and where double the number of usual hours have been worked without any increase of pay whatever. Surely there must be many in a similar position, and who could give us the benefit of their experience.—Yours, &c., AN ELECTRICIAN.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

Our readers are reminded that the 1894 Edition of "THE ELECTRICIAN" Electrical Trades' Directory and Handbook is NOW READY. This valuable book contains 1,000 closely-printed pages, and several new and useful features have been added. The price of the Directory and Handbook is 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.) A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). prospectus on application to the Publisher.

CORRECTION.—A paragraph appeared in our last issue (cut from a local journal), announcing that the debenture holders of the Richmond Electric Lighting Company had applied to the Courts, and had obtained the appointment of Mr. James Worley as receiver and manager. We learn that this announcement was inaccurate, and regret its insertion. We have received the following letter from the Company on the subject:—"SIR: A paragraph (appearing in your issue of February 16th) has been brought to my notice, in which it is stated that the shareholders of the Richmond Electric Lighting Company have passed a resolution for liquidation, and have appointed Mr. Worley liquidator. I beg to deny this statement *in toto*, and would feel obliged if you would inform me on whose authority you have published this misleading, injurious, and wholly untrue statement. I must request that full publicity will be given to this letter.—PERCY W. NORTHEY, Engineer and Secretary, Richmond (Surrey) Electric Light and Power Company (Ltd)."

TENDERS INVITED.—The Corporation of Edinburgh invite tenders for the following work in connection with the electric lighting of the City:—Contract 5, construction of concrete culverts and laying of pipes and casings; Contract 6, supply of cast-iron pipes, casings, and road service boxes; Contract 7, supply of stoneware casings and insulators; Contract 8, supply of copper strip; and Contract 9, supply of armoured and unarmoured insulated cable. All information may be obtained from Prof. A. B. W. Kennedy, 14, Old Queen-street, Westminster, London, S.W.; and tenders must reach Mr. W. Skinner, W.S., Town Clerk, City Chambers, Edinburgh, not later than March 17th. Further particulars appear in our advertisement columns.

——— The Sutton (Surrey) Local Board invite tenders for the purchase of the powers granted to them by the Board of Trade under their electric lighting Order, 1892. The system proposed to be used is the low-tension one. Particulars can be obtained of the surveyor, Mr. A. G. Greatorex. Some further particulars are given in our advertisement columns, where it will be seen that tenders must be sent in to Mr. T. D. Pettiver, clerk, Local Board Offices, Public Hall, Sutton, Surrey, by 12 o'clock of April 4th next.

——— The Corporation of Harrogate invite tenders for plant in connection with their proposed electricity works. The plant consists of refuse sorting and drying apparatus, with accessories; steam boilers and accessories; steam and exhaust pipes; transformers and accessories; distribution mains. Specifications can be had of Mr. Samuel Stead, the Borough Surveyor, Municipal Offices, Harrogate; and tenders must be sent in on or before Wednesday, March 14th. Drawings may be inspected at the offices of Mr. Geo. Wilkinson, the Borough Electrical Engineer, 93, Eastbank-street, Southport.

——— The Swansea Harbour Trustees invite tenders for providing and fixing insulated cables for electric lighting purposes, in lieu of existing wires, on portions of their property. Tenders are to be in by 10 a.m. on the 26th inst.

——— The Borough of Morley invite tenders for the electric-light wiring of the Town Hall now in course of erection. Tenders are to be sent in to Mr. R. Borrough Hopkins, town clerk, by noon on the 26th inst.

——— The Belfast Harbour Commissioners invite tenders for a Cornish boiler for their electric light station at Abercorn Basin. Specifications, &c., can be obtained of the harbour engineer, Mr. G. F. L. Giles; and tenders must be sent in to Mr. W. A. Currie, secretary, Harbour Offices, Belfast, by Monday, 26th inst.

TENDERS ACCEPTED.—The Corporation of Hanley have accepted the tender of Messrs. Spagnoletti and Crookes for the electric light wiring and fittings at the Corporation buildings, the amount of the tender being £3,034. 14s. 1d. The tender is accepted subject to confirmation by the Local Government Board as regards borrowing powers. Some slight modifications are made in the tender, bringing the actual total to £3,000. Other tenders accepted include £207. 10s. for instruments and tools, and £1,000 for meters, switches, cables, fuses, and general stores (no contractors' names given).

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Tenders Accepted.—The tender of Messrs. W. Nicholson and Son, of Hunslet, Leeds, has been accepted by the Yorkshire House-to-House Electricity Company for the whole of the building work in connection with the extension of their electric lighting station in Aire-street, Leeds.

———— The tender of Mr. J. F. W. Bray has been accepted by the Great Yarmouth Town Council for the erection of an electric lighting station for the sum of £2,620.

———— The Burnley Board of Guardians have accepted the tender of Mr. Fletcher to light certain of the rooms in the building by electricity.

Plant for Sale.—Messrs. Wheatley Kirk, Price and Goulty advertise a large quantity of lighting plant for immediate sale, including several combined sets of ship lighting plant, dynamos, boilers, engines (steam and gas), lamps, accumulators, &c.

Bankruptcy.—Under the failure of Edward Brailsford Bright, formerly practising at Delahay-street, Golden-square, and Adelaide-street, Strand, as a civil engineer, accounts were issued on Wednesday, showing liabilities £8,444, and assets "patents—no present value." The debtor states that in 1884 he became interested with others in the construction of a railway in Greece, and in 1888 he entered into an agreement with a firm of contractors for the construction of the railway. He ascribes his failure to losses in connection with that railway and to costs in an action in respect of an alleged breach of contract.

Liquidations.—A petition has been presented by Mr. John Wilson, of Edinburgh, for the compulsory winding up of Martiny (Limited), and is down for hearing at the Royal Courts of Justice on February 28th.

———— A petition for the winding-up of the Platinum Plating Company (Limited) was on Wednesday adjourned, on a statement that arrangements were being made to satisfy the petitioner's debt.

———— At meetings on Wednesday of the creditors and shareholders of Balfours and Co. (Limited) it was decided to leave the case in the hands of the Official Receiver, to be wound up by that gentleman in his capacity of liquidator.

Messrs. Dorman and Smith.—This firm send us a copy of their new catalogue, which is fully illustrated, and contains descriptions and prices of a large variety of articles actually manufactured by them at their Ordsal Station Electrical Works, Salford, Manchester. The illustrations include a large variety of lamp holders, thumb and key switches, main switches, accumulator regulating switches, switchboards, cut-outs, ceiling plates, balance suspension pendants, shades, reflectors, brackets, cast iron mill fittings, &c. The catalogue is very fully illustrated, and concludes with a description of Rayworth's lineman's detector, for which the firm have executed considerable orders.

Messrs. Drake and Gorham.—This firm have received instructions from the proprietors of *The Morning* newspaper to fit up their new offices in St. Bride-street, London, E.C., with the electric light, the plant for which will include a 14-h.p. high-speed Crossley gas engine, and the dynamo will be of the Electric Construction Company's make. Drake and Gorham's patent spring contact switches will be adopted, and several of the arrangements for this installation will be of special design, including the wrought iron bracket for the arc lamp for exterior lighting. Altogether 140 lights are arranged for, which will probably be increased to 200 later.

Messrs. Peto and Radford.—We are informed that Mr. C. H. Cathcart has disposed of his share in the rights of the firm of Cathcart, Peto, and Radford; that these have been purchased by the remaining partners, Messrs. Peto and Radford, and that the business will be continued by them under the latter title.

Colliery Lighting.—Mr. W. Bakewell, of Attercliffe, Sheffield, has recently supplied to Messrs. John Brown and Company (Limited), of the Atlas Steel and Iron Works, Sheffield, all the cables, lamps, fittings, and instruments for the lighting of their Aldwork Main and Warren House Collieries, the dynamos being supplied by Messrs. Mather and Platt (Limited). The cable is laid for about one mile underground without joints, and the light has proved very satisfactory.

Public Clock Lighting.—Messrs. King, Mendham and Co. have just completed the illumination of the large clock at St. Nicholas Church, Bristol, for which purpose gas has hitherto been used. Three 50-c.p. incandescents are fixed behind the 5ft. opal dial at a distance of 18in. from the back. These lamps are provided with reflectors, so that the whole of the light is thrown on the dial. A portion of the old gas-regulating apparatus has been retained, and by an ingenious arrangement of specially-designed electrical contacts the current is switched on and off the lamp-circuit with a very quick motion, to prevent sparking, and to avoid waste of current during the day. St. Nicholas Church is ultimately to be lighted by electricity, and Messrs. King, Mendham and Co. have the contract in hand.

Electric Organs.—The Hope-Jones Electric Organ Company, Limited, of Birkenhead, are building an organ for the Gilfillan Memorial Church, Dundee. The organ extends across the hall, the whole width of the back gallery, a distance of 40 ft. The instrument is to cost £1,300.

New Firm.—Mr. John Brotherton, late works manager of John Brotherton, Limited, has resigned this appointment, and is commencing business on his own account. He has taken the works occupied some years ago by the Elwell-Parker Company in Commercial-road, Wolverhampton, which he proposes to adapt to the manufacturing of all kinds of wrought-iron and steel tubes and fittings.

National Electric Company.—This Company have opened offices and show-rooms for the supply of fittings and lamps at 2, Holborn-place, High Holborn, London, W.C. Mr. A. C. Cockburn acts as consulting engineer to the Company.

Antwerp Exhibition.—A meeting of the Engineering Trade Section of the London Chamber of Commerce was held at Botolph House, Eastcheap, E.C., on Monday last, at which the subject of the Antwerp International Exhibition, 1894, was brought prominently before the meeting with a view to inducing the members of the Section and the Trade generally to exhibit. It was stated that the Exhibition was a very promising one, as Antwerp was an important seaport visited by merchants and all classes from all parts of the Continent and within easy reach of England; that the duties in Belgium were low; that it was under Royal patronage, and that a joint committee representing the Mansion House and the London Chamber of Commerce was acting in London in the interests of the British Section. It was decided that the Exhibition was worthy the support of the Engineering Trades, and that Sir Edward H. Carbutt, Bart., be requested to confer with the Exhibition authorities as to the appointment of jurors for the Engineering Section.

Water Motors.—We have received a circular from Messrs. P. Pitman and Co., engineers, of Withington, Manchester, setting out their claims for the new "Demon" water motor, which the Company have supplied to many of the leading railway companies and other large users. Several improvements and additions have been made during the past few years, and eight years' continuous use convinces the Company that this will be found a most durable and efficient engine. The motor is direct acting, and, having no dead centre, will start from any position. The wiring surfaces are of the best mild steel, gun metal and brass, and the motor is turned out in good style. The main body of the motor is of rustless iron, by a patent oxide process, fitted with a removable flanged cover. It is constructed to work at any pressure over 30lbs. per square inch, special engines being made for low pressures. Full printed particulars are supplied with each motor, reducing the amount of attention subsequently necessary to a minimum. The motors are made in twelve sizes, from a ⅜in. to a 4in. supply pipe.

Ashford.—The Local Board have appointed a committee for the purpose of considering the advisability of taking the necessary steps to obtain an Electric Lighting Order for the town.

Ashover.—The Directors of the Ashover Hydropathic Company (Limited) have decided to instal the electric light throughout the establishment in connection with other considerable alterations now being made.

Ayr.—The report of the Electric Lighting Committee was presented at the last meeting of the Town Council, wherein reference was made to Mr. Christy's report on the proposed electric lighting of the burgh by water-power. As stated in our last issue, the Council have decided to employ the services of an electrical engineer, who is to report. The Chairman of the Lighting Committee expressed the Committee's appreciation of the services rendered by Mr. Frank Christy, and the value of his report. It was from no want of engineering skill on his part that the Committee had been unable to recommend either of the schemes proposed by him for adoption, but it was entirely owing to the heavy cost. Roughly speaking, it was estimated that it would cost between £16,000 and £18,000 to bring 500 H.P. to the outskirts of the town, and this was the maximum horse-power at their command. It would, perhaps, be worth while expending this large sum if they were sure of requiring the whole of the power at the start; but this was very unlikely, and therefore the initial outlay would be in excess of all probable requirements, whereas, if extensions were required later on, necessitating an excess of power over 500 h.p., then they would be face to face with a considerable difficulty. If they adopted steam they could start with a minimum power, and add as the demand increased. The Burgh Engineer has still to send in his report, which may induce the Councillors to proceed further with the matter, although a disposition was shown at the meeting to shelve the question.

Birmingham.—A proposal has been before the City Council for instructions to be given to the Finance Committee to borrow £1,000 for providing the necessary lamps, fittings, &c., for the electric lighting of the Market Hall. Mr. Parkes, in moving the adoption of the scheme, said that the lighting of the building by gas had been most unsatisfactory for some time past, and they had

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received a favourable offer from the local electric company, by which the electric light would cost less than the present wasteful system of gas lighting. Thirty-two arcs would be used in the installation, and eight additional were to be put in for external lighting. The proposal was adopted.

BRISTOL.—The report of the Sanitary Committee, who recently visited Walsall in order to become acquainted with the system of electric traction there adopted, has been presented to the Corporation. Alderman Cope-Proctor said there were several matters for and against the system adopted at Walsall, and he thought there was prejudice in the minds of many against the multiplication of poles, lamp-pillars, and wires. On the other hand, he thought it was only just to say that the Walsall system had great claims for quietness, the ease with which the cars travelled, and the speed with which they went up the inclines. With regard to their visit to the Birmingham Central Tramways, he did not consider this nearly so pleasant travelling, and the vibration was disagreeable. Mr. Swaish strongly advised the adoption of a system similar to that at Walsall. The Town Clerk read the conditions under which the Town Council of Walsall allowed the trams to be erected and worked. The whole of the work had to be carried out to the satisfaction of the Council ; the poles to be of a certain height, and to an approved pattern. The Council also stipulated for the use of the poles for electric light purposes. Undoubtedly the Bristol Corporation would adopt similar conditions to those at Walsall if that system were adopted. A question was asked as to whether the Tramway Company was to pay for the concession if it were granted, to which the Town Clerk replied that he was not aware of any such practice in any town. Some further details were discussed, and the Town Clerk was instructed to send the proposed amendments to the Tramways Company, and to report. A strong local committee has been appointed to assist in the promotion of the Tramway Company's scheme for the electric tramways. A preliminary list comprises nearly 150 names of the principal residents.

FRAMLINGTON.—The local authorities have recently received tenders for lighting the village of Framlington, and it appears that the competitors are oil and electric lighting. A meeting of the authorities is to decide which of the rival illuminants is to be selected.

HALIFAX.—The various tenders required in the erection of the electric lighting works in Foundry-street have been received by the Gas Works Committee, and have been accepted.

IPSWICH.—The Town Council recently referred the consideration of the electric lighting project to Mr. John Pratt, who has now presented a report. He suggests that the old Falcon Brewery should be made the site of the central station, that the area of the district lighted should include all the principal streets of the centre of the town, and he estimates that the cost of the necessary plant would be £9,036 ; annual maintenance (including sinking fund), £2,116. 16s.; estimated revenue, £2,350, from the commencement. Eighty townspeople have guaranteed to take the light if the price is not much in excess of gas. The subject will be further discussed at the next meeting of the Town Council.

KEIGHLEY.—At the meeting of the Town Council, on Tuesday last, a motion was discussed to instruct the Town Clerk to give the necessary notice and make application, when the time arrived, to the Board of Trade for a Provisional Order, empowering the Corporation to instal the electric light, to supply light and energy for all purposes, and to schedule the thoroughfares in which the mains are to be laid.

LONDON CITY COMMISSIONERS OF SEWERS.—In reply to a question asked by Mr. Johnson as to what steps had been taken to remove from the streets the obstruction of the gas standards, now that gas had been superseded by the electric light, Mr. Burmester said that it had been decided to remove these at the end of March, as it was the desire of the Commissioners not to disturb the streets during the dark months of the year. The lighting committee agreed that the lamps were now an obstruction. With regard to the appointment of an electric light inspector, the matter had been referred to Mr. W. H. Preece, the City's electrical engineer, and his report is shortly to be presented to the court.

MAIDSTONE.—The Electric Lighting Committee of the Local Board have presented their report upon the offers received for lighting the district by electricity, and recommend that the offer of Messrs. Bourne and Grant be accepted provisionally, and that further negotiations be entered into with that firm with a view of coming to satisfactory terms, and arranging for a transfer Order. In moving the adoption of the Committee's report, Mr. Alderman Ellis said that the Board obtained their Provisional Order with the idea of preventing any one else setting up electric lighting works in the town, and the order must be carried out by July next, unless the Board of Trade were willing to give them an extension of time. The time had, therefore, come when either the Board must move in the matter, or allow some one else to do so. It was now proposed to transfer their Order to a private firm, the Board to have the option of purchasing the undertaking at the end of twenty-one years "without any extravagant items being added to the purchasing price." Messrs. Bourne and Grant proposed to supply additional streets to those scheduled in the Order, and to charge 8d. per unit, less varying discounts. Several members stated they were in favour of the Board undertaking the work themselves, as money could be borrowed at 3 per cent., and they were in a position to do the work. The further consideration of the report was adjourned for a fortnight.

PETERBOROUGH.—The period for lodging objections to the application of the Local Board for a Provisional Order has expired, and the Board will, doubtless, carry through its application, and obtain the Order.

OSSETT.—The Town Council have received a communication from the Local Government Board in reference to the proposal of the Guardians to instal the electric light in the workhouse. The Board point out that they consider that, under the circumstances, the loan referred to should be repaid in 10 years, and not in 30, as suggested by the Guardians. The Council have received numerous communications from electric lighting firms in connection with the installation, and the tenders for the work have also been received. A motion that the tenders be simply opened and referred to the Electric Lighting Committee for report was agreed to.

PENISTONE.—The Brush Company have written to the Local Board stating that, after a careful examination of the map and general conditions of the scheme for lighting the district, the Company has come to the conclusion that it is not practicable to submit a scheme of lighting, by electricity, for a total of less than 600 16-c.p. lamps distributed over 4¼ miles of road, and that any less number would result in a loss.

SHEFFIELD.—The Improvement Committee of the City Council have adopted a resolution that provision be made for the supply of electricity throughout the new Town Hall, and for a modified supply of gas to the staircases and corridors. The architect is to report to the Council whether, in his opinion, it would be desirable to dispense with gas altogether.

STIRLING.—It will be necessary for the Town Council to begin *de novo* their proceedings in opposition to the application of the Caledonian Electric Supply Company for a Provisional Order, as the Board of Trade has sustained an objection to the decision of the Council refusing to consent to the application of the Company, the Board having decided that the statutory thirty days' notice was not given of the Council's intention to apply for a Provisional Order on their own behalf, and that this was necessary when lodging their objections to the Caledonian Company's application.

SURBITON.—The Improvement Commissioners have accepted the offer of Mr. Sharpe to report to them upon the electric lighting of the district at a fee of £26. 5s.

ELECTRO-HARMONIC SOCIETY.—There will be a "ladies' night" this (Friday) evening, at 8 p.m., at St. James' Hall Restaurant, Regent-street, London, W.

SMOKING CONCERTS.—A successful smoking concert, connected with the City of London Electric Lighting Company, was held on Friday last at the London Tavern, under Col. H. C. Seddon's presidency. The company numbered about 150.

———— Under the presidency of Mr. C. J. Phillips, the Telephone Athletic Association gave the second smoking concert of the season at the "Falstaff," Eastcheap, E.C., under the direction of Mr. T. C. Walker. The party, numbering about 200, passed an agreeable evening.

COMPANIES' MEETINGS AND REPORTS.

The City of London Electric Lighting Company (Limited).

The ordinary general meeting of this Company was held yesterday (Thursday) at Winchester House, Sir David L. Salomons, Bart., presiding.

The SECRETARY (Mr. J. Cecil Bull) read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN then said : I take it that you will pass a resolution that the Directors' report be taken as read. It will probably be agreeable to you to hear the progress which has been made in this undertaking since December 31st last. Any impartial person reading the report will see that the statement is a very fair one, and that nothing has been exaggerated. The past year was a very bad one from an Electric Lighting Company's point of view, there having been so many bright days and such an absence of fog. At the same time this was favourable to the Company, for the reason that they were busily engaged in erecting machinery during the latter part of the year. It must be remembered that for the greater part of last year our income was made from the current produced by the pioneer stations, and two half units, *i.e.*, a total power sufficient for, say, 34,000 8-c.p. lamps, allowing for no reserve. In order to furnish you with figures upon which to form a fair judgment, I will venture to give the following details :—At the beginning of 1893 there were 20,241 lamps connected to the system, and a total current-supplying capacity equal to 32,000 lamps. At the middle of last year there were 45,919 lamps connected, and the

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machinery to supply the current was equal to 34,000. At the end of last year there were 65,341 lamps connected, the machinery being capable of supplying 64 000 lamps. At the present moment the number of lamps connected exceeds 76,000, and the machinery to supply them is equivalent in power to 100,000 lamps. In a very short time the supplying power will be greatly increased, the machines now in course of erection being almost ready to give current. There are yet to be connected some 25,000 lamps in districts where the transformer stations are now being equipped, To take a sanguine view, these stations may be ready for service in April, but at any rate within the next four months there is every reason to believe that they will all be supplying current. The experience of the Company has been similar in one respect to that of others. Applications are only made as soon as those requiring current see an early probability of their want being supplied. You must therefore form no conclusion that because nine transformer stations are in use, and supplying 76,000 lamps, the remaining 13 areas in which there are applications to supply 25,000 more lamps is any criterion as to what the demand will be for these areas, but it would be fair to assume the demand will be approximately proportional in most areas to those now supplied, *i.e.*, equal to, say, 180,000. We hope to obtain a night load shortly by the supply of current to Fleet-street and the adjoining districts. Your Board, in order to keep the Company in a good financial position, has decided to start, apart from other depreciation funds, a large fund which should include mains, which is invested in Consols; and the Board considered that it was fair at this stage of operations to take a portion of the premiums which had been received to assist the depreciation funds. In fact, as you will observe, the whole of the premiums received have been devoted to reserve funds. In the course of another year or two, when the machinery is in full work, and every area in the City supplied with current, it appears hardly likely that it will be necessary to touch these reserve funds, except upon special occasions should they arise. I must candidly tell you that, up till to-day, the Board felt considerable anxiety in meeting the demand for current, which had increased at a more rapid pace than it was possible to supply. The difficulty of running machinery in buildings under construction is far greater than anyone who has not had experience in these matters would imagine, and many minor accidents occurred in consequence. Yet I think the severest critic would not judge harshly when it is remembered that since the current was put on day and night some two years ago, the total number of extinctions have been considerably within an hour, even when all the small stoppages are summed up together. In the public lighting also there has been great freedom from breakdown, as can be seen from the City engineer's report, the most serious one having been due to the bursting of a steam valve. In order that the public lighting may be made as secure as human foresight can provide, the lamps on one side of a street are not run off the same machine as those on the other side. Again, the engine which runs the dynamo to supply current for one side is not the same engine as that which runs the dynamo for lighting the other side of the street. The City has only spent 1s. 2d. for gas up to last July in consequence of breakdowns, and has kept the lamp-posts up at an expense of about £1,200 a year. The City now obtains far more light for the increased expenditure than under the old method. The City authorities evidently place complete faith in your Company, because the lamp-posts throughout the main streets are to be removed by the end of March, and would have been sooner removed but for the fact that it was desirable not to disturb the streets during the darkest months of the year.

At the present time your Board feel that the period of anxiety has passed, and that the station will be able to cope with any demand which may be made upon it for current; and, more than this, they believe that the supply will be satisfactory. I know perfectly well that there have been great complaints on the part of many applicants of the delay in obtaining current. Indeed, many who applied for current a year or more ago have not yet received attention. This has not been the fault of the Company. It is quite impossible to carry out the work faster than has been done, and I fully believe that it will not be necessary for me to make any further apologies on this score, because within the next half year the whole of the network throughout the City will be alive. I take the opportunity on all occasions of hearing what our customers think of the supply we give them, and the general consensus of opinion is decidedly favourable. Many gentlemen have stated that their electric light bills are less than their gas accounts were when they used gas. Some express a contrary experience; but, when cross-examined, these latter clients admit that they are getting far more light than they used to have, and exercise no economy to save the current. It is a strange thing that so many people look for vastly more light when using the new illuminant, expecting to pay the same or less money than they did before. A reasonable person can hardly expect such wonders. This would only be true if arc lights were used, but naturally this class of illuminant would not be suitable for City offices, although in many shops such lamps would be found of service. The number of customers are 1,420, and applications come in daily. Apart from the street lighting, which is now completed in the compulsory thoroughfares, we have received the order to light round Smithfield Markets, and we are waiting daily for the order to complete lighting the lesser streets.

A very difficult work is now in course of progress at Bankside, which will shortly be completed. It is that of laying three large cast-iron tubes in the bed of the Thames for the condensing plant which, it is hoped, will be in use by the autumn. If we are fortunate in getting this done, and the winter should prove a dark one, we look forward to very good results. To give you an idea of some of the incidents which have to be coped with in a central lighting station, I may mention that during the intense frost which occurred in January, our boilers no longer received a water supply, in consequence of the water company's mains having burst at Hampton. With great presence of mind, Mr. Jackson, our third engineer, sent to the fire brigade, and, with their assistance, pumped water from the Thames for the boiler supply. The Board feel much indebted to Captain Simond for this service. By the end of the next six months the station will probably be quite complete, but the whole of the machinery which is to be placed within it is not yet on order, but will be ordered as the demand for current arises, always keeping in view the time necessary to produce the machinery. It is intended to erect a number of dwellings adjoining the works, for those employed on the station. You will observe in the report a short paragraph stating that it is the intention of the Board to issue a portion of the Debenture stock. Further issues of stock will only be made from time to time as money is required, in order not to charge the revenue unnecessarily. The Board have under consideration the desirability of publishing regularly returns on the lines as done by the railway companies. It is with much regret that I have to announce that Mr. Charteris has decided to retire from the Board. You are aware that during the last two years he has been suffering from illness, and he feels that a long period may elapse before he will be fit to resume active duty. It is, consequently, against his principles under these circumstances to remain upon the Board any longer. It is also my turn to retire, and I place myself in your hands, whether it is your pleasure to re-elect me or not. The members of the Board are working in the greatest harmony, and they are dealing with your interests to the best of their capabilities. It is therefore considered advisable to leave the Board as it stands at the present time. The resignation of Mr. Charteris does not affect the active Board, since he has been absent from their deliberations for a long time past. The loyalty, intelligence and activity of our staff cannot be overrated. It has been the good fortune of your Directors to have made an excellent selection of their lieutenants, and when you consider that probably at the end of three years from the starting of this Company the whole of the City of London public and private lighting will be completed without a hitch, and so far, I am happy to say, without loss of life due to electricity, it would not be fair to charge the Board or its officers with having been idle, especially as this work will have been done quietly and without any flourish of trumpets. To Mr. Cook, the engineer and manager, Mr. Bull our secretary, Mr. Nisbett, second engineer, Mr. Jackson, third engineer, Messrs. Deakin, Aspinall and Ferguson, and our various other station engineers, as well as Colonel Seddon, engineer of buildings, and Mr. Thomson, the architect, our thanks are greatly due for their unremitting energy. Indeed, I may include the various minor officers and the staff who serve under them, for however great the generals may be they can do nothing without the army. Indeed, generals are often made by the stuff of which their soldiers are composed. The Board, therefore, take this opportunity of bearing testimony to the valuable assistance received from the Staff generally. For myself I need scarcely say that my interest in the progress of the electrical science and industries has been one of the chief objects of my life. In fact, since I have been connected with this Company, I have always regarded the installation with the same affection as if it was my own private one, so that any responsibility that may rest with me as to want of success will not be due to indifference on my part; and if success should crown our efforts, I can only claim my share in common with my colleagues and the officers of the Company, for it will have been attained by the harmonious co-operation of all concerned. I now move—

"*That the report of the Directors and the statement of the accounts to December 31, 1893, with the appropriation of the reserve fund as proposed, be, and the same are hereby, received and adopted.*"

Before putting this motion to the vote, I shall be pleased to reply to such questions as any gentleman present may desire to ask.

Mr. J. BEVAN BRAITHWAITE, jun., in seconding the motion, said that he might perhaps be allowed to allude to the financial aspects of the report. He was very well aware that the form in which the Board of Trade required them to present their accounts was somewhat of a puzzle, but they had endeavoured to throw the gist of the thing into a more comprehensive shape in the revenue account. It would be seen from this that their gross revenue for the year had been £38,556, and that their working expenses, including repairs and renewals, had been £23,091. 13s. 8d., leaving a net revenue of £15,464. 16s. 7d. If they would turn to the end of the report they would find the rest of the information, which, as shareholders, they would naturally ask for with reference to the financial aspect of their affairs. They would there find the key of the position. The working expenses had been 54·2 per cent. of their revenue. When they remembered that in the case of the railway companies, even after being many years in operation, their proportion of working expenses was round about 50 per cent., they must feel satisfied at the working expenses of this Company, now in its infancy, being only 54·2 per cent., in spite of the two causes mentioned which had affected their earnings this year, namely, the unexpectedly fine weather, which had decreased their receipts, and the coal strike, which had increased their expenses. If they could work under such circumstances, with such a comparatively small number of lights on, he thought they might look forward with confidence to the future. The cost per Board of Trade unit delivered last year was 3·181d., as against 4·733d. in the preceding year, showing a reduction of no less than 32 per cent. in the cost of producing the current; and when it was borne in mind that their station was still young, and that the figures before them were the outcome of an average number of only 34,000 or 35,000 lamps, and that they were looking to an ultimate demand for 300,000 or 400,000 lamps, they would see that the Company was making very substantial progress. Another feature which could not fail to be satisfactory was that they had reserve funds now amounting to £40,000 invested in Consols. They were therefore getting into a very strong financial position, and would be able to meet the charges for the maintenance and renewal of their network. With respect to the coming issue of Debenture stock, some persons seemed to be under an impression—he had noticed that that was the case from one or two notes in the technical papers (and he had been surprised at it)—that the proposed issue had taken the Directors quite by surprise, and it was said that as they had issued Preference shares and were now going to issue Debenture stock they were going from bad to worse. If, however, reference was made to the

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prospectus issued by the Directors when they asked for subscriptions to the Ordinary shares it would be seen that the cost of the undertaking was fully counted before they started. They had really been pursuing a steady and continuous policy from the outset, and, as intimated in the prospectus would be done by them; they first issued their Ordinary shares, then their £400,000 of Preference shares, and now they were about to commence the issue of Debenture stock. After the present proposed issue they would require to issue another £100,000 of Debenture stock. So far as he could see, the original estimates for lighting the City had been very fairly realised, taking the thing all round. He hoped, therefore, that the shareholders would believe that in regard to the issue of Debenture stock the Directors were not taken by surprise in any way, but were carrying out a deliberate policy. The £800.000 already spent had pretty much covered the dead work of the Company. They had got all their tubes in the streets, and a large portion of their cabling in, and the remaining expenditure would be chiefly by way of providing additional machinery for earning revenue straight away. The expenditure of the £100,000 of Debenture stock, so far from putting the Ordinary shareholders further away from a dividend, would do exactly the opposite, for instead of earning £5,000 of net revenue—the interest on the amount at 5 per cent.—it would probably earn much nearer £15,000 or £20,000, because the dead work was done, and the remaining expenditure was only for additional machinery with which to supply additional lamps. He had thought that this explanation was necessary, as some people seemed to have forgotten what was stated in the original prospectus. The fact was that their estimates up to the present time had been remarkably confirmed by their actual experience.

Mr. WILLIAM COOPER said he assumed that there must be a large undeveloped power existing, but he happened to be a shareholder in the Westminster Electric Company. It was very curious that the output of electricity by that company was within a very few hundreds of this Company's, and the net result was within a few hundred pounds of the City Company's, but while the Westminster Company had a capital of £400,000, the capital of the City Company was £800,000, and they were wanting more. He thought that the explanation of the seconder of the motion had thrown some light on the subject, but he would be glad to have any further particulars which could be afforded him with respect to what he had stated. He might add that the Westminster Company had declared a dividend of 5 per cent. on their Ordinary shares.

Mr. WANCKE asked at what price the debentures would be issued, for how long they would run, and when they might be redeemed.

Mr. JOHN NEWTON inquired what advantage it was for the Company to issue Debenture stock instead of issuing further Preference shares.

The CHAIRMAN replied that they had issued all their Preference shares—the whole £400,000.

Mr. BRAITHWAITE: Why, too, should we pay 6 instead of 5 per cent.?

Mr. NEWTON replied that in the building in which they were then assembled some millions of pounds were in jeopardy in consequence of the issue by Directors of Debentures. He could not see why they should not obtain powers to issue more Preference shares, considering the high premium at which those shares stood in the market.

A SHAREHOLDER enquired the cause of the delay in paying the dividend on the Preference shares.

A SHAREHOLDER stated that on the debit side of the capital account, number 9 item was set out as "proportion of management and general expenses chargeable to capital," £24,466. He wished to know whether this matter had been carefully gone into, and whether the Directors were satisfied that none of the amount in question should have been charged to revenue.

A SHAREHOLDER asked whether there was any chance of the telephone tubes being brought into use.

The CHAIRMAN, in reply, stated that the subject of the telephone tubes was still under negotiation, and what the end of it would be he could not say. The matter rested with the City Commissioners; but they hoped shortly to hear something further about it. As soon as a conclusion was arrived at it would be communicated to the shareholders or the Press. With respect to the item of £24,466, to which attention had been drawn, the amount had been apportioned with the very greatest care. A shareholder had asked why the profits could not be paid earlier. He did not know whether that gentleman held railway stocks; probably many of those present did, and they would be aware that a good many of the railway companies had not yet paid their dividends.

Mr. NEWTON pointed out that the Preference dividend was not due until the profits were shown.

The CHAIRMAN, continuing, said that that was so. They had considered it fair to pay the interim dividend on account. In reference to the proposed issue of Debentures, they were not Debentures in the ordinary sense of the word, but debenture stock, and it was decidedly more preferable for the Company to issue Debenture stock—in accordance, too, with the original intention—than to apply for fresh powers to issue further Preference shares. There would be no advantage either, in issuing Preference shares, and by the issue of Debenture stock they would save about 1 per cent. or more in interest, and without endangering in the least the position of the Ordinary shareholders. In fact, their position would be improved. It was no use to compare a company like theirs with a company that had come to grief under circumstances which had no application in the case of a sound undertaking like theirs. The Ordinary shareholders would have the power to take the Debenture stock. He believed the interest it would bear would be about 4¼ per cent.; it would be Five per Cent. Stock issued at 115. The Debenture stock might run to the end of the term, or be redeemed at 125 after a certain period.

Mr. BRAITHWAITE stated that the first option to redeem would be in 1911, when the City Commissioners had the option of buying up the public portion of the Company's undertaking. If they were not then redeemed, and the authorities exercised their option to acquire the undertaking at the end of 42 years, the stock would then be redeemed at 125.

The CHAIRMAN, continuing, said that the stock would be issued in a few days. As to the comparison between their Company and the Westminster Company, the latter had almost got to the end of their work, and the City Company, with double the capital of the Westminster Company, had only just begun theirs. If the City Company could do so well at the beginning of their career as the Westminster Company were doing in their prime, he thought that it showed that the City Company were in a very good position.

Mr. BRAITHWAITE, in answer to another shareholder, stated that the proposed Debenture stock would not give anyone the power to foreclose. It would simply be a first charge on the earnings of the concern, if there were any.

The motion was then unanimously adopted.

The CHAIRMAN afterwards proposed the following resolution:—

"That a dividend of six shillings per share for the half year ended December 31, 1893—making with the interim dividend of 5s. 4d. per share, paid on July 11, 1893, the full dividend of 6 per cent. per annum for the year—be, and the same is hereby declared on Preference shares Nos. 1 to 20,000 inclusive. That a dividend of three shillings per share, being at the rate of 6 per cent. per annum, calculated on the respective instalments for the period ended December 31, 1893, be, and the same is hereby declared on Preference shares Nos. 20,001 to 40,000 inclusive; that the respective dividends be paid on February 23, 1894."

Mr. EDWARD LUCAS seconded the motion, which was carried unanimously.

Mr. FREDERICK W. REYNOLDS then proposed the re-election of Sir David L. Salomons, remarking that after the statement which they had heard from that gentleman, the shareholders had had ample opportunity of judging for themselves of his capabilities. He might state that Sir David Salomons was not connected with any other company, and that his entire services, as far as public companies were concerned, had been at the disposal of the Company from its commencement. When Mr. Braithwaite was fortunate enough to secure the services of Sir David Salomons as Chairman of the Company he thought they might say that their success was assured.

Col. B. H. MARTINDALE, C.B., seconded the motion, which was carried unanimously.

The CHAIRMAN, in acknowledging his re-election, said he would continue to serve them in the future as he had done in the past. When the history of the Company came to be listened to in another year or two he hoped they would find that he had not only done his best, but that he had been successful, with the assistance of his colleagues.

On the motion of Mr. Wancke, seconded by Mr. J. W. Reilly, Messrs. W. H. Parnell and Co. were re-elected auditors for the year ending December 31st next, at a fee of 100 guineas.

Mr. GEORGE HERRING then proposed the following resolution:—

"That the thanks of the shareholders be accorded to the Chairman and Board of Directors and Staff for their able management of the affairs of the Company."

It would, he said, in his opinion, have been almost a miracle if the Directors had been able at present to pay a dividend on the Ordinary shares, but they were working in such a way as would secure a good Dividend in the future. If with the present number of lights the managerial expenses and the Dividend on the Preference shares could be covered, the shareholders might be able to form some opinion of what the position of things would be when they were supplying 400,000 lights, remembering that the additional cost of doing so would be but very small.

Mr. R. PEMBERTON LEACH seconded the motion, which was unanimously adopted.

The CHAIRMAN, in reply, said he thought there was a great deal in what Mr. Herring had said, and that a good dividend would come to the shareholders if people would only take the light, which they had shown themselves ready to do to a greater extent than had been anticipated. If the shareholders would have a little patience the future of the Company was assured. The Directors might, if they had pleased, have strained a point, as was often done, and have paid a dividend on the Ordinary shares, but this would have been a more unsatisfactory proceeding than waiting until they had earned a dividend fairly. The fact that the accounts had been made out so strictly should give the shareholders confidence that no tricks were being played in order to pay a dividend.

The proceedings then terminated.

Oriental Telephone and Electric Company (Limited).

An extraordinary general meeting of the members of this Company was held on Wednesday at the Cannon-street Hotel, Mr. William Addison presiding.

The SECRETARY (Mr. A. B. Chalmers) having read the notice convening the meeting.

The CHAIRMAN said: Without going all over the ground again, I will just remind you that since the present Board have directed the affairs of the Company they have, from time to time, endeavoured to arrive at an understanding by which the two classes of shares, into which the share capital of the Company is divided, should be assimilated, thus abolishing the liability on the partly paid-up shares, and bringing in the Vendors' shares for immediate dividend on reduced capital. The difficulties in the way of the accomplishment of this have until recently been almost insuperable, but after the recent decision of the House of Lords, unfavourable to the contention of the holders of Vendors' shares, your Board was approached by three or four of the largest holders of those shares with a view to endeavour to arrive at a compromise fair and equitable to both classes of shares. As it was clearly desirable that the interests of both sides should be represented at any meeting that might be held between representatives of each class of shares, your Board

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delegated two of its members, who were holders of upwards of 30,000 Ordinary shares, to meet the representatives of the holders of Vendors' shares. After numerous protracted meetings a provisional agreement was arrived at between the respective representatives on the terms contained in these resolutions. It is true that the Ordinary shares will have to submit to a reduction of 1s. per share; but it must be borne in mind that the vendors also reduce their 20s. shares by 4s. 6d. each. However, I think you will agree that a fully-paid £1 dividend-paying share is a more marketable article and likely to fetch a higher price than, say, two 11s. shares with 18s. liability on them, or than one Vendors' share of £1 fully paid up without any chance of a dividend for years to come. The scheme may not be so advantageous as some of the Ordinary shareholders could have desired, nor is it so beneficial to the Vendors as some of them could wish, but it is an honest endeavour to reconcile conflicting interests and to put all the shares on a level basis, and thus further the steady progress of the Company and the welfare of all its shareholders, who now will have but one interest. As the Company's solicitor is present I will now ask him to address a few words to you in explanation of the scheme. I may, however, add, in conclusion, that proxies received by the Board assenting to our proposal amount to about 205,000 shares.

Mr. JOSEPH ADDISON (the solicitor): I will detain you but a very short time, but as the consideration of the scheme does involve a certain amount of legal question, I will explain it to you at the outset. In the first place you may remember that by the constitution of the Company, it was provided that during the first five years of the Company's existence dividends of 6 per cent. should be paid upon the Ordinary shares, and that the vendors should not participate in the profits until the 6 per cent. had been paid. The agreement contained a further clause that if during any of those five years the 6 per cent. was not paid, then that the deficiency should be made up out of the profits available for dividends in future years in priority to the right of the vendors to participate. That is, shortly stated, the exact effect of the language. What happened was this: During the first five years the dividends did not reach 6 per cent. on the Ordinary shares; there was a deficiency of about £20,000. During those five years no dividends at all were declared on the Vendors' shares. All the profits were distributed as dividends upon the Ordinary shares. After the five years the Board proceeded to carry out the same plan, and distributed all the dividends upon the Ordinary shares; but they were then, as they are now, desirous of effecting an arrangement between the two classes of shares, and for the purpose of seeing what should be done, an actuary was called in, and it occurred to that gentleman that what had been done was not quite right—that what should have been done for the five years was that, instead of appropriating all the profits to the Ordinary shares, the profits should have been distributed upon all the shares, Vendors' and Ordinary, and then that the profits of the Vendors' shares—the dividend on the Vendors' shares—should be taken to make up the deficiency of the previous five years. Upon that view being enunciated the opinion was taken of Mr. Cozens Hardy, who said that the actuary was right. Precisely the same state of facts was laid before Sir Horace Davey, who said, with equal emphasis, that the actuary was wrong. Upon that arising the Directors determined, if possible, to have the question set at rest, and Mr. Ness—a gentleman who has taken part in the proceedings, but who was not a volunteer in disturbing the existing state of affairs—at the instance of the Board, was invited to come forward for the purpose of having this question settled, it being part of the arrangement that the costs incurred in taking the decision of the Court of First Instance should be paid as regards both parties by the Board. The decision was taken, and Mr. Justice Kekewich promptly decided that the actuary's view was right. Mr. Ness then went to the Court of Appeal, which consisted of Lords Justices Lindley, Bowen, and Kay. They decided that the actuary was wrong, and they did so in very emphatic terms. The case was then carried to the House of Lords, and that tribunal, by three of the law lords against two, decided that the view of the actuary was right. The result of that very remarkable litigation is that although the decision is against the holders of the Vendors' shares, there are in favour of the view put forward by them, five judges, consisting of the three judges of the Court of Appeal and two members of the House of Lords, as against four judges, consisting of Mr. Justice Kekewich and three members of the House of Lords. You, therefore, see that four opinions have carried the day as against five, to which may be added, if you think it well, the opinion of Sir Horace Davey, who is now one of the Lords' Justices of Appeal, in favour of the Vendors, as against Mr. Cozens Hardy, who is also a very prominent advocate, in favour of the Ordinary shareholders. The expression of such contradictory views was owing to the documents forming the constitution of the Company, and litigation was no consequence of any improper act or improper attempt to take advantage of the holders of the Vendors' shares. After that question had been set at rest by the decision of the House of Lords, negotiations were again opened with a view to a compromise, and in order that you may quite understand the basis of this compromise, I think I should say one word as to the position of the vendors, and of the Ordinary shareholders in the absence of a compromise. As the matter stands at present, there is an arrear of dividend to be made up to the Ordinary shareholders, to make good which they are entitled to appropriate the dividends, which will be declared on the Vendors' shares for some years' to come. The amount at the present moment is about £11,000. When that arrear is made up, bear in mind, the Vendors' shares will participate for dividend, and they will participate on their 20s. per share as against the 11s., which is the amount paid up on the Ordinary shares. There is also, of course, this further consideration: There is a present liability of 9s. per share attached to the Ordinary shares, and, in the event of the Company being wound up, or being amalgamated, or in any event of that kind, which at present is not foreseen, but which may happen, taking place, there would be a right on the part of the Vendors' shares to receive in full their 9s. per share, which is paid up or credited as paid up, before any distribution could be made out of the assets of the Company to the Ordinary shareholders. Those are the considerations which the Directors had to bear in mind in settling the scheme they put before you. There is, no doubt, one other consideration to which the Chairman has referred, and which will appeal to you as men of business, namely, that in the present state of uncertainty regarding your share capital, the shares of the Company do not stand at an advantage upon the market. The buyer of an Ordinary share does not know how long his present dividend will continue in excess, or how soon the vendor will come to rank with him; and the fact that the Company has one class of shares receiving a dividend, which is more or less uncertain as regards the length of time it will endure, and that there is another class of shares now receiving no dividend at all, in the same Company, does to a certain extent affect the market value. The effect of the scheme is this: You will see that 1s. per share is written off the Ordinary shares, and that 4s. 6d. per share is written off the Vendors' shares. I think that the fair way to look at the matter in the first instance is to treat this 1s. per share written off both classes of the shares, as if it was owing to depreciation in the concession and the wearing out of the patent rights. Therefore, what the vendors say to you is this: "We will write off 3s. 6d. a share on our shares; we will also agree to forego that advantage which we might have in the event of amalgamation or of winding up of receiving our 9s. a share before you get anything; and we will also consent to relieve your shares from liability to call." As I said, the arrears of dividend which have to be made up to you are £11,000. The 3s. 6d. a share, which the vendors write off their shares I think amounts to about £13,125, and therefore you see that on the one hand you are making a concession in allowing them to take a dividend on their shares of about £11,000, which would otherwise come to you, while, on the other hand, the holders of the Vendors' shares are writing £13,000 off their shares, they are relieving you of the liability upon your shares, and they are agreeing because that is what it comes to, that in the event of any winding up or amalgamation, your shares shall rank *pari passu* with theirs in the distribution of assets. Of course, every scheme is more or less of a compromise, and there may be some of you who might have wished to get better terms for your Ordinary shares, while there are holders of Vendors' shares who might have wished to get a certain amount more for their shares. Like all schemes, however, this is more or less a compromise, and the Board believe it to be a fair and honest compromise, and one beneficial to both classes of the shareholders. There is only one further matter I should like to mention, and that is with respect to the course we have to take. We shall have to wind up the old Company, but I hope we may so arrange with regard to the formation of the new Company that that may be carried out at comparatively small cost. I should not have referred to any other topic except that I gather from the secretary that some gentleman has raised the question of costs, which are to be paid so as to free Mr. Ness from liability. I think I have explained the circumstances under which Mr. Ness came forward, and I have explained to you the necessity of litigation. Mr. Ness, as part of this scheme of arrangement, says, You must frank me from the expenses I have been drawn into by acceding to your wish that I should take part in this litigation. The expression used in the scheme is that the costs shall be paid as between solicitor and client. As regards the Company's own solicitor, his costs would naturally be paid as between solicitor and client; but I have been looking through my charges in the matter, and I find it makes a difference of but very few pounds.

The CHAIRMAN proposed the resolution, and the motion was seconded by Mr. Lloyd.

Mr. NORRIS said he understood from the notice of the meeting that it would be necessary for the Company to go into liquidation. The resolution would be confirmed after a fortnight. The Company was going to sell its assets to a new Company, and it would then be in the hands of liquidators. How could it be possible, therefore, that the statement of the Directors in the report was in any way accurate—that "there will be an approaching annual general meeting, when a dividend for the past year will be declared?" No dividend could be paid until the new Company had earned profits for the year 1894. With respect to the scheme, the Ordinary shareholders were asked to give up a preferential claim of £11,000 before the Vendors' shares could possibly receive a dividend, which would not be, judging from recent experience, for six or seven years at least. Beyond that, the Ordinary shareholders were asked to relinquish £11,000 of their capital by knocking off 1s. per share. The Company were further to provide not only the costs of their own solicitor, but also the costs of Mr. Ness. Moreover, the Ordinary shares were a marketable security, quoted and dealt in on the Stock Exchange, and the Vendors' shares were, by the proposal before the meeting, to be put on an equality with the Ordinary shares, whereas they were at present not likely to become a marketable security. He thought the proposal required very serious consideration, and he would move the following amendment:—

"*That the proposal be postponed until after the annual meeting has been held and a dividend paid for the year 1893, and that a committee of three shareholders be appointed to confer with the Directors as to any arrangement with the holders of Vendors' shares.*"

The SOLICITOR, in answer to a question, stated that it would be necessary for the liquidation of the Company to be passed at the meeting by a majority of three-fourths of the shareholders present or by proxy.

Mr. SCRATCHLEY seconded the amendment.

Mr. LORRAINE said that the Chairman had stated that the Directors held 205,000 proxies, which he thought included the vendors. He had been a shareholder in the Company from the beginning, and he had also held Vendors' shares. He had always understood that Mr. Ness in the litigation was an antagonistic shareholder, but they now heard that that was not the case, and Mr. Ness, representing the vendors, had been invited by the Directors to bring the action to which reference had been made. In face of the fact that the Ordinary shareholders had won the case and obtained a decision in their favour from the House of Lords, from

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whose decision there was no appeal, it was proposed that they should make an arrangement with the holders of the Vendors' shares giving the latter all that they could want supposing that they had won the case.

Commander HANNAY asked what difference it would make to the dividend on the Ordinary shares if the 58,000 shares which were to go to the holders of the Vendors' shares were brought in for sharing in the dividend.

Mr. CHARLES CHESTON said he thought that an unfair attack had been made on the Board. The Vendor shareholders, who had £75,000 in the capital of the Company, had only one gentleman indirectly representing them at the Board, because that gentleman held a large interest in the Ordinary shares as well. It was perfectly certain that if the compromise had not been proposed the Board would have been stopped by the Courts in any further effort to build up another reserve fund in the interests of the Ordinary shareholders. His own view was that the Vendor shareholders were giving up an enormous amount more than they ought to. The Vendor shareholders owed the Ordinary shareholders £11,000, against which, however, must be set the reserve fund. In two or three years the Vendor shareholders, with their fully-paid shares, would be ranking for dividend with the holders of the Ordinary shares, on which only 11s. was paid. The only reserve wanted by the Company was that which was afforded by the liability of 9s. a share on the Ordinary shares. What had been said about the market value of the shares was not, perhaps, germane to the resolution, but everyone knew that a share with a liability of 9s. was not marketable at anything like its true value. There was no question that immediately the incubus of this liability was removed from the Ordinary shares the value of their property would increase. The opposition to the scheme which had been raised by the Ordinary shareholders was certainly a great surprise to him. With reference to the question of dividend that had been raised, it would be an interim dividend.

The SOLICITOR, in answer to Mr. Seaman, said he thought they might assume that the law costs would amount to about £850. Mr. Norris had called attention to a possible technical difficulty, but he believed they would succeed in finding some way out of it with the assent of the Vendor shareholders. The £28,000 odd unissued would not be issued.

The CHAIRMAN in answer to Commander HANNAY, said that the accounts for the past year were not made up yet. For the last few years the dividend had been declared on the whole of the shares. If the scheme were carried out, the dividend would be paid on £171,000 instead of £200,000.

On the amendment being put to the meeting, the Chairman stated that seven had voted for it and about twenty against it. He afterwards put the resolution, and the show of hands was seventeen in favour of it, and seven against it, whereupon the Chairman demanded a poll.

The SOLICITOR, in answer to a question, said that the proxies received by the Directors were alone sufficient to carry the resolution.

The CHAIRMAN stated, in reference to the remarks that had been made about the Directors in connection with their holding of Vendors' shares, that Mr. Grewing held 21,000 Vendors' shares, and had had them for six or seven years. Mr. Ackers had within the last few months bought 491 Vendors' shares, against which he held 25,000 Ordinary shares; and Mr. Lloyd held 959 Vendors' shares, which he had had for five or six years. No member of the Board had recently bought Vendors' shares excepting the few which had been purchased by Mr. Ackers. The Directors held about 23,000 Vendors' shares, whereas there were 75,000 of these shares.

Mr. LLOYD: The Ordinary shares are much more largely represented on the Board than are the Vendors' shares.

The CHAIRMAN: The Directors hold over 40,000 Ordinary shares, I believe.

The scrutineers having been appointed to take the poll, it was at once proceeded with, and

Mr. CHESTON announced that without taking the proxies or using the votes of the Board, the numbers were 44,456 shares in favour of the resolution, compared with 1,162 shares against it.

On the motion of Commander HANNAY a vote of thanks was passed to the Chairman and Directors.

The CHAIRMAN, in returning thanks, stated that they had never had a stormy meeting before, and he hoped that the present would be the last of such meetings.

The proceedings then terminated.

Westminster Electric Supply Corporation (Limited).

The ordinary general meeting of the shareholders of the Westminster Electric Supply Corporation (Limited) was held on Wednesday at the offices, Eccleston-place, Belgravia, under the presidency of the Right Hon. Lord Suffield, K.C.B.

The SECRETARY (Mr. Frank Iago) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN then said: In moving the adoption of the report I must congratulate you on the steady increase shown in the business of the Corporation and on the fact of increased profits and dividend. You will see that the revenue has largely increased, notwithstanding adverse circumstances, first the very strong competition to which the Corporation has been exposed, secondly that the charge per unit has been reduced by one penny for nine months of the year, and also the abnormally light weather and absence of fogs. The accounts show the net earnings to have been £11,346, which, added to the sum of £1,484 brought forward from the year 1892, makes a total of £12,830 net revenue. Out of this an interim dividend has been paid at the rate of 3 per cent. per annum for the half-year ending June 30, 1892, and we now recommend the payment on March 1st next of a dividend at the rate of 5 per cent. per annum for the past half-year, carrying forward a balance of £1,191. As I informed you last year, the aim of the Directors has been to pay dividends out of actual profits, and to put the business of the Corporation on a sound basis rather than to pay large dividends at first. They are, however, pleased to be able to advise the declaration of an increased dividend over the corresponding period of the previous year, after having written liberal amounts off the preliminary expenses and patents and law charges accounts and having made provision for depreciation, sinking fund on buildings and leases and bad debts, which latter are very small in amount. During the past year, in conjunction with the other low tension companies in London, the Board came to terms with the Westinghouse Electric Company for the use of the Hopkinson Patents for the three-wire system of distribution, and have obtained a licence for the remaining term of the patents and any extension thereof. The cost of this licence to the Corporation has been £3,878. 9s. 9d., and as the use of the patents has been the means of saving a much larger expenditure for copper in the mains, the amount has been charged to capital. I may here state that there is no likelihood of our having to incur any further outlay for patents of any kind. No item chargeable to revenue has been carried to capital account and the plant, machinery, mains, &c., have been fully maintained out of the revenue of the year. I am glad to inform you that we were very little affected by the coal strike, as we had provided a large supply on the vacant ground in rear of this building, which was sufficient to carry us on until the contractors were able to recommence delivery. Your attention was drawn, at the last meeting, to the satisfactory decrease in the cost per unit generated, and I am glad to be able to state that a further saving has been effected during the year under review, so that we have been able to make the reduction of 6d. per unit and still show a larger profit revenue. Owing to the rapid increase in the number of lamps installed, doubtless due to the reduction in price of current, and later to the reduction in that of the incandescent lamps owing to the expiry of patents which put an end to the monopoly of manufacture, the Board found it necessary in the autumn of last year to obtain further capital. They therefore asked for subscriptions for £20,000 of the Four and a-Half Mortgage Debentures. The applications from our own shareholders were for £40,300, and the Board thought it advisable, as the money would soon be required, to issue the whole of the balance of £30,000, which completes the debenture issue, and thus give some of the debentures to each applicant. We informed you at our last meeting that we had been requested to supply current to the Foreign Office, and you will be gratified to learn that the installation there has been connected to the mains, and a satisfactory supply provided. The authorities have also decided to do away with the private plant which has heretofore supplied a portion of the current for lighting the Houses of Parliament, and will now take the whole of the required supply from the Corporation's mains. We hope, also, that before long other large Government departments will be added. It is interesting to note that the Corporation is now supplying current to 25 per cent. of the total number of houses in Mayfair, 15 per cent. in Belgravia, and to a very large proportion, which we are unable to estimate, in Westminster. You will see by the report that there has been a very large increase in the number of lamps on circuit. At the date of the report we had the equivalent of 134,268 lamps of 8 c.p. actually connected to the mains, and applications were signed for a further 9,541. At present we have the equivalent of 138,255 lamps of 8 c.p. actually connected to the mains, and applications are in hand for 9,990 more. It is also a matter for congratulation that a large number of our consumers who have had experience of the light for some time have made considerable additions to their installations. As many of you are no doubt aware, our system of supply, the continuous current, gives us an advantage over the alternating current system in that it can be very much more easily used for power, and I am glad to be able to state that there is a considerable increase in the number of consumers who use our current for motive purposes. We hope that, in the future, this branch of our business will greatly increase, and become an additional source of revenue. Among others, the following are purposes for which current is actually being used from our mains:—Working lifts, crane, organ blowing, hair brushing, dentistry, bottle cleaning, wood cutting, engineers' lathes, &c. In conclusion, I beg to move that the report and accounts for the year 1893 be received and adopted.

Mr. JAMES H. POWELL, in seconding the motion, referred to diagrams appended to the wall, showing the applications for current, the generating expenses, and the consumption. He subsequently remarked that he thought the diagrams showed very conclusively how steadily they had progressed.

Mr. WILLIAM COOPER said he regarded the report as extremely satisfactory.

The resolution was then carried unanimously.

The CHAIRMAN afterwards proposed the payment of a dividend at the rate of 5 per cent. per annum for the half-year ended December 31st last.

Mr. J. BROWNE MARTIN, in seconding the motion, said he thought they might congratulate themselves on being shareholders in such a Company. Whatever improvements might take place—and improvements were continually taking place—he did not think that anything would supercede electricity for their purposes. They might improve on it, and probably they would do so; and possibly at some future day, if what their able engineer, Professor Kennedy, stated were realised, they might be able to generate electricity at half the present price. He thought there was no doubt that electricity was only in its infancy as to generation and as to use. When one considered the large amount of electricity that was now employed, and yet what a very small proportion it meant to what could be used in London, he thought there was not the slightest doubt that electricity would be not only the lighting but also the motive power of the future; and when they considered that their Company supplied possibly the cream of London, and

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that it had its powers for 42 years, he thought they could only congratulate themselves on being shareholders in it.

The resolution was carried unanimously.

Sir DOUGLAS GALTON, K.C.B., F.R.S., then proposed the re-election of Lord Suffield. He had, he said, never known a Board the members of which had attended more constantly and more regularly than had the Board of the Westminster Electric Supply Corporation, and among those who had thus devoted themselves to the service of the Company, none had been more diligent than Lord Suffield.

Mr. DARNTON HUTTON seconded the motion, which was unanimously agreed to.

Mr. S. R. SCOTT afterwards proposed the re-election of the other retiring Director, Mr. W. Hayes Fisher, M.P. In proposing the resolution, he felt, he said, that the shareholders were asking the Directors to perform their duties for a very small remuneration; but he hoped that in the future the shareholders might be able to deal more liberally with the Board.

Mr. PIERCE seconded the resolution, which was unanimously adopted.

On the motion of Mr. STRATTON BOULNOIS, seconded by Mr. COOPER, the retiring auditors, Messrs. Cooper Brothers, were also re-elected.

The CHAIRMAN thanked the shareholders for the confidence which they had placed in him by re-electing him. It was true, as Sir Douglas Galton had said, that he had given the best attention in his power to the affairs of the Company. He had taken the deepest interest in what was one of the most interesting undertakings at present known; and except when he had been ill, or some special reason had prevented him from attending, he had never missed a Board meeting. He could say the same for his co-Director, Mr. Hayes Fisher. As long as they favoured him with their confidence he would do his utmost to promote the welfare of the Company.

Mr. FISHER also returned thanks. He was, he said, the largest shareholder in the Company, or very nearly so; and he therefore had every reason for desiring, on his own behalf as well as that of the shareholders generally, that the dividend they had declared that day might be continuous, not alternating, or, if it alternated, that it might do so in the direction of something higher than 5 per cent.

Lord GALLOWAY then proposed a cordial vote of thanks to the Chair- and Directors.

Mr. F. A. WHITE seconded the motion, which was unanimously agreed to.

The Chairman, in acknowledging the vote, expressed a hope that they would meet in another year with an even more favourable account than he had had the pleasure of giving them that day.

Chelsea Electricity Supply Company (Limited).

The annual ordinary general meeting of this Company was held on Tuesday at their Central Station, Draycott Place, Sloane-square, Mr. J. Irving Courtenay in the chair.

The SECRETARY (Mr. S. J. Cluer) having read the notice calling the meeting, the report of the Directors was taken as read.

The CHAIRMAN said: Gentlemen,—It is a great pleasure to me to be able to congratulate you to-day on the encouraging results of the past year, and to feel justified in saying that there is a reasonable prospect that the Company will continue to improve its position. At our meeting last year I was able to show that the corner had been turned and that we had attained a dividend-paying condition. During the year 1893 progress has been so satisfactory that there is a considerable increase in the profits, the dividend we recommend this year being double that paid last year, on a paid-up capital which is over 10 per cent. larger than that of 1892. I will first draw your attention to the balance on the sale of the South Kensington District, £2,600. 18s. 1d., shown in the Net Revenue Account No. V., and to paragraph 2 of the Report, as I wish it to be clearly understood that our Dividend comes out of the ordinary business of supplying current, and is quite independent of this exceptional item. We have complied with the views of the Board of Trade, and have taken a large sum from Preliminary Expenses and placed it to a Suspense Account. This amount, under ordinary conditions, would legitimately have remained in Capital Account and have been dealt with year by year; the Directors have, however, decided to write £2,500 off this amount in the General Balance Sheet; they have also placed a further sum of £1,000 to Renewals and Depreciation Fund Account. There still remains a balance of £3,105 2s. 7d., out of which the Directors recommend a dividend of 5 per cent. on the share capital, which will absorb £2,485. 18s. 4d., leaving £619. 4s. 3d. to be carried forward. I feel certain that the shareholders will consider the Directors have made a prudent allocation of the profits. The expenditure for the year on capital account, as shown on page 2 of the accounts, is £18,118. 17s. 6d. The actual amount is considerably larger than that, as you will notice that the credit of £5,453. 10s. 4d. opposite the item of preliminary expenses has been deducted from that column. A large portion of this expenditure is due to an extensive increase in the mains, for, besides the ordinary small extensions always necessary, we have covered a large area extending from the Chelsea Embankment on the south to the Fulham-road on the north, and we believe, from the direction which rebuilding is taking, that this area will in the future develop in the same manner, and to a similar extent, as the area previously occupied by our mains has developed. I wish now to allude to the purchase of the works of the Cadogan Company, which we consider we were very fortunate in securing at the time when a substantial increase of our generating power was absolutely necessary. Our station here, Draycott-place, is now quite full of plant, and the buildings in Manor-street, Cheyne-walk, purchased from the Cadogan Company, are being arranged so that boilers and machinery for 1,000 effective horse-power can be fixed there. This means room for plant to supply an additional 75,000 lamps of 8 c.p. fixed, or say 30,000 lamps in use at one time. You will have noted that the total number of lamps on the Company's mains on December 31st was 40,665. We also had the advantage, by acquiring that station, of being able to commence supply from it at once. The number of our customers in the new area in which the mains have been laid is rapidly increasing, and there is also a large increase in the area previously supplied, so much so that the Cheyne-walk Station is now about to be used to assist our Draycott-place Station as well as to supply the new area. The condition of the plant is excellent, and results prove that its efficiency is well maintained. We have benefited considerably by the improvements made in the machinery, and we see no reason why future improvements should not bring us still more economical results. You will have observed the tabulated statement in the Report shewing how the cost has been reduced within the last three years by the amount of 1⅜d. per Board of Trade unit sold, and you will appreciate the effect of this reduction on the sale of 402,848 units last year. The number of units sold would have been still larger had it not been for the unusual absence of fog. I must also call your attention to the fact that the increase in capital expenditure has resulted in a much larger proportion of profits, a result to be expected, as not only are there certain fixed charges which barely increase at all while the revenue increases, but adequate capital enables us to provide and arrange our plant so as to give the best results. It will interest you to note that the capital expenditure and the payments from profits of debenture interest and dividends for the last three years have been as follows:—

——	Capital Expenditure.	Paid out of Profits.
1891	£74,721	£1,206
1892	81,364	3,002
1893	99,633	4,630

From my remarks, you will have inferred that fresh capital has to be raised for the additional machinery and plant necessary to meet the growth of the Company's business; the Directors, with that view, have considered the advisability of exercising the powers already given them by the shareholders, and they intend, at an early date, to make an issue of Preference capital. This the greatly improved position of the Company should enable them to do on favourable terms. No other points seem to call for special comment on my part, but I shall be happy to answer any questions. I now beg to move—

"*That the report of the Directors and the statement of accounts for the year 1893, now before the meeting, be and they are hereby adopted, and that the payment of a dividend on the Ordinary share capital of the Company of 5 per cent. for the year 1893 be and is hereby approved, to be made payable on April 10th.*"

The DEPUTY-CHAIRMAN (Major-Gen. Webber, C.B.), in seconding the motion, said that if there had been seven more foggy days last winter, and assuming that three-fourths of the lights attached to their system had been in use for six hours on each of those days, their net receipts would have enabled them to pay a dividend of 1 per cent. more on the Ordinary shares. He thought that this figure was sufficient to show them the importance of an ordinary winter to them. He thought it probable that a certain amount of their current would be taken for motor purposes during daylight hours in the future.

Mr. JOSHUA KING asked whether the accumulator system was still a success, and further as to the system lately used by the Cadogan Company.

The DEPUTY-CHAIRMAN stated that the best reply was that the Company had just established in Elm Park Gardens a large accumulator and transformer station, which was only just now coming into operation. As regarded the plant taken over from the Cadogan Company, a certain portion of it was useful, but the purchase was made with a knowledge of that fact.

The CHAIRMAN, in further reply to Mr. King, said that the accumulator system was a perfect success, and the system was the same as that which they began with. He then put the motion, which was carried unanimously.

Sir GEORGE PRESCOTT then proposed, and Mr. Joshua King seconded, the re-election of the retiring directors, Mr. Courtenay and Mr. Nugent Daniell; and the resolution was carried unanimously.

On the motion of Mr. J. KING, seconded by Mr. T. CALLENDER, the auditors, Messrs. Cooper Bros. and Co., were also re-elected.

A vote of thanks to the Chairman and Directors for their able administration of the Company's affairs was afterwards passed.

The CHAIRMAN, in reply, stated that the shareholders had always stood by the Directors, and when the Board had asked them from time to time to take debentures and shares they had done so. That was the strongest proof of the shareholders' confidence in the Directors. They had had a "long pull" to bring the Company through but he was glad to say that they had succeeded, and they had got the undertaking into a dividend-paying position.

The proceedings then terminated.

GUERNSEY ELECTRIC RAILWAY COMPANY (LIMITED).—The fifth annual general meeting of this Company has been held at Hougue-à-la-Perre. A dividend of 2½ per cent. per annum on the Ordinary shares was recommended by the Directors, and provoked some criticism as to the advisability of paying a dividend while the balance-sheet showed a total indebtedness of about £5,000. Ultimately the recommendation of the Directors was adopted. The vacancy on the Board, caused by the retirement of Mr. T. P. Hocart, was filled by Mr. W. T. Palmer.

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Charing Cross and Strand Electricity Supply Corporation (Limited).

The annual ordinary general meeting of the shareholders of this Company was held at the Town Hall, St. Martin's-in-the-Fields, Charing Cross, on Tuesday, Mr. G. H. Brougham Glasier in the chair.

The GENERAL MANAGER and SECRETARY (Mr. E. Wilmot Seale) having read the notice calling the meeting, the report of the Directors was taken as read.

The CHAIRMAN: Gentlemen, in moving the adoption of the report of the Directors for the past year and the accounts, there really is very little for me to do. The first point, which, of course, will strike you, is the loss that the Company has sustained by the death of our late Chairman, a gentleman who was particularly well-known to those who reside in this parish, whom I had the pleasure of knowing for many years, and who was one of the most competent men you could meet with. We all very much regret the death of Mr. Spencer Chadwick. The other Directors did me the honour to ask me to fill the office of Chairman, which I have very great pleasure in doing, so long as I can be of service to the Board and the Company. We state in the report that two actions were brought against the Corporation for injunction and damages, both of which resulted in judgments in favour of the Corporation on all points, with costs. That is a matter upon which we may congratulate ourselves, and it must also be a source of gratification to the shareholders. We tell you in the report what we have done as regards keeping up the station in a proper state of efficiency, and how we propose to deal with certain matters of accounts which I think will also commend themselves to you. We then deal with the earnings, and state what we propose to do with the balance remaining for division. We recommend a dividend of 4½ per cent. for the year 1893, less the interim dividend paid last August, and we carry forward a small balance. Those are the salient points in connection with the report, and I do not think there is anything else which calls for any observation from me. The other matters alluded to in the report will come on later, but meantime I have to move—

"*That the Directors' report and accounts be received and adopted, and that a dividend at the rate of 4½ per cent. per annum on the share capital of the Corporation, less the amount of the interim dividend paid in August last, be declared for the year ended December 31, 1893, and that such dividend be payable on and after February 27th inst.*"

Mr. I. P. MENDOZA seconded the motion.

In reply to questions by Major DOBBS and Mr. TOOTH,

The CHAIRMAN stated that the item on the credit side of the balance-sheet of "sundry debtors for current supplied to December 31, 1893, £6,041," represented the amount due to them at that date. It was impossible on December 31st to collect a sum which could only be ascertained when the meters were examined. Of the £6,000 odd in question a very large portion was now received, and this would enable the Directors to pay the dividend. With respect to the question how it was that they could only pay a dividend for the past year of 4½ per cent., when in the previous year they paid 5 per cent., it was mainly because of "the cutting" of the rates started by other companies. The cutting of the rate by another company which had the right to go through the parish supplied by this Company caused them to lower their own rate, so that they might be on an equal footing to secure the custom of the district through which they passed.

The resolution was then unanimously adopted.

On the motion of Mr. TOOTH, the retiring Directors, Mr. Agostino Gatti, Mr. Stefano Gatti, and Mr. Richard Chadwick were re-elected; as were also the auditors, Messrs. O. R. Johnson and Son.

A vote of thanks to the Chairman and Directors was afterwards passed.

The CHAIRMAN, in acknowledging the compliment, said that it had given him great pleasure to find that the accounts were so satisfactory in view of the severe competition they had had to contend against. Having regard to the accounts presented by other similar companies, he thought they would agree with him that their Company had done as well, if not better, than many of the others. They could not help competition, and they must keep themselves well before the public by going with the times. Had they gone through the year receiving the same amount for electricity consumed as they received in the year before, instead of the dividend being that which they had declared, it would run out to over 6½ per cent., and very nearly 7 per cent. That was what competition had done for them, and they could judge for themselves what the position of the Company would be as soon as the competition had ceased. He believed that the competition which they had had to contend against could not go on, and that cutting rates would die out.

The proceedings then terminated.

Dover Electric Lighting Company (Limited).

The statutory meeting of this Company was held at Castle-street, Dover, last week, Sir W. Crundall, Chairman of the Company, presiding.

The CHAIRMAN explained that this was merely the statutory meeting, and, therefore, formal, but he wished to explain the position of matters. As they were aware, the Company had gone to allotment, and a certain number of their shares had been allotted, not so many, perhaps, as the Directors would have wished, but sufficient to enable them to go on with the business. After this meeting the Directors would meet to receive tenders for the erection of the works. One of these tenders would be accepted, and the works would be proceeded with forthwith. They would also commence to lay the mains in the public thoroughfares, and they hoped to be in a position to supply the electric current before the end of September next. As the shareholders were aware, the Company had made a contract with the Dover Corporation to take over their powers, acquired under Act of Parliament; and not only had the Company done this, but they had completed their contract, so far as the financial part of the operation was concerned, by paying the Corporation the cost of obtaining the Provisional Order, in the first place. The Directors particularly desired to obtain the support of a large number of the local public, not only in order that they might have a financial interest in the Company, but that they might become customers of the Company. It was only by this means that success would be assured. He believed there were a large number of customers waiting to be supplied with the electric light, and the Directors felt confident that when they were in a position to supply them they would soon have sufficient applications to utilise all the current at their disposal. In order to interest the local public in the subject, the Company proposed to hold an electrical exhibition in the Town Hall, together with a reception, when they hoped to be able to show the people of Dover what their intentions were of lighting the district by electricity. The shareholders were aware that the Corporation had decided not only to light the Sea Front and the principal streets of Dover, but also to light the Town Hall by electricity, and had given the necessary orders for that purpose. Similar companies in neighbouring towns round the coast were in a fairly prosperous condition, and it was reasonable to suppose that Dover, when it was thoroughly aroused, would take an "interest" in its electric lighting industry; and it was the intention of the Directors to do their utmost to bring the Company to a successful issue, and he asked the shareholders to induce their friends to take a financial interest in the concern. Dover was exceptionally well situated for such business, and they confidently anticipated, with such exceptional facilities, complete success.

Mr. SELLON, the engineer, fully agreed with the remarks of the Chairman as to the favourable position of the Company. The town had more public institutions than most towns of its size, which, together with the Barracks and Castle, were likely to become large and always prove valuable customers to an electric supply company. He was well acquainted with many of the provincial companies, and felt no hesitation in prophesying an early success for the Dover Company.

After a few remarks from shareholders present, the meeting terminated.

Notting Hill Electric Lighting Company (Limited).

The following is the report of the Directors of this Company for the period ended the 31st December last, to be presented at the seventh ordinary meeting to be held at the offices, Bulmer-place, Notting Hill, on Tuesday, the 27th inst., at five o'clock:—

The expenditure on capital account at the date of the last balance sheet amounted to £76,900. 7s. 7d. During the year a further sum of £1,628. 12s. 3d. has been so expended, bringing up the total to £78,528. 19s. 10d. The two principal items of expenditure are £744. 10s. for mains, and £522. 11s. 11d. for "purchase of patents and patent rights." The result of the law suit between Dr. John Hopkinson and the St. James' and Pall Mall Electric Lighting Company having established the validity of the patent for the three-wire system, the property of the Westinghouse Company, we, in conjunction with the other low-tension electric lighting companies operating in London, agreed to purchase a licence for the use of this system throughout our area for the full term of the patent and for any extensions thereof, the proportion paid by this Company amounting to £522. 11s. 11d. This amount has been carried to capital account, under the heading above mentioned, and is only a fraction of the additional amount that would have been expended on construction had the three-wire system not been adopted.

The revenue account shows a profit of £1,481 7s. 1d., as compared with a profit of £112 6s. 1d. in 1892, and a loss of £554 18s. 6d. in 1891. The amount received from the sale of current shows an increase of £998 7s. 7d., whilst the expenditure shows a decrease of £552 14s 8d. This result has been achieved by the abolition of the City offices and strict economy in every detail of the work, for which great credit is due to Mr. George Schultz, the Engineer and Manager. It was only possible to carry these alterations into effect in the middle of the year; it is therefore estimated that a further reduction in management expenses, amounting to £280, will appear in the accounts of 1894. The Directors wish to point out that the prime cost of the generation of the current during the second half of the year is lower than that appearing in any of the accounts of other London Companies for 1893 hitherto published.

On the occasion of the last general meeting, the Directors voluntarily surrendered one-half of the fees due to them up to and inclusive of the 31st December, 1893, amounting to £1,125, and postponed the drawing of the balance until the present report should have been presented and approved by the shareholders. With a view of enabling the Company to start the new year free from all liability, they now surrender £685 of the balance due to them, making £1,810 in all, and accept in full payment for their services since the commencement of the Company's operations a sum of £440. The balance of net profit, after writing off the loss of £347 16s. 4d. brought forward from the previous year's account, amounts to £1,081 16s. 1d., and out of this the Directors recommend the payment of a full dividend on the 6 per cent. Preference shares, requiring a sum of £640 19s. 4d. The Company has now been placed on a dividend-earning basis.

The Directors are able to report that the machinery and plant at the central station, as well as the mains, are in excellent condition, and that the supply of current during the year has given general satisfaction to the consumers. The number of houses supplied has increased from 124 to 173, and the number of lights from 9,438 to 12,153. The mains at present run past and opposite to 980 houses which are not yet taking current. The

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Company suffered no inconvenience through the coal strikes, as a contract had been made and a sufficient store laid down in view of possible contingencies.

The Company has been in communication with the Vestry of Kensington with a view to an extension of its area in the district relinquished by the House to House Electric Light Company in the north-west portion of the parish, and has expressed its willingness to undertake whatever work may show a reasonable prospect of profit.

The Directors who retire are Messrs. Alex. Howden and J. T. Jervis, and being eligible they offer themselves for re-election. The shareholders, auditors, Messrs. Deloitte, Dever, Griffiths and Co. retire, and do not propose to seek re-election, and Messrs. Fox, Sissons and Co., a member of whose firm was formerly secretary of the Company, offer themselves for the vacant post.

Telegraph Construction and Maintenance Company (Limited).

The following is the report of the Directors to be submitted to the members at the thirtieth ordinary meeting, to be held on Tuesday next, the 27th inst., at one o'clock :—

The Directors have the pleasure to submit their thirtieth annual report to the members. Their first wish at this meeting is to express their deep regret at the death of their late Chairman, Sir George Elliot, Bart., a feeling which they believe will be fully shared by the proprietors, and they desire to lay before them the copy of a resolution which was passed at the Board meeting of January 9th. Sir George Elliot was one of the original proprietors of the wire rope business before it was taken over by the Company in the year 1864, and, therefore, brought to bear, as a first Director, an intimate knowledge of its details. Resolved: "That on the death of their Chairman, Sir George Elliot, which took place on the 23rd ultimo, the Directors desire to record their deep regret at the loss of a valued colleague, and their appreciation of his services as a Director, a position which he held, with the exception of a very short period, for the space of thirty years, during the last four of which he occupied the post of Chairman with much advantage to the Company."

The Directors considering that Admiral Sir George Henry Richards, who had been Managing Director for a period of 20 years, and who had lately resigned that position, was, from his intimate knowledge of the Company's business, the most fitting person in its interest to fill the office of Chairman, unanimously requested him to accept that position, and he was duly elected.

They regret to report that by the death of Captain Halpin, which occurred on January 20, 1894, the Company has lost a valued officer who had been in its service for nearly thirty years, and who, by his just and upright character, had gained the respect and esteem of the Directors. Captain Halpin was known to many proprietors as Commander of the "Great Eastern," and as Marine Superintendent of the Company.

The accounts for the year show a net profit of £99,435. 8s. 11d., after charging the interest on the debentures. To this sum must be added £41,433. 1s. 9d. brought forward from last year, making a total of £140,868. 10s. 8d. From this amount is deducted the interim dividend of 5 per cent., paid July 25, 1893, amounting to £22,410, leaving £118,458. 10s. 8d. to be dealt with. Of this sum the Directors propose to distribute a dividend of £1. 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2. 8s. per share, or 20 per cent., free of income-tax, leaving £51,228. 10s. 8d. to be carried forward to the next account.

During the past year the following works have been carried out:—A cable was laid between Bonny and Cameroons for the African Direct Telegraph Company: a cable, connecting the Azores Islands with Lisbon, has been manufactured and laid for the Europe and Azores Telegraph Company: and a cable has also been manufactured for the Eastern and South African Telegraph Company, and laid from Zanzibar to the Seychelles and Mauritius. Various lengths of cables have, in addition, been manufactured during the year, as well as 2,483 miles of insulated wire for land lines, &c. Repairs have been effected in the German Government's Greetseil-Valentia cable; and the "Calabria" has been chartered for cable operations in the Mediterranean, and was employed in attempting to repair the 1874 Atlantic cable.

The Company's steamships, and their factories at East Greenwich and Wharf-road, are in good and efficient condition.

The retiring Directors are Sir George H. Richards and Mr. Philip Rawson, who, being eligible, offer themselves for re-election. The meeting will have to appoint auditors for the ensuing year. Mr. John Gane (of the firm of Messrs. Gane, Jackson and Jefferys), and Mr. Patrick A. Glegg (of the firm of Messrs. Welton, Jones and Co.), who retire, offer themselves for re-election.

Yorkshire House-to-House Electricity Company (Limited).

The following is the report of the Directors to be presented to the ordinary general meeting of the Company, to be held at the offices of the Company, Whitehall-road, Leeds, on Tuesday, March 6th, at 2.30 p.m. :—

The net profit for the year ended December 31st last amounts to £1,155 6s. 1d., out of which the Directors recommend that £1,000 be appropriated in reduction of the preliminary expenses account, carrying forward the balance of £155 6s. 1d. In view of the short period during which the plant has been in use, and the fact that in respect to a large portion thereof the contractors' guarantees of maintenance had not expired on December 31st, the Directors do not consider it necessary at the present time to make any provision for depreciation. The absence of such necessity renders it possible to write off the above named comparatively large sum from preliminary expenses.

The Company's permanent plant has only been at work since May 1st last, a period comprising all the summer and only half the winter months: the accompanying accounts, therefore, practically show results obtained during the least favourable portion of the year. The effect of the dispute in the coal trade was to add considerably to the cost of production, although the precaution was taken of securing a large stock of coal before the stoppage. Under all the circumstances, the Directors think the accounts now presented may be regarded as satisfactory, and they are glad to report that the supply of electricity has been maintained in such a manner as, in their opinion, to reflect credit upon the makers of the plant, and upon the Works Manager (Mr. Harold Dickinson), and the rest of the Company's staff.

Almost immediately after the starting of the works it was found advisable to order an additional 200-I.H.P. engine and dynamo, which have been in satisfactory operation since the month of November. In order to obtain necessary capital the Directors invited the existing shareholders to take up the balance (2,634 shares) remaining unallotted of the first issue of 10,000 Ordinary shares, and the whole of these shares have been applied for and allotted.

In view of the expected early increase of demand, a further extension of the Company's works has been resolved upon, and tenders have been accepted for additional machinery of a capacity of 800 I.H.P., and for the necessary additions to the buildings, the whole to be completed and ready for next winter's lighting. The capacity of the works will thus be increased from 700 to 1,500 I.H.P. This extension will necessitate a small increase of capital, in addition to the amount now uncalled on part of the Company's shares, and the Directors will consider how this additional capital can be raised most advantageously for the shareholders.

The Directors have announced that on April 1st next, the standard price of electricity will be reduced from 8d. to 7d. per Board of Trade unit, subject to a scale of discounts, &c.

The retiring Directors, Mr. George Henry Crowther and Mr. Arthur Greenhow Lupton, being eligible, offer themselves for re-election. Mr. John Gordon, jun., offers himself for re-election as auditor.

Scarborough Electric Supply Company (Limited).

The following report will be presented by the Directors of this Company at the meeting to be held on Thursday next, at the offices, 102, Westborough, Scarborough, at 11 a.m. :—

The Company's electric supply station is now in full working order, the business is steadily increasing, and prospects are most encouraging. On September 1st last, when the regular supply of electricity was commenced, there were connected to the Company's mains 468 8-c.p. lamps. By December 31st this had increased to 4,114, and on February 13th to 4,489. By the end of March it is anticipated that nearly 6,000 lamps will be connected. The present capacity of the generating plant provides for about 10,000 lamps. Seeing that it would have been inexpedient to commence a profit and loss account with only a small portion of the machinery at work, the Directors have deemed it advisable to place all receipts up to December 31st to the credit of formation and preliminary management account. Mr. G. L. Beeforth, the Hon. C. A. Parsons, and Mr. G. Alderson Smith are the retiring Directors, and offer themselves for re-election, as does the auditor, Mr. C. E. Bradley, C.A.

NEW COMPANIES, STATUTORY RETURNS, &c.

In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1894, pages 274-300, *&c., &c.*]

ELECTRIC TIME-DISTRIBUTING AND CLOCK COMPANY (LIMITED).—This Company was registered on February 17th, with a capital of £5,000 in £1 shares, to purchase or otherwise acquire the invention for Great Britain of Edward Dubois, of Hatton-garden, London, E.C., together with all British and foreign patents now or to be granted for his method of "Improvements in Electrical Clocks" (Provisional Specification, No. 6233, of March 23, 1893), with a view thereto to enter into and adopt an agreement dated February 9, 1894, and made between Edward Dubois, of the one part, and William Aubert, junior (for the Company), of the other part, and to carry on the business of watch and clock makers, electrical clock and watch manufacturers, electrical and mechanical engineers, merchants, &c. William Aubert, junior, is the first managing director.

ELECTRO-CHEMICAL COMPANY (LIMITED). — This Company was registered on February 14th, with a capital of £200,000, divided into 26,000 £10 per cent. Preference and 14,000 Ordinary shares of £5 each, to acquire from the Electrolytic Caustic Soda and Chlorine Trust (Limited), the British Patent No. 2296, of 1890, for "Improvements in the electrolytic production of caustic soda, caustic potash and other products from their salts," and certain other patents for inventions relating to electrolytic and electro-chemical operations, and to carry on the business of manufacturers of and dealers in caustic soda, caustic potash, sulphuric and hydrochloric acids, &c. Some further particulars of the Company appear in the "City Notes."

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FOREIGN CHEMICAL AND ELECTROLYTIC SYNDICATE (LIMITED).—This Company was registered on February 14th, with a capital of £3,000, divided into 200 "A" shares of £10 each and 1,000 "B" shares of £1 each, to enter into and carry into effect an agreement with F. Maxwell Lyte, C. H. M. Lyte, and Prof. George Lange, for the acquisition of certain patented inventions relating to the production of chemicals by electrolysis or other means, and to carry on the business of manufacturing, analytical, scientific and general chemists. The first directors are Cecil H. M. Lyte and Henry K. Baynes.

PERU TELEPHONE COMPANY (LIMITED).—In connection with the return of this Company, which was filed on January 15, 1894, only the seven subscribers' shares have been taken up, out of a nominal capital of £100,000, in £5 shares, and no calls have been made.

PONTYPOOL ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The first annual return of this Company, made up to December 30, 1893, was filed on January 4th. Out of a nominal capital of £10,000, in £5 shares, 398 have been taken up. Upon 429 of these the full amount has been called, and a call of £4 per share has been made on the remainder, resulting in the payment of £4,021 (which includes a payment of £20 received on shares applied for but not allotted), leaving £20 unpaid.

QUEEN ANNE'S MANSIONS LIGHTING AND HEATING COMPANY (LIMITED).—The annual return of this Company, made up to December 27, 1893, has been filed, and shows that the whole nominal capital of £60,000, divided into 3,000 Ordinary and 3,000 Preference shares of £10 each, has been issued as fully paid.

RAILWAY AUTOMATIC ELECTRIC LIGHT SYNDICATE (LIMITED).—The annual return of this Company, made up to November 6, 1893, has been filed. The nominal capital is £25,000, divided into 400 Ordinary and 600 Preference Shares of £25 each; 396 Ordinary and 520 Preference shares have been taken up, and 200 Ordinary have been issued as fully paid: Upon the remaining 196 Ordinary shares the full amount has been called, upon 480 Preference shares £15 per share, upon 30 Preference a call of £10 per share, and upon 6 Preference £5 per share has been called, resulting in the payment of £11,550, leaving £985 in arrears; £45 has been paid on four forfeited shares.

SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company, made up to January 3rd, has been filed. Out of a nominal capital of £1,000,000, in £5 shares, 98,699 shares have been taken up, and 19,750 of these have been issued as fully paid. Upon the remaining 78,949 shares a call of £3. 10s. per share has been called, resulting in the payment of £279,851. 10s. The sum of £3,530 has been paid on 1,201 forfeited shares.

S. Z. DE FERRANTI (LIMITED).—The annual return of this Company, made up to January 13th, has been filed. The whole nominal capital of £100,000, divided into 2,000 Preference and 8,000 Ordinary shares of £10 each, has been taken up, and, with the exception of seven Preference shares, issued as fully paid. The sum of £70 has been received in respect of the said seven shares.

CITY NOTES, &c.

BLANDY'S PATENTS SYNDICATE (LIMITED).—At the ordinary general meeting on Tuesday, the Chairman stated that the Directors had been trying to establish a company, with a capital of £40,000, to take over the patents and work them, and he believed they would succeed: but meanwhile it was necessary that the shareholders should subscribe £1,000 (for which they would receive debentures), which would come to 1s. 4d. per share. A resolution was passed approving of the proposal, and the Directors' report was adopted.

BRUSH ELECTRICAL ENGINEERING COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend at the rate of 6 per annum on the Preference shares, and at the rate of 5 per cent. (the maximum which, according to the Articles of Association, can be paid on an interim dividend) on the Ordinary shares of the Company, for the six months ended December 31st last, and payable 1st prox.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended February 18th, were £938, the same amount as in the corresponding period of 1893. The total receipts for the half-year amount to £6,665, as against £6,800 for the corresponding period of last year, being a decrease of £135.

ELECTRO-CHEMICAL COMPANY (LIMITED).—The prospectus is issued of this Company, which is registered with a capital of £200,000, in 26,000 Preference shares and 14,000 Ordinary shares of £5 each. Preference shares are entitled to a preferential dividend up to 10 per cent. per annum, and to a ratable participation in further profits after the Ordinary have received 10 per cent. The Ordinary shares are issued as fully paid, in part payment for the British, Foreign, and Colonial patent rights sold to the Company; and subscriptions are now invited for 26,000 Ten per Cent. Preference shares, payable 10s. on application, £1. 10s. on allotment, and £1 per share one month after allotment, the remainder as required. The Company is formed to work in the North of England an electrolytic process for the decomposition of salt, and the production therefrom of caustic soda and bleaching powder. The process has been carried on for two years past at Snodland, Kent, where (the prospectus states) the commercial value has been thoroughly tested on a practical working scale, with results which are testified to by the reports, accompanying the prospectus, from Dr. John Hopkinson, F.R.S., Mr. James Swinburne, Mr. J. Leith, Mr. Walter Tate (of Messrs. A. Norman Tate and Co.), and Mr. George Pilkington, the two last named having analysed the Company's products with satisfactory results. In addition to erecting works for manufacturing, it is proposed to grant licences to paper and soap makers, bleachers, and other large users of chemicals, from which considerable additional revenue is anticipated. The Company acquires the British patents, and all other patent rights applied for in France, Austria, Belgium, Italy, Norway, United States, and Canada, which are taken over from the Electrolytic Caustic Soda and Chlorine Trust (Limited) (the vendor Company), all British patents and foreign and Colonial patent rights, subject to certain reservations, which, however, if carried out by the various firms on whose behalf they are made will bring to the Company a considerable annual income. These reservations are in favour of several of the principal paper makers in this country, who have the optional right to manufacture caustic soda and bleach at a royalty of 15s. per ton, for their own use, at their own works, to the aggregate extent of over 28,000 tons per annum. The amount paid to the Vendor Company for these various rights is £100,000—£70,000 in fully paid Ordinary shares, and the remainder in cash or Preference shares, at the option of the directors. Mr. J. Fletcher Moulton, Q.C., has given a favourable opinion as to the value of the Company's patent rights. The directors include the principal members of several of our leading papermaking firms, and Mr. Leopold Field, of Messrs. J. C. and J. Field (Limited), soap and candle makers, of Lambeth: Mr. James Swinburne is consulting electrician; the secretary *pro tem.* is Mr. T. Hitchcock; and the offices are situate at 57, Old Broad-street, London, E.C. Accompanying the prospectus is the following circular:—"Messrs. Sheppards, Pellys, Scott and Co., 57, Old Broad-street, London, E.C., beg to recommend a careful perusal of the accompanying prospectus and reports, which place before you one of the most promising investments offered for some considerable time, and one that should prove eventually almost as remunerative as a somewhat similar undertaking, 'Brunner, Mond and Co. (Limited),' to which Messrs. Sheppards, Pellys, Scott and Co. have been brokers for several years past."

ELMORE'S AUSTRO-HUNGARIAN PATENT COPPER DEPOSITING COMPANY (LIMITED).—A circular issued to the shareholders of this Company announces that the £5,000 Ten per Cent. Debenture Stock recently issued has been allotted; that the owner of the property taken over by the company has been satisfactorily arranged with; and that the future of the Company is now entirely in the hands of the shareholders. The circular claims that all the promises of the Directors have been fulfilled, and that the Company is on the high road to success, which has been brought about not so much by the help of the shareholders as a body, but by a few who have come forward and have supported the Directors in their policy. In return the Directors state that unless the general body of shareholders come forward with their assistance those shareholders who do assist will have those material advantages offered to them to which the Directors consider they are justly entitled. These material advantages are not more fully referred to. It is now necessary to raise another instalment of money for the purchase of copper and for the putting down of longer tanks for the orders offered, and further, for the erection of a drawbench to allow of the rapid manufacture of special size tubes. The Directors therefore require a further £5,000, which they propose to obtain by the issue of debentures at 8 per cent. instead of 10 per cent. as previously. Unless this invitation to subscribe further capital is universally responded to (applications closed on the 19th inst.), the Directors notify that an extraordinary general meeting will be called for the purpose of creating £30,000 in Preference shares, which will practically take all the profits of the Company. These Preference shares will be offered *pro rata* to the shareholders, and unless each shareholder takes his proportion he will practically lose his entire interest in the Company. The Directors announce that they would have made the issue of Preference shares some time ago were it not that they felt a hardship would have been inflicted upon shareholders so long as there was the slightest chance of failure in the Company's operations, but that now the Company has passed the critical point of its existence the Directors feel no hesitation in making the issue, and shareholders must not complain if they suffer in consequence of their tardy response to these appeals. In conclusion, the Directors claim that this Company (the Austro-Hungarian) "is manufacturing on a commercial scale articles that, so far as they are aware, none of the other Elmore Companies are manufacturing"; "there is now no difficulty in getting abundance of orders"; and finally, "the cash in hand and amounts due are more than the current liabilities and liabilities shortly maturing."

LONDON, DEPTFORD, AND GREENWICH TRAMWAYS.—At the meeting of the shareholders of this Company, on Monday last, Mr. W. J. Carruthers Wain, the Chairman, stated that during the past year several offers had been made to experiment with motors of various kinds on their line; but owing to the fact that the Deptford Company were not prepared to spend money on these experiments very little had come of these offers. The Company had adopted several suggestions for improving their cars, amongst which was that of introducing the electric light. Hitherto the chief difficulty had been the expense, but he understood they were within measurable distance of having electric light supplied to them, which would be effective, steady, and cheap, and they would then only be too glad to place it into their cars. The electric light would certainly form an attraction, and increase their traffic.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED). Notice is given that the transfer books of this Company will be closed from the 19th to the 27th inst. inclusive, preparatory to the payment of dividend.

WEST AFRICAN TELEGRAPH COMPANY (LIMITED).—The half-yearly interest on this Company's Five per Cent. Mortgage Debentures, due on the 1st prox., will be paid on and after that date by the National Bank of Scotland, 37, Nicholas-lane, E.C. Coupons must be left three days for examination.

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WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the two weeks ended February 15th were £2,615, as compared with £3,009 for the corresponding period of last year. The October receipts, estimated at £3,822, realised £3,867.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The Company's traffic receipts for the week ending February 16th after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,287.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Feb. 14.		Price Wednesday, Feb. 21.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Feb. 21: Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	13/6	Anglo-American	43	45	42	44	5 13 8	Jan., Apr., July, Oct.	..	
£2,932,680	Stock	27/0	Do. Preferred	80½	81½	78½	79½	6 5 9	" "	81¼	79
£2,932,680	Stock	5/0	Do. Deferred	7½	7¾	7	7½	..		..	
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	100	103	100	103	3 17 8	January and July ..	..	
130,000	£10	3/0	Brazilian Submarine	11½	12	11¼	12	5 10 8	Mar., June, Oct., Dec.	11⅝	
£18,700	£100	5%	Do. 5 per Cent. Bonds	99	102	99	102	4 18 0	January and July ..	..	
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	110½	
10 000,000	$100	7%	Commercial Cable Capital Stock	135	145	135	145	4 16 7	Jan., Apr., July, Oct.	138	
16,000	10	8/0	Cuba Submarine	12	13	12	13	6 3 1	February and August	13	
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18½	19½	5 2 7	" "	19	
12,931	5	1/7½	Direct Spanish (£4 paid)	2	3	2	3	5 6 8	April and October	..	
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	..	
60,710	20	3 0	Direct United States Cable, 1877	10¼	10⅝	10⅜	10⅝	6 2 8	Jan., Apr., July, Oct.	10⅝	
400,000	10	2/0	Eastern	14⅞	15⅛	14⅞	15⅛	4 5 11	" "	15⅛	
70,000	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16¼	3 13 10	" "	16¼	
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	115½	
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	106	109	106	109	4 11 9	February & August	..	
250,000	10	2/6	Eastern Extension	15½	15¾	15⅜	15⅝	4 9 7	Jan., Apr., July, Oct.	15⅝	
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	114	117	114	117	3 8 5	February & August	116½	
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	102	105	102	105	4 15 2	January and July ..	102½	
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	102	105	102	105	4 15 2	" "	..	
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	102	105	102	105	3 16 2	February & August	104½	
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	106%	109%	107%	110%	3 12 9	May and November	108½	108
180,227	10	1/3	Globe Telegraph and Trust	8½	8¾	8½	8¾	5 2 10	Jan., Apr., July, Oct.	8½	
180,042	10	6%	Do. 6 per Cent. Preference	15½	15⅞	15½	15⅞	3 18 (	" "	15⅜	
150,000	10	5/0	Great Northern	21¾	22¼	21	22	3 17 3	Jan., April, and July	21½	21
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	..	
17,000	25	12/6	Indo-European	42	45	42	45	5 11 1	May and November	44	43
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	3 6 8	" "	..	
£100,000	100	6%	Do. 6 per Cent. Debentures	107	110	107	110	5 9 1	March & September	..	
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red 1942	102	105	102	105	3 16 2	..	..	
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	..	
3,381	£100 Cert.	25 0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	" "	115½	
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July ..	..	
£249,900	100	5%	Do. 5 per Cent. Debentures	100	103	100	103	4 17 1	March & September	102	100½
30,000	10	2/0	West Coast of America	2	2½	2	2½	..	January and July ..	..	
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	97	101	99	101	7 18 5	June and December	99	
88,321	10	1/0	West India and Panama	1	1¼	1⅛	1⅜	..	..	..	
34,563	10	6%	Do. 6 per Cent. 1st Preference	9½	10	9¾	10¼	5 17 1	May and November	10½	9¾
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	" "	..	
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 7	June and December	..	
64,242	15	4/6	Western and Brazilian	6½	7	6½	7	..	May and November	6⅞	
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5½	6	5½	6	..	..	5⅞	
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¾	2¼	1¾	2¼	..	..	1⅞	
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	103	106	104	107	5 12 2	February & August	..	
£222,700	100	6%	Do. 6 per Cent. Mort. Debs.. Series "B" 1910	103	106	104	107	5 12 2	" "	—	
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	105	102	105	5 14 3	March & September	..	
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	—	—	
224,850	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	
220,000	£1	4·76d.	Oriental Telephone and Electric (11s. paid)	½	⅝	½	⅝	5 6 5	Yearly	..	
484,597	5	2/6	National	4⅝	4⅞	4½	4¾	5 5 3	June and December	4⅝	
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½	15½	14½	15½	3 17 5	" "	14⅞	
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	14	15	14	15	4 0 0	" "	14½	
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¼	5½	5¼	5½	4 10 11	..	—	
925,017	£100	4½%	Do. Deb. Stk. 4½%	113	115	113	115	3 18 3	January and July	114¾	
58,000	5	1/0	United River Plate	1½	2	1½	2	..	" "	—	
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	—	
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	10½	11½	10	11	—	..	10 15/16	
20,000	10	5/4	Do. 6 per Cent. Cumulative Pref. (fully paid)	12¾	13¼	12¾	13¼	..	—	13 3/16	
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	—	
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	—	—	
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	—	—	
8,322	£5	..	House to House Electric	..		..		—	—	—	
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		—	—	—	
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	—	
30,000	£5	1/9	Liverpool Electric Supply (£4 10s. paid)	5¼	5⅝	5½	5⅝	..	—	—	
15,000	£5	2/6	Do. (fully paid)	6½	6⅝	6½	6⅝	..	—	..	
111,000	5	..	London Electric Supply	¼	¾	¼	¾	—	..	..	
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	8	8½	8	8½	2 5 7	..	8 1/16	
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	104	108	104	108	4 12 7	June and December	105½	
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	—	—	4¾	
19,980	£5	4/6	St. James' and Pall Mall	6½	6¾	6½	7	..	—	6¾	
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	—	8⅜	
59,900	5	1/6	Westminster Electric Supply (fully paid)	5½	6	5¼	6¼	2 16 0	—	5 13/16	
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	2/1	Brush Electrical Engineering	2⅝	2⅞	2⅝	2⅞	6 5 4	—	2 13/16	
90,000	2	6%	Do. 6 per Cent. Preference Non-Cumulative.	2⅛	2⅜	2⅛	2⅜	5 1 1	—	2 3/16	
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	104	106	105	107	4 4 1	March & September	..	
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	3	4	3	4	..	January and July	..	
12,139	5	..	Edison and Swan United	—		—		—	—	—	
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		—	—	—	
120,000	2	..	Electric Construction	¼	¾	¼	¾	..	—	..	
12,845	2	..	Do. 7% Cumulative Pref.	1½	2	1½	2	..	..	..	
91,195	2	10/0	Elmore's Patent Copper Depositing	¾	⅝	9/16	11/16	—	—	⅝	
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	—	..	
50,000	10	10/0	India Rubber, Gutta Percha &c., Works	24	25	24	25	5 0 0	February & August	24½	
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	102	104	4 6 7	March & September	—	
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	—	—	
16,000	£10	..	Do. 8 per Cent. Preference	—		—		..	December and June	—	
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/16	5/16	3/16	5/16	..	—	—	
78,949	5	3/6	Swan United (£3. 10s. paid)	2	2½	2	2½	—	May and November	..	
37,350	12	12/0	Telegraph Construction and Maintenance	42	44	40	42	4 5 8	March and July	42½	
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	—		—		..	January and July	—	
37,514	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	—		—		—	—	—	
41,098	£5	..	Do. Preference (fully paid)	—		—		—	—	—	
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	5%	City and South London Railway xd	27	32	27	32	4 5 11	May and November	29½	28½
87,500	£10	1%	Liverpool Overhead Railway	4 13/16	5 1/16	5¼	5½	—		—	

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THE ELECTRICIAN:

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NOTES.

Pending the issue of the final Board of Trade Regulations for Electric Traction, those of our readers who are interested in the matter will be able by study of our report of the conference, which we print elsewhere this week, to obtain a good idea of the amendments which are being introduced. In many parts we have been obliged to condense the remarks, especially where these were of a conversational character. As Regulation No. 14 drew near, discussion waxed warmer; over No. 13 there was a long wrangle, beginning with and ending in nothing in particular. When No. 14 was at last reached there was an ominous hush, and every eye was turned on the chairman, from whom a weighty speech was expected. Weighty perhaps it was, but brief. "Now we come to Regulation 14, amended by these words, please, after the word 'shall' insert 'take all reasonable precautions to.' Now, what has anybody got to say about that?" There was no need to invite speeches, for many a solemn harangue had probably been prepared, but the voluntary amendment had knocked the bottoms out on both sides. The Institution of Electrical Engineers proposed their amendment notwithstanding, and in the discussion which ensued it appeared that most of the members could not divest their minds of the fact that there was nothing to fight about. Sir Courtenay Boyle put an end to it at last by assuring them that the regulation, as amended, had very little effect one way or the other. It is not surprising that this regulation should have created some excitement when we learn that the Permanent Secretary of the Board of Trade himself thought, when this rule was first brought to him, that it threw back the whole responsibility on the traction men, and was practically doing what the rules themselves ought to do. But it was pointed out to him, as we pointed out to our readers two months ago, that it applies only to feeders.

One or two definitions in the new Board of Trade regulations possess some interest. These relate to the measurement or description of differences of potential and to small resistances, and are of a thoroughly practical character. It is proposed to measure a difference of potential of about four volts by the opposing force of three Leclanché cells. This idea was not appreciated by the Committee of the Institution of Electrical Engineers, but their objection was not accepted. The professors probably thought that a nice brass, glass, and mahogany affair would be much better, and possibly the manufacturers thought (unconsciously, of course) that a demand for a new instrument would be a good thing. The very reason for this definition was that a new or special instrument would be needed if the volts were to be measured professiorially, while, on the other hand, Leclanché cells are to be found in every town in the country. In another instance it was proposed to define a connection between two conductors as one which would not appreciably heat when a current of 100 amperes was passed. Neither the resistance nor the leakage of the line was defined in ohms, the former was defined by fall of volts, and the latter by leakage current in amperes.

The subject chosen by Prof. S. P. Thompson for his Friday evening discourse at the Royal Institution was a large one, and the material with which it was illustrated was correspondingly elaborate; the only fault was that an attempt should have been made to compress so much into one hour, but Royal Institution audiences, tolerably familiar with this fault, are ready to forgive it. "Transformations of Electric Currents" of all kinds were raced through, polyphase non-synchronising and other fancy forms of motors, combined with different types of dynamos were shown, either actually running, or by photographs. M. Pollak had brought his rectifier from Paris, and was present to demonstrate its use. In the library, the English version of the combination of motor and commutator was shown, the rectifier of Messrs. Ferranti and Co. Those who imagined that this latter device was to be sold at 15s. 6d. and packed inside the hood of each lamp, had reason to modify their opinion, for the apparatus shown was to turn 10 amperes at 1,000 volts alternating into 10 amperes at 1,000 volts continuous. Most of the experiments were on a large scale, but perhaps the most interesting of all was one of the last, and simplest. A compound horse-shoe magnet was spun on a whirling tube, the poles standing upwards. A strip of copper, about 2ft. 6in. long, 2½in. wide, and $\frac{1}{16}$in. thick, had two slots running nearly all its length, and ending in enlarged holes, not unlike the gamekeepers' wooden affair for carrying dead birds. Thus there were three copper bars connected in parallel. This slotted strip was held horizontally, one end being immediately over the spinning magnet. On the other end was a delicately-pivoted copper ring with an iron core. This was caused by three-phase currents generated in the copper, to spin round. The copper strip formed, at one end, the armature of a three-phase alternator, its length was the triple line, and the far end was the field-winding of the motor; the copper ring was the armature.

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This interesting experiment was shown to be a development of the Arago disc and rotating magnet, and led the Professor into a speculation about the course which electrical science might have taken, had Arago's researches been properly understood, investigated, and developed. The effect was attributed to "rotary magnetism." The mere creation of such an expression is sufficient, or, at all events, was, a hundred years ago, sufficient to actually impede further investigation. Had a copper disc been used to explore the space round the spinning magnet places would have been found where rotation would take place, and others where it would not. It might have been discovered that a sheet of copper held in a certain position between the disc and the magnet would set up rotation where no rotation would otherwise have been found. By further research, the experiment which we have attempted to describe might have been arrived at, and from this the steps to a multi-phase alternator and motor are conceivable. We might then have had these machines in their present form, the latest developments of modern electrical engineering, even if Volta, Galvani and their batteries had never existed. The whole of electrical science might thus have been diverted and might have arrived at its present position by another route. It is doubtful, said Prof. Thompson, whether in that case we should be speaking of currents passing along wires, or think of anything being transferred along the copper.

It would appear that the Institution of Electrical Engineers is very well off for Papers this session. The last two Papers were well calculated to give rise to interesting discussions, but in each case the subject was hurried through in one night. Gen. Webber's Paper needed study, and would have elicited a good deal of useful comment, while Mr. Kapp's communication could be dealt with off hand by those who have been engaged in similar work. Several members were quite ready to speak, and we believe that more than one iron maker was present. To cut short the discussion in this fashion is to throw away much valuable information, for a similar opportunity may not arise again for a long time. Much of the discussion, as it was, was quite beside the mark, yet the ten minutes' rule was not enforced, whilst on the other hand one speaker who began to allude to the important question of testing armature iron was called to order. The ten minutes' rule may well be relaxed when the discussion tends to drag, but on this occasion closure had evidently been arranged, and under such circumstances prolix and irrelevant remarks should be cut short.

The arrangement for cooling condenser water, whether for jet or surface condensers, which was described by Mr. Druitt Halpin at the Society of Arts meeting recently, and which is illustrated in our columns this week, is compact in form, but not new in principle. At any rate, the evaporative cooler which Mr. Halpin described has been manufactured by several English engineering firms for many years, in one form or another. Messrs. Körting Bros. make, we believe, a stack composed of slanting battens, set so that when the hot water is sprayed from a nozzle on to them it trickles down from top to bottom of the stack, over the series of wooden battens, and reaches the well or tank in a comparatively cool state. A somewhat different form of evaporative cooler is made by Messrs. Ledward and Co. The advantage of this kind of cooler over the tank or cooling pond lies in its compactness. The stack may be placed on the roof, and need not occupy any otherwise useful space. The use of an air blast gives a much greater rapidity of action than is the case with a stack or tower cooling by natural circulation. In some English forms of evaporative coolers an average of about $\frac{3}{4}$lb. of water is evaporated for every 1lb. of steam condensed, a slight increase over the figure mentioned by Mr. Halpin. In residential districts this evaporation would not be as unpleasant as steam condensed from a works chimney, for it would be free from admixture with soot.

We are afraid that our American friends are becoming conservative. The very phrase "municipal rapid transit" that they are so fond of using would appear to connote what we, with our "inborn conservatism," should call reckless driving. At Brooklyn, however, there has actually been a hubbub over the maiming of a few foolish members of the public who have succeeded in getting run down by the electric cars, and, in spite of the characteristically transatlantic opinion of President Norton, of the Atlantic Avenue System, who thinks every person "who gets run over by a trolley car ought to be arrested," there seems a likelihood of something very different taking place. Good roads, high-speed telegraphy, and safe expresses will no doubt follow in good time.

For want of a ready-made intelligible name, a colonial professor, writing on quartz fibres some time ago, alluded to "*Nachwirkung*" to denote the slow return to zero of a twisted fibre. We complained at the time of this poverty of expression, and suggested two extremes, the simple word "creep," and a couple of compound Greek words. There is some objection to the use of a colloquial word in its everyday form for a special technical purpose; but much can be done by the use of suffixes, especially when these are treated in the systematic manner devised by Mr. O. Heaviside. The only fault of his system is that we are hardly ready for some of the terms, though there are always men to be found who will take up such an idea and run it to death, as was recently proved in *Nature*. Prof. V. Boys at the last meeting of the Physical Society used the word "creepage" for the property to which we have alluded. The word seems to be excellently adapted for the purpose. The word "conductance" will be found in the new regulations of the Board of Trade. It is used with reference to the joints between conductors and pipes, and is intended to simplify the monthly records. If the resistance had to be given it might, it was argued, have to be expressed in a long clumsy decimal of an ohm, while for conductance it is only necessary to record "good." This argument is not, however, altogether logical, for the resistance might have been given in microhms.

British Association.—The next meeting of the British Association will be held at Oxford, and will commence on August 8th.

The Late Prof. Hertz.—The late Prof. Heinrich Hertz has left behind him a somewhat extensive treatise on "The Principles of Mechanics treated on a new System," which will be published at Easter, in Leipzig, by Johann Ambrosius Barth.

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Destruction of a Laboratory by Fire.—The fine engineering laboratory belonging to the Purdue University, Lafayette, Indiana, and which has cost some £35,000 to build and equip, has been completely destroyed by fire. The building was only completed on January 19th last, and was burnt four days afterwards.

Cable Interruptions :

	Date of Interruption.
Cayenne-Paramaribo	Oct. 15th, 1893.
Bissao-Bolama	Nov. 24th ,,
Garachico-Santa Cruz de Palma	Dec. 27th ,,
St. Thome-Loanda	Feb. 5th. 1894.
Malta-Pozzala	Feb. 21st ,,

The Budapest Tramways.—These tramways carried in 1893 12½ million passengers, as against nearly 11 million in 1892, and 8½ million in 1891, the receipts having risen from 700,000 to 1,000,000 gulden (about £100,000). The lines are being extended, the number of cars is now over 100, and a dividend of 8 per cent. on the share capital of 4,000,000 gulden (about £400,000) is recommended.

The Gresham University Commission.—The report of the Commissioners appointed to consider the draft charter for the proposed Gresham University in London has been issued, together with dissentient and other notes, as a Parliamentary paper. The *Athenæum* says that a Committee of the Convocation of London University will be appointed immediately to consider the scheme of the Commission.

The Board of Trade Electrical Standards Committee.—A meeting of the Electrical Standards Committee was held at the Board of Trade on Friday, at which the following members were present :—Sir Courtenay Boyle (in the chair), Mr. F. J. Hopwood, Major Cardew, Lord Kelvin, Mr. W. H. Preece, Lord Rayleigh, Prof. G. Carey Foster, Mr. R. T. Glazebrook, Dr. John Hopkinson, Prof. W. E. Ayrton, and Sir T. W. P. Blomefield, secretary.

The Hermite Process at Worthing.—M. Hermite's system of "electrical sanitation" is now being tried at Worthing. The Town Council has voted a sum of not exceeding £200 to enable M. Hermite to demonstrate the practical value of his scheme, and the British Institute of Preventative Medicine has deputed Sir Henry Roscoe and Dr. Ruffer, its president and secretary, to watch the proceedings on its behalf, and to make the needful chemical and bacteriological analysis.

Aberdeen.—The inauguration of the electric light at Aberdeen took place last Tuesday evening, in the presence of the civic officials and a great concourse of people. Owing to some unforeseen cause, it appears it was impossible to turn on the private consumers' lights; but the street arc lighting seems to have been a great success. The series system is used for this latter, ten arc lamps having already been wired. The private consumers' circuit is arranged on the three-wire system, with bare copper strip conductors.

The Bell Telephone Patent in America.—In anticipation of the expiration of the Bell Telephone Patent on January 30th many electrical supply dealers and manufacturers, says our New York correspondent, under date February 17th, had made preparations to enter extensively into the manufacture and sale of telephones. The American Bell Company, however, interfered with their plans by offering Bell receivers for $1.25 each, at which price anyone can now purchase a standard Bell receiver in a rubber case—the same style as used by the Bell Company.

Telegraph Construction in South Africa.—A Reuter telegram, dated Cape Town, February 26th, states that intelligence has been received that the Portuguese officials, acting on instructions from Lisbon, threaten to oppose the construction of telegraph lines between the British spheres of influence and Tete on the Zambesi. This is the route which it was intended should be followed by the sections of Mr. Rhodes's projected overland telegraph line, to connect Matabeleland to the south of Portuguese Zambesia with Nyasaland to the north.

Electrical Infection.—Apparently very vague ideas exist in some minds of the powers and limitations of the telephone. At a recent meeting of the North Bierley Joint Hospital Board, a proposal was made that the infectious diseases building at the hospital should be connected with the administrative department by telephone. But one member of the Board shook his head dubiously over the proposal. He was afraid, he said, that the telephone would transmit smallpox as well as speech along its wires.

The Royal Society.—The following Papers, among others, were down for reading at the meeting of the Royal Society, which was held yesterday afternoon, March 1st, at 4:30 :— "On the Effect of Magnetisation upon the Dimensions of Wires and Rings of Annealed Iron," by S. Bidwell, F.R.S. ; "On the Relations of the Secular Variation of the Magnetic Declination and Inclination at London, Cape of Good Hope, St. Helena, and Ascension Island, as exhibited on the Magnetarium," by H. Wilde, F.R.S. ; and "On a Spherical Vortex," by Prof. M. J. M. Hill.

Personal.—The many old friends of Mr. A. E. Kennelly on this side of the Atlantic will be glad to hear of his continued success on the other side of the ocean, and to learn that he is about to sever his six-year connection with the Edison Laboratory and join hands with Prof. Edwin J. Houston, whose name is linked with that of Prof. Elihu Thomson in connection with the well-known dynamo and arc lamp. These gentlemen have decided to establish in Philadelphia a firm of electrical experts to be known as Houston and Kennelly. We wish Mr. Kennelly success in his new undertaking.

The Waterloo and City Railway.—The Waterloo and City line, which will afford a much-needed connection between the terminus of the London and South Western and the City, bids fair to be the first completed of the several underground railways, plans for which are more or less advanced. The London and South Western Company has agreed to work the line for the owners taking as remuneration 55 per cent. of the gross receipts, and guaranteeing to the new Company a dividend of 3 per cent. on the investment, while any profits above the sum necessary to pay this dividend is to be divided in the proportion of one-third to the shareholders of the London and South-Western, and two-thirds to the new Company.

Electric Lighting of Forli.—The electric lighting plant at Forli, a town on the Adriatic side of northern Italy, has the almost unique distinction of consisting of exclusively Italian materials and machinery. According to a notice in *L'Elettricista*, the power is obtained from the fall of 2,000 litres of water per second through a distance of 4 metres, which works a Girard turbine constructed by Alberto Riva, of Milan. To meet the necessities arising from insufficient water supply a compound condensing 50-H.P. steam engine, by Messrs. Tosi, of Legnano, has been added to the plant. Two shunt-wound dynamos, one of which is held as a reserve, both giving 100 amperes and 160 volts, supply the current, either direct or through accumulators. The latter consist of 88 cells of the Tudor type, constructed by the Fabbrica Nazionale of Genoa. The battery is capable of feeding 250 16-candle lamps. The distribution is at present arranged on a system of two wires, but the great demand which has grown for the supply of electricity in the town has made the adoption of a three-wire system a matter of urgent necessity.

Railway Telegrams.—In the House of Commons, on Monday evening, Sir J. Fergusson asked the Postmaster-General what was the present position of the negotiations with the railway companies for limiting the increase in the number of telegrams which the companies were entitled to send over the public telegraphs free of charge ; and whether the arrangement with the Midland and the Manchester, Sheffield, and Lincolnshire Companies, announced by the Postmaster-General on February 27, 1893, had now been adopted by the companies generally ; and, if not, whether, in fairness to the companies which had come to terms, as well as in the interests of the public, he would take steps to ensure an early and complete settlement of the question. Mr. Morley stated in reply that since the date of his reply to a similar question in February last several important railway companies had entered into agreements similar to that concluded with the Midland and the Manchester, Sheffield, and Lincolnshire Railway Companies. Negotiations were pending with the London and North-Western, the Great Western, and other large companies, but he regretted to say that these companies had not yet seen their way to accept such terms as he had felt able, in justice to the public

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interests, to offer. He agreed that it would not be fair to the companies which had entered into agreements on the subject that a settlement with the other companies should be indefinitely postponed; but he trusted that a spirit of accommodation would prevail on the part of these companies, and that exceptional measures for the protection of the public revenue would not become necessary.

Electrical "Private Views."—"Misconceptions," says our New York contemporary, the *Electrical Engineer*, "are very common as to the apparatus and *employés* that come in between the parties to telephonic conversations. Any intelligent effort to remove some of these misconceptions is to be applauded, and an interesting example comes to hand in the novel policy recently inaugurated by the management of the Metropolitan Telephone and Telegraph Company in inviting its subscribers and their friends to view the new central office in Broad-street, New York. A few days after the exchange was opened a general invitation was issued to the Broad-street subscribers. During the two afternoons appointed nearly 500 telephone users made a tour of inspection under the guidance of the Company's staff. The usefulness of such an object lesson was abundantly illustrated by the comments of the visitors, most of whom were entirely unprepared to encounter such a display of highly-finished and intricate apparatus, or such a numerous and industrious operating force. Many subscribers resolved on the spot, after watching an operator handle half-a-dozen calls in ten seconds, never to swear at 'central' again, and some even declared that they would cease grumbling about the rates, so obvious did it appear that there really were other items in the cost of telephone service besides the set of instruments at the subscribers' station."

Obituary.—Mr. Henry Vernon, one of the oldest pioneers of telegraphic engineering, died on Tuesday, the 20th ult., at Weston-super-Mare. Mr. Henry Vernon, better known to telegraph engineers of 50 years ago as Henry Vernon Physick, was born at Bath on March 14, 1814. He was at one time at Fox's, Birmingham, and was afterwards in the office of Mr. George Parker Bidder, C.E. He worked here with Mr. Austin, who married a sister of Charles Dickens, and as Mr. Vernon lived with Mr. Austin he became intimate with the family of Mr. Dickens. He was one of the earliest workers on telegraph lines, and put the wires along the Blackwall railway in iron pipes. Afterwards he was for several years assistant engineer to the Electric Telegraph Company, Mr. Hatcher being the engineer-in-chief. In 1850 Mr. Hatcher was succeeded by Mr. Edwin Clark, and Mr. Physick by Mr. Latimer Clark. Mr. Physick then took to contracting, and taped, tarred, and sanded all the gutta-percha covered wire used in the four cables between Ofordners and Holland in 1853. He executed large orders for stores and instruments for the Indian Government, and various Colonial and foreign railway telegraphs. He was the inventor of the first insulator that had any attempt to make a shelter groove round to keep a dry zone. This was patented in the joint names of John Lewis Ricardo (chairman of the Electric Telegraph Company) and Mr. Henry Vernon Physick. The insulator was used on many lines in England, and if we mistake not on the land lines through Corsica and Sardinia for the Mediterranean Telegraph Company. Mr. Henry Vernon, who discarded the name of Physick, retired many years ago to Weston-super-Mare. He was a thorough mechanical engineer, and had a room in his house fitted with numerous working models of steam-engines and steamboats.

Sun-spots and Magnetic Disturbances.—The *Memoirs* of the Società degli Spettroscopisti Italiani, Vol. XXII., p. 189, says *Nature*, contains a Paper by Dr. L. Palazzo on the magnetic disturbances of August, 1893, considered in relation to the extent of solar spots. When the very large spot, or rather group of spots, was passing the central meridian on August 6th and 7th of last year, the bifilar magnetometer of the Roman College Observatory was considerably disturbed. On August 18th, that is, when the spots were again near the plane of the central meridian, but on the other side of the sun, all three magnetic elements suffered a disturbance. Another magnetic storm was recorded at the Marine Observatory of Pola on August 12th and 13th. Dr. Palazzo has collected all the facts connected with these three disturbances, and discusses them with the idea of determining the relation, if any, between them and sun-spots. The disturbances of August 12th preceded by about twelve hours the transit of the largest spot visible upon the sun at the time. On August 18th, however, no spot could be seen near the central meridian when the magnetic needles were recording a perturbation, while neither when the double spot again appeared on the sun's limb, nor when it passed the central meridian on September 2nd, did the magnetic needles flutter. We have, therefore, spots without disturbances, and disturbances without spots, thus indicating that the connection between the phenomena is by no means a simple one. Prof. Ricco's discussion of the relation between solar spots and disturbances of terrestrial magnetism (*Mem.* degli Spettrosc., Vol. XXI., p. 153, 1892) led him to believe that magnetic disturbances occur, on the average, about 45·4 hours after the transit of spots over the central meridian of the sun. M. Marchand (*Comptes Rendus*, 1887, p. 133) showed that such disturbances occurred when groups of spots or faculæ were near the centre of the sun's disc, and Dr. Veeder has given evidence to prove that the appearance of spots on the sun's eastern edge is the signal for magnetic fluctuations. Dr. Palazzo, however, believes that the position with respect to the earth of the solar region disturbed is really unimportant.

Internal Combustion Engines.—A Paper on this subject was read before a recent meeting of the Graduate Section of the Institute of Engineers in Scotland, by Mr. P. F. MacCullum. The first portion of the Paper dealt with the amount of energy per pound of coal obtained by the earlier and the very latest forms of steam engines. It was stated that, early in this century, there were steam pumping engines at work in Cornwall indicating a horse-power for about 2lb. of coal per hour, and that at the present time the very best marine engines required 1¼lb. of coal per indicated horse-power per hour. The history of gas and petroleum engines from the earliest times was then sketched, and the determination in more recent years of gas engines into two distinct types pointed out. The first class included those working on the four-stroke cycle, invented by Beau de Rochas, and brought into practical use by Dr. Otto. The second embraced a large variety of motors, which might generically be called "displacer" engines, employing a separate pump to draw in the charge of gas and air, which was then used to force the waste products out of the combustion cylinder. Apart from the increased complication of this type, the almost impossibility of expelling the waste products without losing some of the fresh gas made these engines inferior in economy to Otto engines, the general superiority of the latter being convincingly shown on the expiry of the patents by the almost universal adoption of the four-stroke principle by gas engine makers. A very simple form of vertical displacer engine, made by Messrs. Day and Co., was described as being free from many of the defects of this class, and it was shown that but for the difficulty of preventing some loss of gas when expelling the waste products, there was no reason, practical or theoretical, why such a motor should not work as economically as an Otto engine, and moreover give an impulse at every revolution. Producers for converting solid and liquid fuels into gases suitable for use in gas engines were next described, the calorific losses due to the conversion processes for coal or oil being stated as about one-third of their total heat-energy. Oil engines of the vaporiser type were described as modified Otto gas engines, and the average consumption of ordinary commercial petroleum per indicated horse-power was stated as 0·6 to 0·71b. per hour. Gas engines using oil gas made in a special apparatus appeared to require about 0·91b. of oil per indicated horse-power, including an equivalent of oil for the fuel consumed in the gas-making operation; so that oil engines have a considerable advantage in economy, and at the same time require no subsidiary plant. In oil engines the author considered that considerable loss of fuel resulted from condensation of vapour on the cool walls of the cylinder during compression, and the initial sudden expansion of the gases at the moment of ignition. Still the oil engine worked with great economy, and formed the most convenient motor for moderate powers wherever cheap gas was not available.

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MAGNETISM AND THE MAKERS OF IRON.

BY SYDNEY EVERSHED.

When Tubal-Cain accidentally puddled a pot of molten iron into a usefully tough and malleable mass, he unconsciously laid the foundations of an industry which has lasted with but little change in methods until our own day. The craving for blood, so characteristic of the descendants of Cain, acted as a powerful stimulus to invention, and in steel a third variety of iron was soon recognised as possessing highly desirable qualities; but there invention ceased, and the art and mystery of workers in iron was handed down from generation to generation, becoming, in the course of ages and with the growth of mechanics rather less of an art, and with increase of knowledge more of a mystery.

But while the operations of iron manufacture have in essentials remained without change for thousands of years, the applications of iron and steel have steadily, and of late rapidly, increased in number, and magnitude, and complexity. The modern blast furnace is only a larger earthern pot in a fiercer fire; the steam hammer is merely a stronger and heavier stone; but in the nails and swords made in the days after the bronze age we can hardly see a germ of our ironclads and Forth bridges. These larger works have compelled attention to the chemistry of iron in relation to its strength; but having once for all discovered the right process for producing material of definite mechanical properties, the manufacturers have, for the most part, resumed their traditional attitude as masters of a traditional mystery; and so it comes to pass that when called upon by a new and strident industry to produce iron with new qualities having no apparent relation to those concerned in mechanics, their first impulse is to pacify the fractious infant with smooth words, or a *non possumus*; and their second to ask, very meekly, "What is permeability? What hysteresis?" The reply being practically incomprehensible, they very naturally say, "Tell us what sort of iron, what percentage of carbon and so on, will produce or annul those incomprehensibles?"

Is electrical engineering in a position to do this? We fear not. The last meeting of the Institution of Electrical Engineers emphasised the fact that we are not yet agreed about the best means of detection and measurement of the magnetic properties of iron, much less about their explanation in any rational or even empirical manner. We know that permeability and purity go together to some extent, but even here cast steel is a stumbling block. So also presence of carbon, and "hardness"—whatever that may be—imply large coercive force, and therefore hysteresis; yet pure electrolytic iron is by no means free from coercive force—it may be worse in this respect than mild steel. In short, present knowledge of the subject is just that mass of detached facts which precedes useful and sometimes splendid generalisation. The facts are almost ready for marshalling, but where is the marshal? It must be confessed that the accumulation of facts tends to outstrip sound generalisation, and especially is this the case in branches of science on the borderland of physics and chemistry. The temptation to discover new phenomena, a "Smith effect," or "Robinson effect," or to add one to the host of compounds belonging to the "Benzene ring," seems well nigh irresistible to our physicists and chemists, and so we must wait, and keep the manufacturers of iron waiting, for a rational explanation of the true inwardness of the iron molecule. Until a seer is forthcoming we must be content to blunder along more or less in the dark.

The darkness is, however, no excuse for hazy notions of the tendency of well-ascertained facts. The experimental work of the past few years, so far as it relates to the phenomena of magnetic hysteresis in iron, has cleared up many obscure or doubtful points, and one step in the way of generalisation together with one experiment by way of confirmation, have practically removed all but the last veil between us and the reality. Prof. Ewing having shown that, theoretically, no artificial control of molecular magnets was needed to explain the observed facts, Mr. Capstick made a model of a piece of iron by grouping together twenty-four little pivoted magnets. We have the cyclic curve of magnetisation obtained from this crude and excessively simple model of molecular structure before us as we write, and its perfect agreement with the cyclic curves obtained from groups of millions of molecules, points so clearly to a simple explanation of hysteresis as a phenomenon quite apart from chemistry, that we feel bound to warn manufacturers of iron that the hope held out to them during the discussion of Mr. Kapp's paper—the hope that by further purification they might eliminate hysteresis entirely — is almost certain to prove illusory. Before Dr. Fleming encouraged the iron makers to purify and purify until hysteresis was gone, he should have shown us how to eliminate hysteresis from Mr. Capstick's four-and-twenty magnets. There is no question of chemistry indeed it is difficult to see anything more abstruse than geometry in the model. The size, shape, and relative positions of the little magnets obviously affect the magnetic cycles, but the constitution of the magnets themselves, so long as they are practically permanent, must be a matter of indifference. We must not be understood as saying that the chemical composition of iron plays no part in its magnetic behaviour, the presence of carbon, for example, has a marked effect, but the Ewing-Capstick model does seem to us to prove conclusively that hysteresis is a property inherent in a group of magnetic molecules; it exists by reason of their mutual attractions as magnets; abolish it and the magnetism of the molecules goes with it. Small quantities of carbon, if in combination, may conceivably alter the structure and shape of the molecules, and if free may merely clog them; in either case an increase of coercive force is quite probable.

For the present, then, makers of iron must look for little help from electrical science; let them purify iron as far as possible, and above all endeavour to supply quantities of uniform quality—a matter of far more importance to electrical people than absolute purity. To the builders of dynamos and transformers we can only say—test, test, test! Buy from a tested sample, test the bulk supplied, buy from the maker if you can, and remember that the middleman is in the iron trade generally a muddleman.

AN EVAPORATIVE COOLER FOR CONDENSER WATER.

In the course of the discussion on Prof. Robinson's Paper on the electric lighting of St. Pancras, recently read at the Society of Arts, Mr. Druitt Halpin described a system of condensation he had lately seen on the Continent, which he thought would be very suitable for stations working in towns where condensing water was not available, and where the nuisance caused by steam passing off was very great. In this plant the whole power to be provided for was about 10,000 to 12,000 h.p., and when he saw it at work already between 2,000 and 3,000 h.p. were actuated by it.

The arrangement consists of an ordinary jet condenser worked by a special engine, and dealing with the steam from a number of engines about the works. This jet condenser only had a supply to keep it going for about ten minutes, and after the water had been warmed by passing through the condenser it was pumped up to the top of a light wooden building, and then ran down over boards placed vertically, adhering to the surface of the boards by capillarity. The boards were in two lengths, the upper and lower lengths being placed at right angles to each other, in order to ensure the water being broken up. At the bottom, air was driven into this structure by a fan worked by the same engine which actuated the centrifugal pump for lifting the water from the tank in which it was received from the condenser to the top of the boards. This air passes up between the boards, which are a slight distance apart, and effects the cooling partly by carrying heat away and partly by evaporation.

The water was cooled to about 80°F., but it was found that this water was capable of producing as good a vacuum as water ordinarily does at a temperature of 50 to 55°F., and this can easily be explained by the fact that this water is almost completely devoid of air; passing through and through the condenser continually the air is taken out, and when passing

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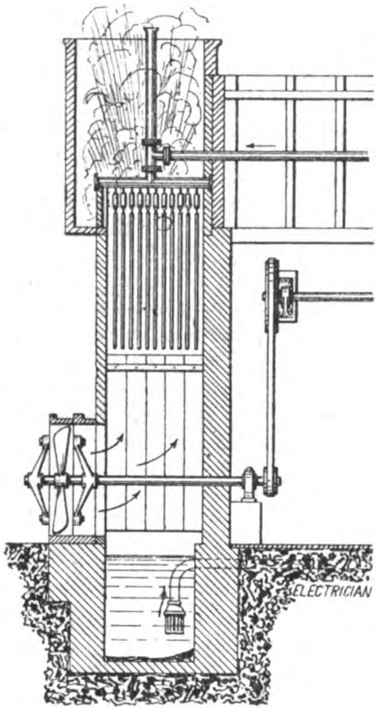
through the arrangement of boards the air pressure is so slight from the fans and the time is so short that there is no opportunity for it to absorb air again before retiring into the condenser.

The quantity of water carried away in evaporation by this arrangement was about half the total quantity of feed water



An Evaporative Cooler for Condenser Water.

passing through the engines, so that a quantity of water equal to about half the volume of the feed water had to be continually run to waste to prevent an undesirable accumulation of water. As the whole of this apparatus is so very light, cheap, and simple, Mr. Druitt Halpin thought it was specially adapted for placing on the roofs of central stations in London and elsewhere in order to obtain the economy due to condensing, and also to avoid the nuisance of steam passing into the atmosphere.

SOME NOTES ON THE ELECTRIC LIGHTING OF THE CITY OF LONDON.*

BY MAJOR-GEN. C. E. WEBBER.

(Concluded from page 453.)

It being very desirable that the works of distribution in the City should receive efficient criticism, Professor S. P. Thompson was (at my suggestion) asked, in October, 1891, to advise and report, which he did ; and I regret that circumstances permit me only to give the sense of his reports. He dealt with the subject of any possible advantage from the use of low-tension dynamos and step-up transformers at the generating station, in comparison with the generation and transmission at 2,000 volts as specified, without recommending any change in the designs. He recognised the extreme difficulty, in certain thoroughfares, of getting ways for the laying of conduits ; in certain rich blocks, of getting a cellar for a distributing station ; and the necessity for the principle routes to run north and south, not east and west, because the generating stations were on the south side. As an example, he regarded Cheapside as practically an impassible street ; as it runs east and west, "as almost useless for the purpose of a route." That shops in it must be approached through side streets and from the rear he considered in reality as no disadvantage, "for lamps are wanted most, not in mere frontages, but in back offices." He thought that there was the less need in the central areas to trouble about keeping them of equal size, since the distances from one sub-station to another were necessarily short. Having secured a sub-station in any one spot, it was easy to estimate, from the accommodation it affords, the extent of the district which it will subserve. He told me that the general plan I had prepared of distributing the alternating current at a pressure of 2,000 volts by mains to transformer sub-stations "could not be improved upon," and agreed entirely in principle with the general plan of distribution as provisionally set out in the maps shown ; and, further, approved generally the size of areas assumed in those maps to be suitable, and that the richest areas so mapped out are the eight areas surrounding the Mansion House (see plan, Fig. 19) marked respectively C^1, C^2, C^3, C^4, and E^1, E^2, E^3, E^4. The diagram map shows eight central districts in the City which were presumed to be those richest and having the largest immediate demand. He agreed entirely with me in deprecating the provision of mains, through long streets, as had been laid out in the pioneer contracts, and saw the need to break up long streets into sections, each such section to be supplied as part of a compact surrounding area. The exact delimitation, even, of the individual areas he considered a less important matter than their compactness, solidity of work, and efficiency of supply. At that time, and with the same gentleman, the question of automatic switching of a bank of transformers was discussed. It was a novel one as regards experience. We regarded it as essential that, although at first manual regulation with daily shifts of attendants could not be avoided, eventually it would have, for economical reasons, to be done automatically. And in connection with this the inventions of Messrs. Gordon, Mordey, Tomlinson, Ferranti, and Kapp were considered. Of these well-known electrical engineers some are present, and will, I hope, give us the benefit of their remarks on this very interesting and important part of the subject.

Execution of the City Street Work.

Although it may not fall to the lot of any present to have to carry out a similar work under the same conditions, it seems to me that a short account of a portion of what was done in the City streets may prove instructive to engineers. Our papers are generally very full of technical interest, but few ever narrate the practical working engineer's experiences. This must be my apology for some diffuseness. Enforced inaction for an engineer is always irksome especially as he is well able to anticipate the loss and overwork that must follow through dilatoriness of those whose duty it is to make up their minds. Such was my position between July and December, 1891, when valuable time was lost, and heavy and pressing work requiring to be completed by the end of February, 1892, had to be suddenly put in hand. Fortunately, I had foreseen the rush that would come, and had engaged and organised my office and staff so as to be ready to go to work when required, and had also called for and received tenders for the various kinds of articles of plant and materials (several of which had to be specially designed) that the work would require.

The chief difficulties that had to be faced, besides those inseparable from street work in the City, were—(1) the time of year (all the fine autumn had been lost), with its wet, mud, and fogs; (2) the difficulty of readily finding a sufficient number of suitable foremen to take charge of such work ; (3) the inconvenience caused to the public by having 100 yards of footway "up" in nearly thirty different places at one time. My estimates of the cost of the work had been based on the assumption that it would be carried out under our own staff, by hiring labour, and by purchasing tools and material, with a reasonable rate of progress. There was no doubt whatever that the intermediary of contractors would be wasteful, even although it was easy to find road and paving contractors in every city of the kingdom. Time being precious, and the Commissioners threatening, my ideal could only be partially carried out. Tenders had, therefore, to be called for for separate sections of the obligatory streets ; but here the obvious difficulty of price had to be faced. No contractor would quote to lay anything under a City footway without at least 100 per cent. margin, unless he could first take up the surface. But this first taking up was not permissible. Tenders under such conditions were obviously objectionable. Then, considering that we wanted several contractors to go to work at once, besides our own gangs, it would have sent the price up a hundred-fold if their tenders were to include the supply of tubes, cases, and material, because they would have been competing for such unprecedented quantities in the same market. There was only one course to follow, namely :—(1) To purchase all the materials ourselves ; (2) to prepare a specification and schedule of measured prices especially suitable and confined to the kind of work ; (3) to pay for the work under measurement.

As regards the first, namely, the material : wrought-iron tubes, although a considerable stock is to be found amongst makers, are not held in quantities representing hundreds of miles, particularly of the quality of iron, and lap-welded, that we wanted. Our tests of samples were necessarily hasty ; but the steam hammer, though rough, gave us a pretty fair indication of toughness. The very fact of so large a quantity being wanted, instead of enhancing the price, enabled us to do what is called "break the ring," and I believe it is one of the very few cases in which tubes have been sold some 20 per cent. below "ring" prices. All the tubes were treated with Angus Smith compound. As regards the Callender-Webber casing,

* Paper read before the Institution of Electrical Engineers, February 8, 1894.

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there was only one maker; but here, again, foresight on behalf of the City lighting had a long time previously provided for special rates in favour of that particular work. At the same time, I cannot speak too highly of the great efforts of Mr. Tom Callender at that time to extend his company's means of output, and that at very short notice. I remember that at one time the bitumen we were bound to lay underground in January, 1891, was still, in Christmas week, 1890, on board ship in the chops of the Channel.

As regards the second, namely, the specification and schedule (of which a copy may, if the Council permits, be attached), it is sufficient to state the former consisted of 44 clauses, and that the latter had 55 items, which the tendering contractors were asked to price. But even with these precautions it was felt that, in the case of the most difficult streets, no contractors could be asked to tender at all except they were allowed to charge for whatever they paid out, and then with no obligation to meet all the liabilities for damage to person and property in the most crowded and intricate places in the whole world. To our own engineers and men the work in such places as Cannon-street, Thames-street, Cheapside, Poultry, St. Paul's-churchyard, and around the Bank, &c., was allotted. In the 22 streets in the eastern and central districts which remained to be dealt with at the end of December, the total length of trench to be excavated, and completed with conduits and boxes, was nearly 24,000 yards, of which 9,700 was allotted to the company's that, if the adverse conditions I describe could have been avoided, a saving of about £7,617 on what actually cost over £30,000 would have been effected; and that is exclusive of the advantages in the minor results in the form of better "finish" when the work is done under one's own foremen. If the same work had been carried out at the rates of the highest tenders accepted it would, including material, have cost £72,000; and if entirely in the way my estimates contemplated, the costs would have been, correspondingly, £40,000. But in neither event, having been begun in December, would it have been all done, as was essential, early in February.

A glance at the map (*see* Plan 19) will show that in the heart of the City there are eight transformer areas designed; and, naturally, as soon as the main thorougfares were completed, to the completion of conduits in the lesser thoroughfares, streets, and courts of these areas was immediate attention turned.

The amount that had to be paid for the work done in the streets by the pioneer contractors (already referred to) was £22,850, which, added to the previously-stated amount, came to a total for the main thoroughfares of the eastern and central districts of £81,850. In the whole City there are 92½ miles of frontage, and in the eight special areas there are 22,000 yards. If the average demand for lamps is 2·1 per yard, we get 42,600, or about 6,000 per sub-station area; but, being the richest areas, three lamps per yard, or 8,500 per acre, was estimated. By March, 1892, the

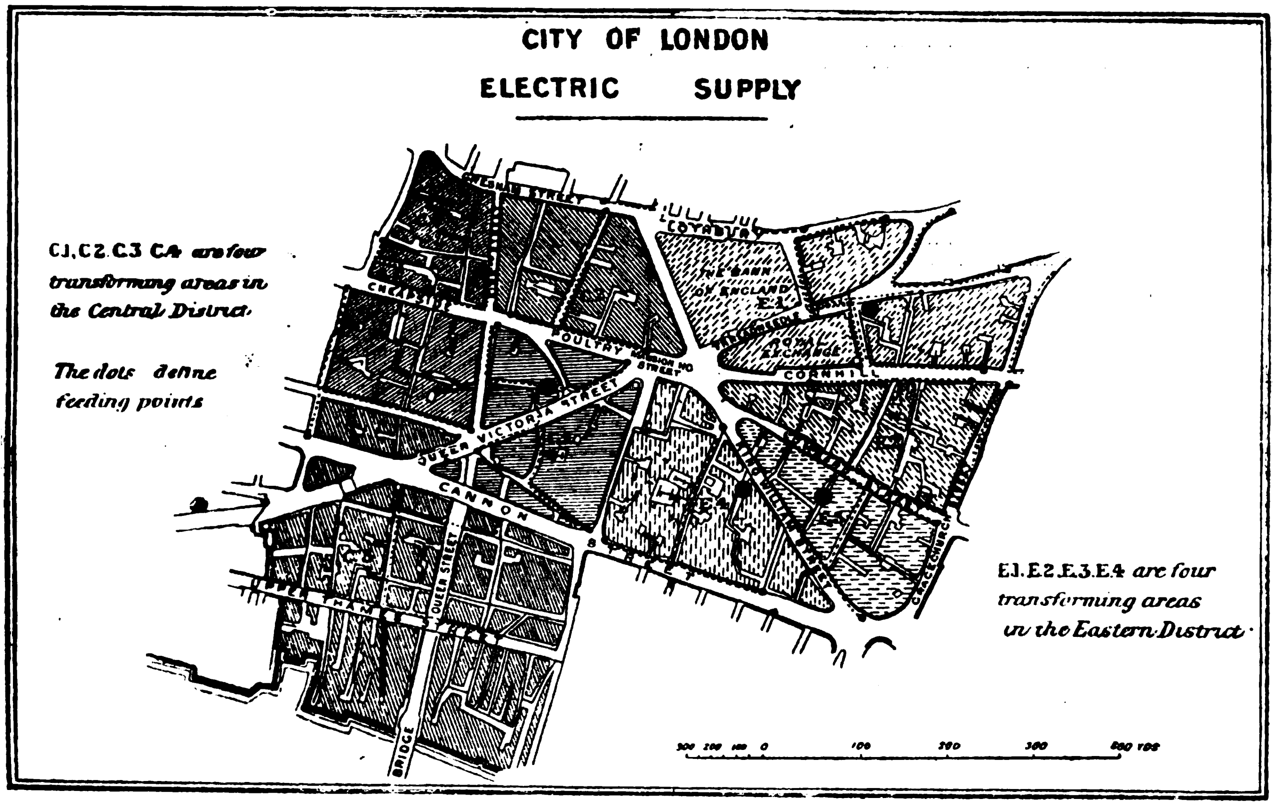

FIG. 19.—Centre of City.

gangs. There was only one month to do it in to carry out the conditions of the contracts with the Commissioners. Three contractors at first—afterwards a fourth was added—competed successfully.* The abstracting of all the tenders showed a variation on the average work between £188 the highest and £79 the lowest, per 100 yards of work. The highest tender accepted was at the rate of £128 per 100 yards. The same work in the more difficult ground done by the company's gangs cost only £60, including the cost of the plant used by them. The average cost of the materials was about £118 per 100 yards. The actual cost of the work essential to be completed in February was about £59,000. The maximum rate of progress was attained at the beginning of March, 1892, when 1·65 miles of trench was completed in six days' work.

An analysis shows that the 4,260 yards by one of the contractors, at £128 + £118 = £246, cost £3,069 more than it would have cost if done by the company's gangs; that the 4,010 and 5,270 yards of the two others respectively cost £2,560 and £1,265, correspondingly, more; giving a total of £6,894. But it may fairly be said that, if the contractors had tendered to do the work when the days were fine and long, their prices would have been 5 per cent. less, say, £723. It may be instructive to young engineers present to realise cost of the work (not done by contract) could be pretty closely detailed, and the cost of the conduits in portions came to a little over £17,000; giving a total for the completed street work in the main thoroughfares and eight sub-districts of the eastern and central districts, exclusive of conductors (except a small quantity of cable provided under the pioneer contracts, which is included), of £98,850. Of this, the length of trench completed by July, 1892, was 43,000 yards. I have little doubt we shall be told that most of the lighting in those areas is with 16-c.p. lamps. In this respect, I think it is evidently the wrong initiative policy to try to make up a big load before you are ready in order to make a fair show, instead of keeping it down when first starting by encouraging in every possible way an economy of light by the use of 8-c.p. lamps. It is well known that I have been from the first an advocate of this policy, and I now attribute our measure of permanent success at Chelsea as being largely due to it.

It will be readily understood, by a glance at the plan, that the streets bounding the areas having been completed with all the "ways" actually necessary, and that could be put in, the internal cross streets could be provided with all that the future load could possibly demand for feeders of any size.

A more precise idea of the cost of this kind of work laid in streets presenting exceptional difficulty is given below. In an example of

* Nine firms tendered.

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the streets in question only eight "ways" could be introduced under the footways on each side, viz. :—

	Ways.
In Callender-Webber casing	3
In 1¼in. tubes	4
In 2½in. „	1
Total	8

The length of the two sides, taken together, inclusive of the lengths occupied by boxes, is 1,328 yards.

The cost of taking up the surface and temporarily relaying it, at 3s. 9d. per yard lineal, was	£250
Laying conduits and pipes, at 1s. 3½d.	85
Cost of „ „ at 8s. 6d.	718
Superintendence, storekeeping, cartage, sundries	78
Small stores and blacksmith's work	27
Wear and tear of plant, and contingencies	116
Cost of draw-boxes and service-boxes where actually required	99
Approximate cost of restoring the surface) performed by the Commissioners' contractors, and on their schedule	554
Total	£1,927

Or £1. 9s. per yard lineal of trench, exclusive of cables.

The equipment of this line with cables of the following sections, namely :—

2 of 0·3 square inch section of copper	} for low
1 of 0·15 „ „ „	} pressure,
4 of 7/16's	} for high
1 of 0·158 square inch (concentric)	} pressure,

costs, in addition, £2,037, giving a total cost per yard lineal, inclusive of cables, of very nearly £3.

Including casing used for house services, the total length of ways in bitumen concrete casing laid in the streets and areas named up to July, 1892, was

In casing unsheathed with iron	4,356 yards
„ sheathed in iron	148,068 „
Total	152,424 „

Or over 80 miles.

The internal diameter of these varied between 1in. and 2⅝in. The largest proportion of these were of the triangular form. The total of 1¼in. wrought-iron tubes laid was 173,000 yards, or 98 miles; of 2½in. wrought-iron tubes, 164,000 yards, or 93 miles. Total of ways of all sorts laid in the City between December, 1891, and July, 1892, 271 miles.

Of the Raworth-Callender-Webber conduit, 212 yards, containing four ways, were laid in Queen-street. This was an experiment, and is an example of paper-lined ways bedded in bitumen and lying in cast-iron troughs, with separate cast-iron joint-pieces, and cast-iron covers bolted down.* The durability of the paper has yet to be tested, but of this I have little doubt, if it is thoroughly impermeated; the only drawback is that they cannot be easily bent during laying, and that, as laid in the City, the cast-iron cover has to be cut through with a cold chisel to make a house service connection.

The sheathing of the Callender-Webber cases was mostly made of No. 22 gauge sheet mild steel, which covered the three sides of a triangular and the four sides of a retangular case, then secured by studs or cut-in pieces, or 1½in. hoop iron riveted, and the whole painted over with a bitumen solution. Sheathing for these cases was first used in the City work. As is well known, the cost of the casing when it is triangular in section and has three ways of 1¼in. diameter each is, without sheathing, 1s. 11d. a yard, which is 7⅔d. for each way; the same sheathed costs 2s. 10d., or 11⅓d. per yard. Nearly all the 1¼in. wrought-iron tubing laid (generally four tubes under each footway throughout)† cost 9½d. a yard, which was an exceptionally low price, for the reason I have already given; this is, against the first cost per yard of ways of the former material, less by 1⅚d. per yard. The advantages of the bitumen case, I think, more than counterbalance this: (1) durability; (2) there is less labour in making two bitumen joints than three screw joints (the former are 6ft. apart, the latter 12ft.); (3) the bitumen is more easily cut to lengths and bent than the wrought iron; (4) there is no risk of rust sealing in the cables after they are in the bitumen ways, as often occurs with iron ways.

* This latter system, called the "Callender-Raworth-Webber," in which I am joined with those gentlemen by an act of courtesy on their part, is chiefly attractive to me through the possibilities it offered for the use of bare stranded copper. Since then I have brought out, in conjunction with those gentlemen, a further development, being a combination of the two systems above mentioned, called the "Webber-Callender-Raworth" conduit, which I hope may be a step in advance in that much-to-be-desired direction.

† Two 1¼in. tubes are destined for the public, and two for private arc lighting series cables.

When you come to compare the 2½in. ways in bitumen and wrought iron, the costs are as follows:—In the former each way in a *sheathed* case costs—

	Per yard. s.	d.
With triangular section, three-way	1	9⅓
With rectangular section, „	2	1

This at once compares favourably even with the exceptional low cost of our 2½in. wrought-iron tubing used in the City, which was 2s. 6¼d. And when there are six 2½in. ways in a case the cost per way comes out 1s. 5d. per yard, and a large economy is at once evidenced (increased if the cost of sheathing is avoided). But it must at the same time be noted that where we laid 18 (and more) 2½in. tubes in the same trench with other conduits—for instance, throughout Thames-street—we might not have found room for three more six-way cases, which in cross section occupy more space than 18 2½in. tubes.

I have not referred to the western district, the contract for the public lighting of which did not require completion before November 5, 1892; but it may be stated that this work alone required 11,614 yards of trench, which, at an average cost of £1. 12s. 1d. a yard, would cost £18,630, exclusive of spare tubes for other purposes.

CONDUCTORS.

As has been stated, the primary alternating-current conductors were concentric 0·154in., with high-class insulation; the high-

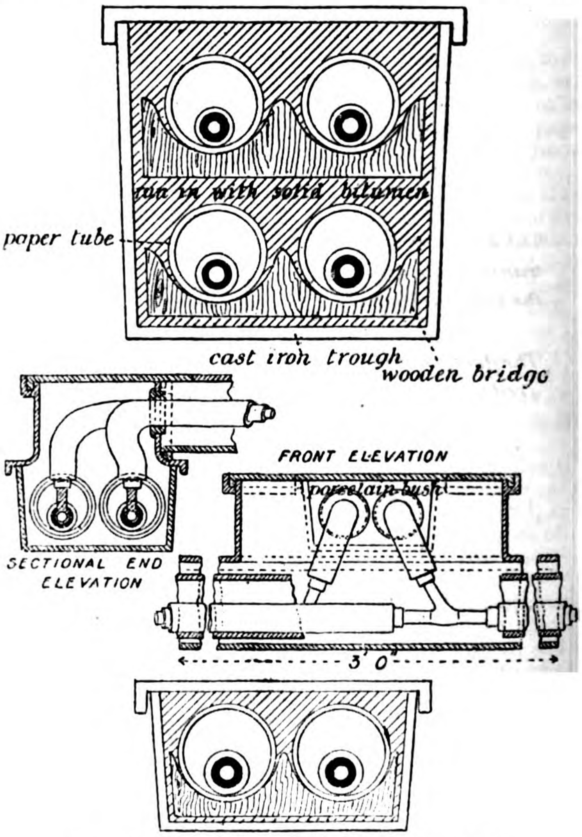

FIG. 20.—Callender-Raworth-Webber Conduits.

tension continuous-current conductors were 7/16's concentric, except where the lamps are connected, also with high-class insulation; and the secondary conductors on the three-wire system of various sizes, has Callender extra standard type insulation. The two first were drawn into 2½in. and 1¼in. wrought-iron tubes respectively. The last was drawn into the three-way Callender-Webber casing, manufactured of three sizes, namely, with 1½in., 2in., and 2⅝in. ways; in each of those the third way is smaller than the other two. The largest were for feeders where necessary, and the two smaller for distributors.

In the eight sub-district areas shown on the map (plan No. 19) it is seen that no consumer's terminals would be more than 100 yards, measured along the main, from a transformer station; consequently, allowing the Board of Trade drop of 4 per cent. above and below the normal, the section of cables first drawn in, the maximum areas of the three conductors, taken together, was five-sixths of an inch; and very few feeders except quite short lengths were necessary. It was considered that for a considerable time to come this would comply with a demand of at least three lamps per yard of frontage, the frequency of transforming stations being maintained. The impedance due to retardation was, therefore, negligible with those sizes.

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The cable specifications giving the special conditions under which the manufacturers had to tender (of which a copy will be attached to this Paper) had some special features, namely:—The same results of insulation as were prescribed for the tests at the maker's works were required after each length of cable had been drawn in, in the presence of the maker if he wished it, and before joints were made in it. The maintenance of the insulation, except at joints, was guaranteed by the maker during three years from the date of it being drawn in, and if within that time the dielectric had deteriorated the maker was to replace the cable. With a view to the company having the advantage of the market rate of the price of copper at the date of the quotation, the contractor was required to state the number of tons of copper, made up in insulated cable, for which he would receive orders at that rate during one year.

As it became soon apparent that in each of the eight sub-districts above referred to separate transforming stations might not be obtainable, the question of a distance between them probably greater than had been calculated on required consideration, and the consequent enlargement of the sectional area of the copper in the conductors. The first point that had to be considered was as to the saving that could be effected by the use of hollow-cored cable. With alternating currents having a frequency of 100 there is an inequality of distribution of the current over the cross-section of the cable, and for practical purposes the penetration may be regarded as not exceeding $\frac{1}{4}$in. from the outside of a cable of stranded copper, and, therefore, if above $\frac{1}{2}$in. diameter, the copper in the centre of the strand is not useful. These conditions led to the adoption of the Callender hollow cables for sizes varying between 0·4 and 0·7 of an inch sectional area as the simplest and cheapest form. For instance, such a cable, having $\frac{1}{2}$ sq. in. section of copper, was made up of 38 No. 10's, or 30 No. 9's, in two layers, round a hempen core, when the outer diameter of the copper is 1·05in. For anything over $\frac{3}{4}$ sq. in. section of copper it was apparent that some form of multiple strand would have to be adopted; but for the supply then contemplated (even with only 600 amperes per square inch density) the maximum of 0·7 of a square inch was sufficient to provide.

As regards joints and jointing—that very important matter both in first cost and maintenance—I had examined every form that in 1891 had been before the electrical engineering world, and at that time had no reason to alter the opinion formed from long experience, that only when forced to adopt anything else by the construction or dielectric of the cable, could I recommend anything more simple, practical, or durable than the joint made of the same material and of the same form of covering as the cable itself; and this is applicable to both straight and T joints.

As regards the experience gained by the Company in the matter of their mains since July, 1892, I shall hope the Institution may have the most instructive information from the engineers who carried on the work after I retired from it. The best qualified is Mr. G. H. Nisbett, who since the autumn of 1890 had been my right hand in all matters connected with electrical distribution, and whose intimate knowledge of every part of the City work made it absolutely essential that he should pass from my service to that of the Company when I left it.*

Public Lighting—Lamps.

The lamp-posts and lanterns first erected in 1891 by the contractors, to the number of 72, in some of the main thoroughfares, under the pioneer contracts, did not meet with the approval of the Commissioners, and had all in time to be replaced. The only portion which was allowed to remain was the lantern which had been designed by the Brush Company, and which I have illustrated, and called the "Raworth" lantern. My own views had advocated a different shape, having a wide pagoda roof, and sides at smaller angle to the horizontal. In the case of the Raworth lantern, which is in use throughout the City, the dimensions were found to accommodate the Thomson-Houston arc lamp as well as that of the Brush. The interior is easily accessible; and the lamp, instead of being suspended, stands on a porcelain insulator. The other details are shown on the drawing. As regards glass, Colonel Haywood was very particular in selecting one that was least absorbent of light, while being sufficiently diffusive of the arc. The first sample, put in by the Brush Company, which gave the effect of there being four small blurs of light inside, was rejected as being too absorbing, and perhaps requiring too much labour in cleaning. Three samples of glass were submitted to the engineer, and tested by him in three street lanterns in use. They were respectively—

	Thickness. Inch.	Per cent. loss by absorption.
Ground glass	0·058	46·24
Opal	0·072	25·18
Rippled	0·145	21·73*

* I cannot refrain from also mentioning here two indefatigable assistant engineers on the same duty, namely, Mr. Buck (late R.E.) and Mr. Bates.

The last was approved, and is now in use, and is the cheapest.

The lamp-posts, as finally designed and approved by Colonel Haywood, are in two pieces, the base having two forms; the smaller base, which is round, is fixed in the narrower footways. As regards the shaft, one matter which required careful consideration was the means of assisting the lamp-trimmer to ascend and descend. In any case, fixed projections below the lantern upon which the man can stand at his work are necessary. These are the arms shown in the elevation. Fixed projections, or means of attaching them, were not admissible on the ornamental base; but something had to be done to assist the man to mount the shaft, so as to save the carrying and use of a long ladder in the streets. The permanent attachment of steps, for obvious reasons, the Commissioners would not allow.

Three methods were proposed, namely—

(1.) By the Brush Company, in which short pieces of rod iron, with a round head at each end, were passed into holes in the hollow shaft at intervals on alternate sides. These rods lay concealed—all except the heads—when not wanted; when in use they were pulled out as far as the head on the rod within the shaft would allow.

(2.) By Colonel Haywood, which consisted in a structure like a parallel ruler, concealed in and bedded in each side of the shaft. When shut up, no evidence of its existence could be seen; when opened, the whole has the appearance of a ladder with a centre stave, and, but for extreme complication and costliness, it might have been a very excellent design.

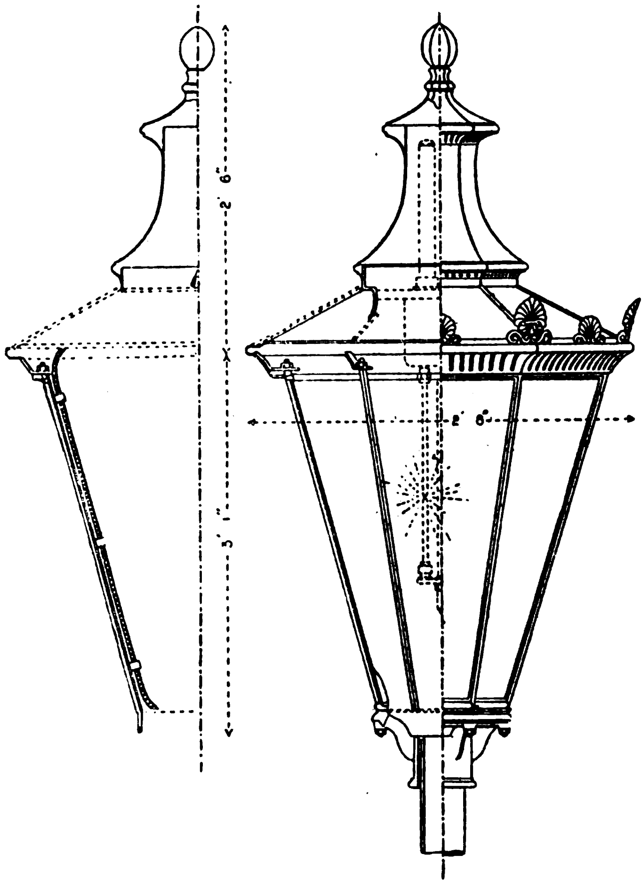

Fig. 21.—Street Lantern.

(3.) The plan which suggested itself to me was very simple, and has been adopted. It consists in using alternate side holes in the shaft, which are not conspicuous, and in having six or eight portable steps of light steel, which can be securely hooked into the holes as he ascends, and taken out by the trimmer as he comes down the post.

Where the footways are very narrow, and posts are inadmissible, it became necessary to use wall brackets; of one of these, illustrations in two aspects are given. The suspended lantern is the same in design as that on the posts, with some small differences in detail. It took a considerable time for the Commissioners to obtain the way-leaves for such heavy attachments to private buildings. The suspension gear was specially designed to allow the lamps to be independently and rigidly suspended inside the lantern, while the lantern itself is free to swing slightly and swivel round.

In both cases—namely, in the base of the lamp-posts and in a box fixed to the wall under the bracket—an absolute cut-out switch

* These tests were, I understand, made by Mr. Preece.

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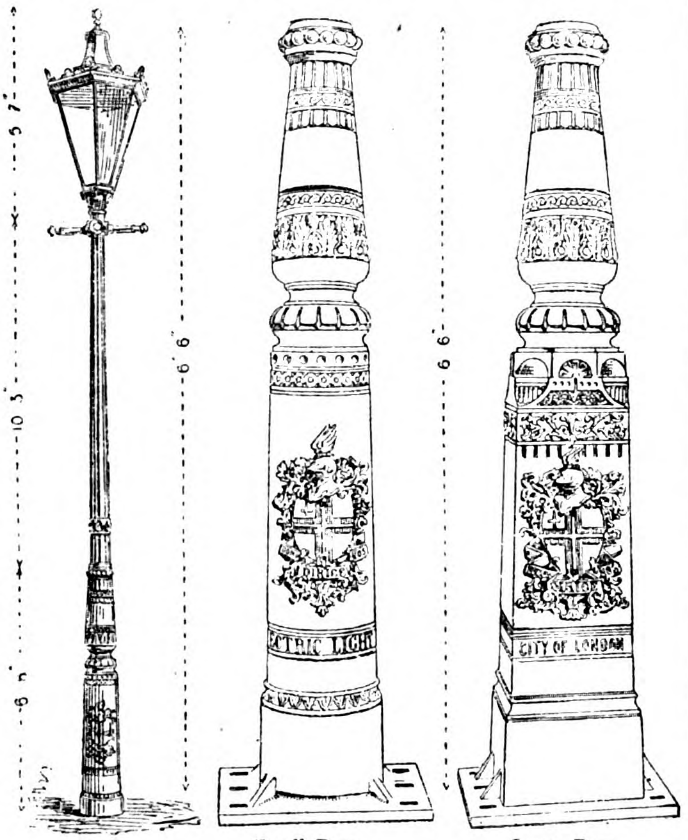
on an incombustible insulating base, approved by the Board of Trade, is provided. Each contractor has his own form.

In connection with fixing the posts more difficulty than might be expected was found. The base plates below the ground could not



Small Base. Large Base.

FIG. 22.—Lamp Posts.

be by any means uniform in pattern. It was impossible to tell before the ground was opened whether the posts could be solidly supported by a deeply set base, or by one that spread out under

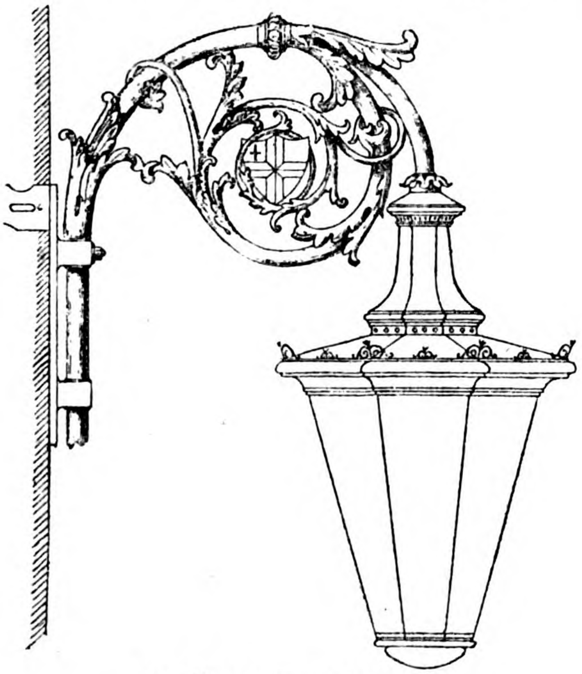


FIG. 23.—Lantern and Bracket.

the ground.* Several forms of modification of these conditions had to be provided for. In some cases heavy masonry and concrete had to be cut through and replaced. Of the 371 arc lamps contracted for in the eastern and central districts, in March, 1892, the positions of 340 only had been decided on. Of the 340 points 37 were brackets.*

The contracts with the Commissioners provide for the substitution at 906 points of glow lamps of not less than 200 watts† for gas lights throughout the City where arc lights have not been put up.‡ The contracts with the two manufacturing companies specify that they are to supply and erect 100- and 200-watt series glow lamps; all arrangements in connection with the first installation to be experimental. The carrying out of these arrangements are still in the experimental stage. The Commissioners had the power to compel the Company to complete them in the eastern and central districts by May last; but in withholding their engineer's order to have this done they have, I think, acted wisely in the interests of public lighting by glow lamps. At the beginning of this Paper I stated that the experiment on the Holborn-viaduct in 1882 had brought discredit on this means of public street lighting. The experiment now going on by the City Company in Basinghall-street is, I think, only calculated to produce the same result: but it is to be hoped the Commissioners will be as well advised in this matter as in the past.

The principles detailed by Mr. Trotter in his admirable Paper before the Institute of Civil Engineers on public lighting by electricity are equally applicable in the case of glow lamps as in that of arcs. His dioptric lantern, which we have known ever since the days of the Inventions Exhibition, is the mathematical example of

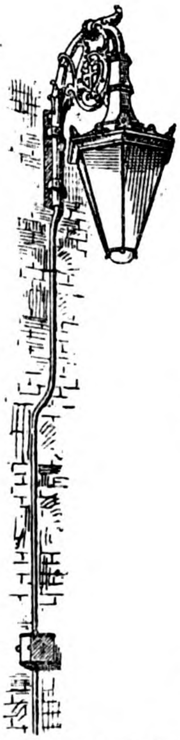


FIG. 24.—Lantern and Bracket, with Pipe under.

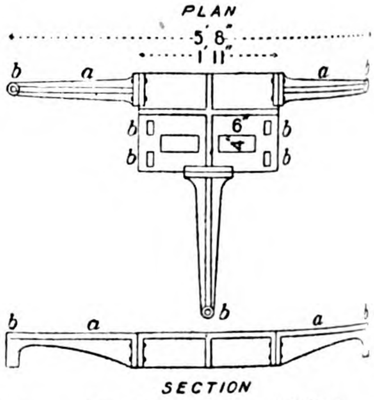


FIG. 25.—Underground Base of Lamp Post.

that for which he contends. It is many years since, at the Society of Arts, in a Paper on glow lamps, I demonstrated that the exposure of the filament to the eye, or the eye to the filament, is an abomination. I do not attempt to supplant Mr. Trotter's originality by showing a sketch of a street lantern with a hood, and inverted truncated glass cone underneath, the glass being cut up throughout a zone of its surface into diamond-pattern facets. There is nothing geometrical in their form (though there

* In erecting the posts extra expense was incurred through having to open the ground a second time after the trench for the mains had been made. The Commissioners were responsible for this, owing to delays in approving of the patterns, and in finally deciding on the actual points to place each post.

* The weights and costs of these posts, above-the-ground brackets, and lanterns, are as follows:—

	£	s.	d.
A large base weighs 9cwt. 2 qrs., and costs	£6	0	0
A small base weighs 6cwt. 3 qrs., and costs	4	10	0
Each shaft and lantern gallery weighs 3cwt. 1 qr., and costs	1	18	0
Each lantern weighs 3 qrs., and costs	7	0	0
Each bracket weighs about 1cwt., and costs	2	2	0

† The prices to be paid by the City for glow-lamp lighting is (sunset to sunrise)—

For a lamp of 200 watts .... £10 per annum.
" " 100 " .... 5 "

‡ It may here be stated that as early as 1888 every point in the City where arc or glow lamps would be likely to be required had been surveyed and plotted under my superintendence. The deviation from that design has been very small.

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might be). They are only intended to intercept the direct view of the filament, within an area of space outside the lantern, and diffuse the rays of light from it. The simplicity of the design as regards convenience, &c., will, I hope, commend itself to the Commissioners, and I believe that, if posts in the small thoroughfares and courts were made entirely to disappear, and light, ornamental brackets, with lanterns such as I have illustrated, were used, the City would in this respect have also taken the lead, and have set a good example to all other municipal bodies.

This paper, as its title shows, only deals with a portion of the great work of lighting the City of London. Necessarily, my duties as engineer up to July, 1892, required my superintendence of the starting of many works at present far from completion; and while in every case I have been careful to avoid enlarging on matters which could be better described by the engineers more directly responsible, obviously there are also several matters which might be regarded as more or less confidential. These I have avoided, and in selecting illustrations from figures have confined myself to those previously accessible to the profession.

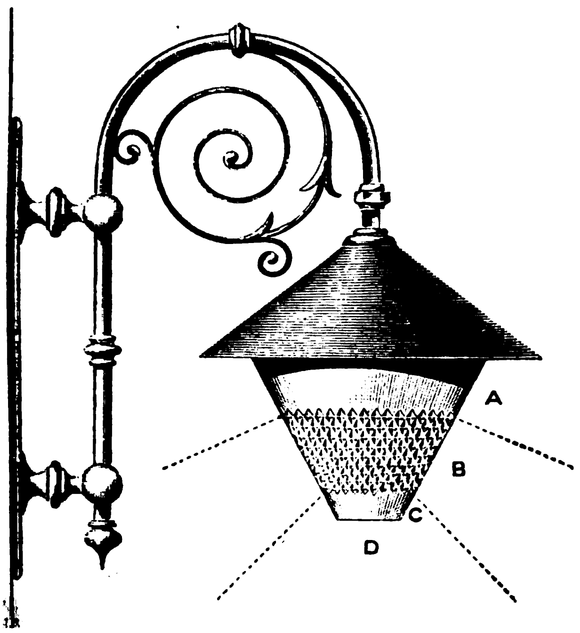

Fig. 26.—Wall Bracket, Glow Lamp Lantern.

In concluding, I hope I may be allowed to state that never was an engineer better served than I was by my staff, and that each and all fully justified their selection, equally those who were new to me and those who were old friends. It is no flattery to them to believe that my severance from the position of being their chief has in no way lessened the value of the services which they have since rendered to the shareholders of the City of London Electric Light Company.

DISCUSSION.

The following is an abstract of the Discussion which followed on the reading of Major-General Webber's Paper. Speakers whose remarks are prefaced by an asterisk have returned their proofs revised.

A MEMBER asked whether the sum named for the conduits included the money spent on telephone tubes.

Another MEMBER referred to the marvellous speed with which the work had been carried out; an enormous amount of bitumen casing had been laid down, and engineers all knew the difficulty attendant on the laying of bitumen casing.

*Mr. GISBERT KAPP said that a large amount of information was given by Major-Gen. Webber as to the way in which he had designed the distributing plant. But what about the working of it? One illustration, showing a transformer sub-station, showed a two-storied building with the transformers in the lowest part. What about the water? Could transformers placed in this position be kept dry? Had Gen. Webber found a way of preventing the danger arising from this? Another point was that various systems of mains were being used, some in iron pipes, some in conduits; how had these behaved in practice? He did not think that sheet iron or steel, especially in such thin sheets as No. 22, could give much screening effect. He should expect it soon to be eaten away, and whatever shielding effect it had would thus be destroyed. Another point he should like to hear about was the connection with the customers. He understood that the low-pressure net works were not connected with each other; if this was correct he should like to know the reason for it. As to glow-lamp lighting, Gen. Webber seemed to have great doubt as to the practicability of lighting streets by glow lamps. Now it seemed to him (Mr. Kapp) that glow lamps were the right thing in many cases. Arc lamps cost £25 a year, and one wanted a good many of them to light a mile of street, so that their expense was enormous. In fact, it could only be used where the traffic was large; in all other places the expense was out of all proportion. What one wanted was a generally-distributed light For this glow lamps seemed the right thing. They had, moreover, the advantage of not requiring trimming.

*Mr. W. B. ESSON said that he would like to know something about the endurance of the distributing system, also the methods adopted for regulation at the sub-stations. Although there was a large number of statistics in the Paper, there was nothing much connected with the actual working of the system.

*Mr. ALEX. SIEMENS thought that there were many points in the Paper which deserved better treatment than had been accorded them by the meeting. He would like to call attention to one statement, which appeared to be entirely against a generally-accepted principle. Gen. Webber said that the consumption of coal was to be 7lb. per Board of Trade unit delivered at the terminals of the primary mains in the stations for arc lighting, and it was not to exceed 5lb. for alternating. This was directly contrary to the results which had been obtained. It would be very interesting to hear some remarks on this point. Another point about which he would like to hear something more was about telephone cables being protected against interference by sheathing. Twin telephone circuits should not want any protection. It was always invidious for him to say a word for lead-covered cables. All these wonderful conduits had various good qualities, such as bending, &c., but, nevertheless, he would have preferred to have laid lead-covered cables, which could be laid anywhere and anyhow, and could be threaded in, under or over, gas and water pipes, and tapped without any difficulty. He (Mr. Siemens) had not been without experience of city work, for, as Gen. Webber said, one of the three districts allotted in 1880 was given to his firm. One advantage of lead-covered cables was that there was no necessity to take precautions against gas explosions. Gen. Webber's statement that hollow-core cables were an advantage in the case of alternating currents was a fallacy. If alternating currents obeyed all the laws which were made for them they should keep to the outside of the cable. But the effect in practice was very slight, and the difficulty was overcome by making the cable slightly larger, which was better than making a hollow cable with a hemp core, which involved much more insulation and sheathing. For practical engineers money was the only thing which decided whether this or that system was to be adopted.

*Mr. J. B. BRAITHWAITE, jun., thought that Gen. Webber had indulged in uncalled for sneers against those who had the pluck to come forward and raise the capital at a critical moment. Gen. Webber had used the following words:—"As we all know, a very old way of commencing to raise capital has been brought out under a new name, namely, by the starting of a 'pioneer company,' which is one way of getting an instalment of capital together to make a beginning. Of course, there is no engineering justification for it, but the financial physician has prescribed it, and hence this first capital must be spent with a primary object of showing that something can and will be done. The future of the undertaking from the structural point of view may become quite a secondary consideration, and, indeed, may be ignored if it interferes with the parade with which it is intended to 'draw' the investing public. They—the public—have only themselves to thank if this sort of thing is necessary. Engineers and contractors have no real interest in its existence." He could not imagine a greater disservice than to tell electrical engineers that they had nothing to do with finance. What were the facts? At the time when it was necessary to commence work under the Provisional Orders for the Eastern aud Central Districts, the City had just experienced the greatest shock since Black Friday, 1866, by the collapse of the great house of Baring. Had money not been obtained, Parliamentary power would have lapsed, and this money had to be obtained at a time when it was commonly said that it was impossible to borrow 15s. on the security of a sovereign. Now it seemed to him that it was a matter of great interest to electrical engineers that men should have come forward and saved the provisional orders, and thus provided the means for enabling one of the largest electric lighting schemes in this country to be carried out. He, for one, entirely took exception to the sneers in the Paper, and would not further follow Gen. Webber's statements, many of which were—should he say—inaccurate.

*Mr. J. F. ALBRIGHT entirely endorsed Mr. Braithwaite's remarks. He had had some experience in trying to get schemes of the kind carried out and if they were to avoid all this sort of thing no large schemes could be carried out. He could not agree with Gen. Webber upon glow-lamp lighting, though they certainly wanted to be properly put up. He (Mr. Albright) should not like it to go forth from that Institution that the glow-lamp was inadequate to the requirements of street lighting. Glow lamps were undoubtedly useful, although, of course, they were not equal to arc lamps. He could not quite agree with Gen. Webber as to the advisability of adopting the Callender-Webber system. Experience had shown that it could not be relied upon as a "drawing in" system. He also joined issue with the President as to lead-covered cables. He believed the best of the systems they had before them for work in this kind o street lighting was wrought-iron tubes, into which thoroughly well insulated cables were drawn.

*Prof. SILVANUS P. THOMPSON said that General Webber was very anxious to do him justice in quoting his reports. The extracts made must not, however, be taken as giving the whole of his views. The reports were made to the City Company, and were not his property. He would not like it, therefore, to go out that those views were in any way his final ones; they were quoted apart from context. For instance, he was quoted as saying that the correct thing for electric lighting was vertical engines direct-coupled. Now, he gave that opinion with reference to a particular station and a particular district, and he was not to be understood to make the same recommendation where land could be had for almost nothing. Also his opinions about transformer sub-stations must be taken as bearing on the

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particular case for which they were given. He would forbear to make any further remarks, because he had not had permission to make use of his reports. The suitability of glow lamps for street lighting largely depended on the way in which they were used. He should like to possess more facts about series glow lighting. Arc lighting was undoubtedly the right thing in many cases, but the use of glow lamps was usually restricted on account of the cost of parallel distribution. With respect to dioptric shades for arc lamps, they all knew Mr. Trotter's researches, which might in the future be found to possess more value than many engineers were aware of. At the present moment, in France, some engineers were carrying out Mr. Trotter's ideas to a further point. One thing certainly could be obtained in this way, namely, the abolition of the dark shadow immediately under the arc lamp. The very worst thing, too, was to place an arc lamp in a lantern on the top of an opaque pole, thus casting deep shadow at its base. With the proper use of the dioptric shade diffuser many objections against the use of arc lighting for interiors would be removed.

*Mr. R. E. B. CROMPTON: Gen. Webber had asked, in a footnote, the cost of laying bare copper strip in culverts on his (Mr. Crompton's) system compared with that of the high-pressure concentric main, running to the transformer sub-station, for which Gen. Webber gave the total cost of laying 1,200 yards, at £5,146, the annual upkeep being £367, whilst for low-pressure Gen. Webber had estimated a low-pressure feeder at more than £15,000. He had only received a copy of the Paper that morning, and had had no time to study it. but during the discussion he had worked out the cost of a low-pressure feeder to be about £4,400, and he would be perfectly prepared to carry out the work 100 times over at this price. Now, when they came to the maintenance, Gen. Webber gave for his high-pressure arrangement interest and principal at 4 per cent. ; £161 per annum depreciation and repairs ; 2½ per cent., £136 ; £70 for attendance ; and small stores, making a total of £367. Now he had had some experience in the upkeep of mains, and it was no longer a matter of guesswork or of estimated percentages to him, and he would assert that the total annual cost on his (Mr. Crompton's) system, would not be more than £150, as against £367. Either he was right or he was wrong, and in these figures lay the whole pith of the controversy between high and low-pressure mains. Only time and the accounts of the Companies would show who was right and who wrong. The Paper had not been sent out in time for him to take more than a superficial view of it, but so far as he could see the way in which the capital was raised was the most difficult part of the undertakings.

*Major-Gen. WEBBER, in reply, said that with regard to telephone or spare tubes, the figures given were extracted from the prospectus and published reports of the Company. As regards Mr. Kapp's remarks about the very slight screening effect of steel sheathing, he could only say that it was thought desirable that every precaution should be adopted. The reason that sound was heard in the test referred to was due to the fact that the telephone wires were parallel, not spirally twisted. There was no means of telling whether the sheathing was any good until it was down, and possibly money *had* been thrown away. Mr. Esson only made reference to the very points which he (Gen. Webber) had carefully guarded himself from going into. The information required could only come from those who had since had the experience. With regard to Mr. Siemens and the 5lb. and 7lb. coal consumption, these figures had not been adopted without due care and consideration. The 7lb. was an accepted figure for the Brush and Thomson-Houston arc lighters, and the contractors would not have been prepared to accept any other. As to the 5lb., he thought the figure a very safe one. As to the controversy between lead-covered cables and conduits, it was like the battle between the broad and narrow gauges. The essential object of conduits was to provide a means of drawing in wires for future requirements ; they did not wish to repeat the experience of the gas companies who first laid down small pipes, and then had to lay larger and larger ones. He did not pretend to quote Prof. S. P. Thompson literally, but merely wished to draw attention to such opinions of Prof. Thompson as justified the steps taken by him (Major-Gen. Webber). They were very much indebted to Mr. Crompton for the figures which had been drawn from him, and whether the £4,400 was sufficient to construct a conduit only occupying the same sectional area as that given by him as costing £15,000 was a question which practice alone could prove. The only note of discord was with regard to the steps taken by the financial world, and the remarks were all the more ungracious considering the quarter from which they had emanated. He had given the fullest credit to the Brush Company, and it was remarkable that the attack was made by their chairman.

PHYSICAL SOCIETY.

At a meeting of this Society on February 23, 1894, Prof. A. W. Rücker, M.A., F.R.S., President, in the chair, Mr. J. W. Kearton was elected a member of the Society.

A "Note on a New Electrical Theorem"

was read by Mr. T. H. BLAKESLEY, M.A., M.Inst.C.E. Two or more dispositions of electromotive forces in any network of conductors which produce at every part of the network the same currents are defined as *equivalent systems*. The following theorem is then stated and proved:—In any system of conductors possessing seats of electromotive force at any number of points, if any of these sources be moved along the various bars of the conducting system, and where a point of junction is encountered, each becoming a seat of the *same* electromotive force in *each* of the newly encountered bars, then the disposition at any moment is equivalent to that at any other moment, and, therefore, to the original disposition. Equivalent systems might also be defined as being such as produce equal expenditure of power in each part. From the above theorem the following propositions are deduced by the author:—1st. That if any closed surface contains a portion of a network then an electromotive force in any bar cutting the surface can be replaced by equal electromotive forces (in opposite directions as regards the surface) in all the other bars cutting the surface, without disturbing the current in any part of the network. 2nd. If two systems of electromotive forces be equivalent, one may be derived from the other.

Prof. C. V. BOYS, F.R.S., read a note

"On the Attachment of Quartz Fibres."

When torsion fibres are required to carry large weights approaching the breaking weight the ordinary method of attachment by shellac is not always satisfactory, for if the part of the fibre in the cement is twisted or bent the yielding of the sheliac causes uncertainty of zero. To avoid these troubles Prof. Boys has devised and perfected a method of soldering the fibres, full details of which are given in the Paper. After selecting a fibre of the right diameter and length, small weights are fixed on the ends by shellac. The end parts are then cleaned by dipping in strong nitric acid, washed, silvered, and electro-coppered. The weights are then cut off, and the coppered ends soldered to tags of tinned metal foil, chloride of zinc being used as a flux, and its capillarity serving to hold the ends to the tags whilst the latter are heated. The superfluous copper and silver are dissolved off by nitric acid, the tags and solder being protected by beeswax. After washing in boiling water the fibre is ready for use. Melted shellac is used for securing the tags to the torsion rod and suspended body. Several ingenious details of procedure to avoid capillary difficulties in the cleaning, plating, and washing processes are described in the Paper. If fibres are required to conduct electricity, they are silvered and washed after the tags have been soldered on. Such fibres the author considers essential for making connection with electrometer needles of the greatest delicacy, for liquid connections are fatal to stability. Methods of rendering fibres visible by smoking with arsenic or magnesium are mentioned in the Paper. At the meeting a perfectly circular hole $\frac{1}{5000}$ of an inch in diameter, made by soldering round a quartz fibre passing through a hole in a metal plate, and then drawing out the fibre, was exhibited under a microscope.

Mr. INWARDS asked if the shellac used to secure the tags was melted or dissolved.

Mr. BLAKESLEY inquired if silvering fibres did not destroy their perfect elasticity?

Dr. SUMPNER wished to know if any data as to the relative torsional rigidity of silvered and unsilvered fibres had been obtained, and if the electric resistance of silvered fibres had been determined?

Mr. WATSON said silvered fibres had been successfully used in electrometers. As regards their torsion, he had found it differ from day to day, and the resistance varied enormously.

In reply to a question, Prof. BOYS described the exact process of soldering the coppered fibre to the tags. As to the torsion of silvered fibres, he would not expect much increase as the film was very thin. He also thought the elasticity would not be destroyed, for silver and gold make very good torsion wires.

Mr. LITTLEWOOD read a note

"On a Method of Determining Refractive Indices."

This method was commended by the President, as being novel and very interesting, particularly well adapted for either homogeneous or heterogeneous liquids.

APPARATUS FOR THE STUDY OF HERTZIAN OSCILLATIONS.

Signor Augusto Righi, in the January number of the *Nuovo Cimento*, describes a modification of oscillation apparatus for lecture experiments for which he claims decided advantages over the earlier forms, and gives a preliminary report of some extraordinarily short waves which he has been able to investigate. In his apparatus an influence machine is substituted for the induction coil to excite the oscillator, the sparks in the latter cross between the terminals in an insulating liquid, and a Geissler tube is attached to the resonator. The terminals of a Holtz machine are connected with two brass rods, ending in knobs 30cm. in diameter. Between these knobs is introduced the oscillator. This consists of two brass rods ending in knobs on both sides. Two of these knobs approach each other to within 3 or 4mm., and are immersed in liquid vaseline. The other knobs are opposite those of the influence machine. The whole oscillator is about 72cm. long. Two copper discs 25·5cm. in diameter slide along the oscillator rods, and are usually placed 43cm. apart. The resonator consists of a circle of copper wire, 57cm. in diameter, part of which is formed by a

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Geissler tube, 15cm. long. The wave length corresponding to this resonator is about 4·1m. With a Holtz machine, giving sparks 30. cm long, the tube glowed at a distance of 6m. from the oscillator sufficient to enable a large audience to perceive it distinctly, whereas the glow produced by an induction coil of 25cm. spark-length was extinguished at the distance of 1m.

Some good experiments could also be shown with a circular glass tube exhausted to 0.0086mm. A vertical sheet of zinc, 4 sq. m. in surface, was placed at a distance of 5m. from the oscillator, and the nodes and ventral segments between them manifested by the glowing of the rarefied gas. The glow was even more brilliant when the tube was employed to show the waves propagated along a wire.

Besides this lecture apparatus, Sgr. Righi has been able in the laboratory to investigate the shortest wave-lengths hitherto attained. In this case the oscillator was reduced to two brass spheres, and the resonator was made according to Hertz's original pattern. The shortest waves thus attained were 7cm. long. With these waves the experiments of Hertz and his successors were repeated, using reflectors, lenses, prisms and other apparatus of dimensions hardly exceeding those of the corresponding optical instruments. Besides the reflection by metals and refraction by prisms and cylindrical lenses, successful experiments were made upon the principal phenomena of diffraction, the interference of direct and reflected waves (like optical interference with a single mirror), and total reflection by a rectangular prism. The absorption of electric energy by metallic films and liquids was also studied. The greatest distance between oscillator and resonator was in many cases very considerable. It amounted to 1m. without, and 6m. with parabolic reflectors. With waves 20cm. long and two such reflectors, the greatest distance at which the sparks could be clearly observed was 25m.

THE ELECTRICAL EQUIPMENT OF THE LIVERPOOL OVERHEAD RAILWAY.*

BY T. PARKER, M.INST.C.E.

The plant was required to run a three-minute service on six miles of double track. In designing it, curves were drawn of the energy required at any point along the line of one loaded train with various accelerations, &c., to meet the time table service. From these curves the power required at the generating-station was calculated, and four dynamos were arranged for, yielding 475 amperes at 500 volts and 420 revolutions, or 1,200 e.h.p. in all. The dynamos were of the double-line type, rope-driven, with pulley between two bearings, so that the armature could be taken out without disturbing the ropes. The electrical efficiency of the dynamos was 97·77.

The switch-board, specially designed for safety and simplicity in working, was fully described. The main current passed to the line through a main magnetic cut-out, to break circuit at 3,000 to 4,000 amperes. The conductor was of steel, 4 sq. in. in section, supported on porcelain insulators. There were no feeders, and the return circuit was through the rails, which were bonded. At each station there was a cross-over road. The conductor was broken at these points, and the collector bridged across over the main rails without breaking circuit. It was necessary that the cars should be of the double-bogie type; it was, therefore, difficult to design motors to give the power necessary on standard bogie frames. Finally a type was adopted, as patented by Mr. Eickemeyer, which gave complete satisfaction. The motor occupied the front half of the bogie-truck. The weight of the magnets was taken off the axles by adjustable springs, and the magnets were kept in horizontal position by a lever arm fixed to the bogie-frame. Each car was complete with motor and switch-gear to run independently. Two cars were coupled together to form a train. Either the driving or trailing motor could be plugged out of circuit at will. A Westinghouse air-brake was attached to the car, also the usual hand-brake. The stations were lighted by 50-volt glow-lamps, run off accumulators fixed at the station, and charged from the main dynamos.

The efficiency of i.h.p. to e.h.p. on the line was taken with carefully calibrated instruments in the presence of the engineers. The tests extended over 3½ hours. The mean value of seven tests of No. 1 engine gave 88 per cent. i.h.p. to e.h.p. Curves were given of the power consumed during an experimental run of one train completing 5¼ miles in 24 minutes, 57 seconds, and 23 minutes, 47 seconds, with stops of 25 seconds at each station. The power required was 44·4 i.h.p. and 46 e.h.p. respectively. To compare this with actual running, curves were given from daily log sheets showing the effects on the generating station of the alteration to the train service. The advantage of a large number of trains in pulling down the maximum current per train was apparent. With seven trains this was twice, and with twelve trains only 1½ times the average current per train. With twelve trains running, the average demand for power continuously was 37 e.h.p. per train.

A comparison of coal used when the train service varied was given. During April and part of May seven trains were running at one time, and the coal used was 22·5lb. per train mile. From June to October there had been a 5-minute service from 9 a.m. to 5:30 p.m. The coal used per train mile for the four months of June, July, August and September, was 17·8lb., or making allowance for charging batteries, say 17lb. per train mile. The price of the Lancashire slack, which was used till the latter part of August, was 5s. 10d. per ton, but since that date, owing to the strike, the price for coal from various sources had varied up to 17s. 6d. per ton. Under the agreement the contractors had to run the service of trains for 3½d. per train mile, on a full service of 2,400 miles per day, but as only 5¼ miles of line were open they received 4d. per train mile, and for current to charge lighting batteries 7d. per Board of Trade unit. Figures were given of the actual working costs for July, August, and September, 1893, which were 3·44, 3·70, and 4·07 pence per mile respectively. The increased cost of running for August and September was fully accounted for in the item of coal, and as the railway company had not employed as frequent a service as at first anticipated (this being only 1,350 miles per day) the figures showed most favourably, it being evident that, with coal at an average value, the line could be run at a cost well within that guaranteed by the contractors.

* Abstract of a Paper read before the Institution of Civil Engineers, Tuesday, February 27th.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, March 2nd.

INSTITUTION OF CIVIL ENGINEERS.

7:30 p.m. Students' Meeting at 25, Gt. George-street. The following Paper will be read: "Efficiency and Economy of Elevators," by Herbert W. Umney Stud.Inst.C.E.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting at 28, Victoria-street. The following Paper will be read: "Lightning," by E. H. Bowyer.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Theory of the Cochlea and Inner Ear," by Prof. John G. McKendrick, M.D.

SATURDAY, March 3rd.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture on "Light," with special reference to the Optical Discoveries of Newton, by the Rt. Hon. Lord Rayleigh, F.R.S.

MONDAY, March 5th.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

TUESDAY, March 6th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Monthly Ballot for Members. The following Papers will be further discussed: (1) "The Liverpool Overhead Railway," by J. H. Greathead and Francis Fox, M.M.Inst.C.E.; (2) "The Electrical Equipment of the Liverpool Overhead Railway," by Thomas Parker, M.Inst.C.E.

WEDNESDAY, March 7th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read: "Refrigerating Apparatus," by Prof. Carl Linde, of Munich.

THURSDAY, March 8th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper will be read: "A Note on Parallel Working through Long Lines," by W. M. Mordey, Member.

FRIDAY, March 9th.

PHYSICAL SOCIETY.

8 p.m. The following Paper will be read: "Calculating Machines and especially a new Harmonic Analyser," by Prof. O. Henrici, F.R.S,

JUNIOR ENGINEERING SOCIETY.

8 p.m. Ordinary Meeting at the Westminster Palace Hotel, Victoria-street. The following Paper will be read: "The Design, Construction, and Working of Boilers for Locomotive Engines," by Mr. G. Frank Burtt.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "The Making of a Modern Fleet," by William H. White, C.B., F.R.S.

SATURDAY, March 10th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture on "Light," with special reference to the Optical Discoveries of Newton, by the Rt. Hon. Lord Rayleigh, F.R.S.

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THE BOARD OF TRADE AND THE ELECTRIC TRACTION REGULATIONS.

The result of the important conference over which Sir COURTENAY BOYLE presided last week will be announced in the course of the present month by the issue of regulations for the use of electricity by tramway and railway companies. From the contentious atmosphere of Mr. Justice KEKEWICH'S Court, from the ill-feeling encouraged by direct conflict of commercial interests, and provoked by acrid cross-examination, the change of venue to the august but less formal Committee of Lords and Commons was some relief; but even here the battle of telephones *versus* traction was carried on, chiefly by the harangues of Parliamentary barristers, who could always say or suggest unpleasant things, "by instruction." But when the scene changed, for the third time, to the quiet gathering round a table at Richmond-terrace, all ill-feeling seemed to have disappeared. Angry threats, the quibbling of experts, and tall talk about disagreeing with the whole of the draft regulations *en bloc*, were impossible at such a meeting, and with such a Chairman.

The drafting of these regulations is a rather remarkable piece of work. The Joint Committee recommended that such regulations should be made, and their Report was ordered to be printed on July 13, 1893. Four months later, the draft regulations were issued; three months have been allowed for their consideration by the various parties interested, and

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within a few weeks of the recent conference, the final regulations will be scheduled to the various Bills passed last session. The regulations cover quite new ground; they are not modelled on existing railway work, nor on electric light supply. It may be confidently said that they give general satisfaction to all those who have carefully studied them. Not less remarkable than the regulations themselves, is the procedure of the important Government Department which was charged with the work. There is certainly no other Government Department in this country, and probably in no other land, which would issue tentatively in draft form, a set of altogether new regulations—to all intents and purposes, laws—and invite, listen to, and amicably discuss them with the public. No formal deputation, no frigid official speech, not a sign even of red tape in any form, no parties hurt because not invited, none injured because unheard. The Board of Trade is a department of which Englishmen may be justly proud, and few there are who have a clear idea of its manifold duties. The Electrical Department, in some respects an offshoot of the Railway Department, is perhaps most remarkable for the disproportion between the public importance of its work and the ridiculously small staff for executing it. For the drafting of these regulations we estimate that rather more than three-quarters of one officer was available. We reckon one-seventh of Sir COURTENAY BOYLE's time, one-sixth of that of Mr. HOPWOOD, one-fifth of Sir THOMAS BLOMEFIELD, who was for a few years engaged almost exclusively with electric lighting, but who is now, according to "Whitaker's Almanac," one of the "principals," and, we understand, chiefly concerned with the Railway Department. Major CARDEW, the "electric adviser," is, of course, busily engaged in scientific work in the Standardising Laboratory and elsewhere, and we have estimated one-third of his time for the work we are discussing. The whole adds up to a very vulgar fraction, but not a vestige of inefficiency is discernible in the work. It was promised, if we remember rightly, by the then Government, in connection with the Electric Lighting Act of 1882, that the care of electric lighting by the Board of Trade should cost the Treasury nothing—it would be self-supporting. How has this promise been kept? A fee of £50 has to be paid upon each Provisional Order; 280 Orders have been granted, and £14,000 have accordingly been paid to the Board of Trade. But one of the remarkable customs of our Government department is, that all such fees go straight to the Treasury; they merely pass through the books of the Department that really earns it. One source of revenue after another is created and developed, the money is not earmarked, it all goes into the general revenue of the country, and as soon as it has grown into a sum worth grumbling about, it has become a sum which the Chancellor of the Exchequer finds to be worth sticking to. Nothing is capitalised, even on paper; there is no reason for this, only a custom. The Patent Office, another department of the Board of Trade, has for many years earned large sums, and only quite recently has it been permitted to spend anything on much-needed buildings for new offices and library. The Electrical Department needs developing. Busy as are its officers, every one who has to go to or to correspond with any of them is ready to acknowledge the courtesy, care, and thoroughness which distinguishes this from many other Government Departments. Up to the present the Board of Trade has managed to keep pace in the matter of electric lighting with the work devolving upon it. It is true that at first there was great delay in auditing the accounts of the electric supply companies, but now they are audited before they are published. Although the number of new Orders in each year has diminished rapidly since 1890, the work of the Electrical Department must increase as steadily as electrical supply is increasing, and the recommendations of the Joint Committee on "Electric Powers Protective Clauses" opens an entirely new branch, not contemplated under the Electric Lighting Acts. As traction some of this work will no doubt fall to the Railway Department, but the majority of it is purely electrical, and all of it is additional and new.

When it was decided that a Parliamentary Committee was to discuss the question of the regulation of electric traction, those interested in heavy electrical engineering were filled with a mixture of anxiety and joy. When the Committee formulated its recommendation they were still filled with the same things, but in different proportions: more joy and less anxiety. Joy because they had good hope of electric traction being made commercially possible; anxiety because regulations were to be drawn up, and they did not quite know what those regulations might demand. The most curious part of the affair is that it was originally war to the knife between the telephone and traction interest; but the gas and water companies gave watching briefs to counsel, who watched, and were astounded to find that not only were the telephone people sending messages along their pipes without even asking permission, but the traction companies were slowly but surely converting their tubes into hydrated ferric oxide. As the telephone interest did not want clauses preventing the gas and water companies from sending fluids through the pipes in case they might interfere with their use as telephone conductors, the telephone and ponderable fluid companies were not inimical; but traction found it had stirred up a hornets' nest. The telephone subsided into the background, and the question of real importance was how to protect pipes. This was, of course, a matter of grave importance. The Committee, with the caution begotten of wisdom, left the matter to the Board of Trade, knowing that if care and hard work could frame suitable regulations, the experts advising the Board would succeed in doing so. Indeed if one thing be more remarkable than another in connection with the recent industrial development of electricity it is perhaps the perfect unanimity with which Lords and Commons, traction men and telephone men, the public and the expert are ready to leave the solution of all and every knotty problem to the Board of Trade. On the Board of Trade! let us leave the interpretation of our laws, the making of our rules, our lighting, traction power, our lives, our sins lay on the Board of Trade.

At one time the question was, Which side will win? But no such issue appeared to be in view at the conference. The struggle was really at an end when the Report of the Joint Committee was issued. The traction members appeared to concern themselves about details, while the National Telephone Company strove rather for principles. The object of the conference was to settle details, for the Joint Committee had decided principles, and anything more that could be said about them was to interpret or to apply them. One danger threatened the traction interests. The draft regulations had been carefully considered by a committee of the whole council of the Institution of Electrical Engineers, by a special committee of the Electrical Trade Section of the London Chamber of Commerce, by certain experts in connection with Imperial Tramways Company, and by Dr. FLEMING on behalf of the Association of Municipal Corporations. More than once the views of these parties differed, more than once an amendment proposed by one was unhesitatingly opposed by the representatives of another, nor on purely technical matters did they always agree. But their common opponents took no advantage of this weakness, they were merely amused. One result

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of this lack of unanimity on the part of the traction members was to disincline the representatives of gas, water, and railway interests to place much reliance on the technical opinions expressed by the electrical engineers and electricians. On Regulation No. 5, the gas companies were greatly alarmed at the idea of deliberate connections between the negative conductor of a tramway and their pipes "which contain an explosive mixture," and implored that no connection of any sort might be made. Assertions that this was the safeguard against corrosion were unheeded until Sir Courtenay Boyle himself assured them that this was their only protection.

THE MAGNETIC TESTING OF IRON.

It is some years since the Institution of Electrical Engineers has devoted a sitting to the discussion of a purely magnetic subject, and Mr. Kapp is to be congratulated on having endeavoured, by means of a somewhat too brief a Paper, to elicit from several firms of dynamo and transformer makers their respective methods of determining permeability of, and hysteresis loss in, the various qualities of iron used in their machinery. It must be frankly confessed that one of the most unsatisfactory features in connection with modern dynamo design is the lack of any simple and rapid workshop method of determining hysteresis loss and permeability, and we hardly think that Mr. Kapp has satisfactorily solved the problem. The objections to his method, in common with many others, may be summed up in one word—joints. In every method with which we are acquainted of determining permeability by means of a sample forming a joint with a soft iron return, the resistance of the joint is indeterminate and is a cause of magnetic leakage between the sample bar and the return; that is to say, the length of the sample bar under test is not a constant quantity, and varies with its permeability and with the resistance of the air gap. This objection, of course, applies equally to the instrument devised by Mr. Kapp for testing transformer iron. But putting aside for the moment the question of method, we are glad to see stress laid upon this last remaining source of uncertainty in dynamo design, and since Mr. Kapp recognises the importance of eliminating it, it is curious to note that his Paper contains no allusion to the question of the armature in dynamo machines; the armature is the soul of the dynamo: one can imagine a dynamo having an armature and no field-magnets, but a dynamo having only fields would not be a dynamo at all. Why, then, this neglect of the armature? The answer is, we are afraid, obvious. Mr. Kapp's methods do not directly admit of the determination of the permeability of the armature on which depends to a large extent the characteristic of the machine, and no method of iron testing can be considered of any great value unless it allows of this determination. The only clue to this, in Mr. Kapp's instrument, is the magnetising current, and the pressure on the terminals of his magnetising coil, and these are only available if the shape of the current and electromotive-force waves is known, for the measuring instruments only record effective and not maximum values. Not only is this difficulty encountered, but the losses in the armature due to hysteresis are often of importance, and the quality of the iron used in the armatures of large machines should always be the subject of investigation. Mr. Kapp gives us no clue as to the method which he would adopt in this case; would he run alternators at a frequency of between ten and twenty periods per second, or does he derive his estimate of hysteresis by elimination of eddy-current losses from observations at varying frequency? Some years ago, in our columns, Mr. Evershed gave a formula for the calculation of eddy-current losses in a lamina of given thickness for given induction, and it is possible that Mr. Kapp uses a similar method of calculation, but we do not know whether anyone has actually tried an experiment to determine whether or no the formula is in accordance with the facts. We believe Mr. Evershed assumes that the lamina is very thin, whereas armature plates are often of a reasonable thickness, since, owing to the low frequency, eddy-current losses are small in comparison with those due to hysteresis. There is thus reason to doubt whether any calculation of eddy-current losses would be satisfactory. But not only is there this source of uncertainty—even supposing that the test were carried out by means of an alternator running at a frequency of about fifteen periods per second, it is by no means certain that the result would be in accordance with that which actually occurs in the dynamo when running. We believe it was Mr. Swinburne who made the remark that if the Ewing theory of magnetism is correct, the hysteresis loss should be less, other things being the same, in a dynamo armature than in an alternator; for the loss by hysteresis must be due to the oscillation of the molecular magnets about their mean position on the sudden breaking up of the molecular chains, and the formation of new ones; and this would not occur in an armature where the molecule are rigidly held and gradually turned round and round. This point can apparently only be settled by direct measurement in an armature, or by subjecting the iron under test to a magnetising force rotating in direction, and not varying in strength.

In fact, the whole question of the workshop testing of iron is in a most unsatisfactory state, and none of the methods employed by the various firms represented on Thursday last appears to be quite perfect. The amount of skill and time required to turn Mr. Kapp's test bars quite counterbalances, if it does not more than counterbalance, the fact that his experimenters need comparatively little skill. The amount of skill required to read any instrument whatever in a proper manner, precludes the use of a totally untrained man for the work; and the increase of skill required to read a ballistic galvanometer deflection is not very great. Too much was, in fact, made of this point. In these days, when the market is flooded with students of technical colleges, all more or less capable of reading a ballistic galvanometer, and whose services may be secured for a most modest honorarium, it is idle to talk of the skill required to take ballistic galvanometer deflections. The inception of the methods, the design of the instruments, these may require skill and experience of an expensive kind; but the use of this machinery is not confined to its designers, and it should be an easy matter to the average "third-year student."

There are one or two methods to which allusion was not made last Thursday, the chief omission being, doubtless, Prof. Ewing's ingenious and beautiful machine, which is, perhaps, too much of a laboratory instrument for workshop tests, and the complete ring methods used by Prof. Ewing, Messrs. Evershed and Vignoles, and others. There is little doubt in our minds that the wattmeter method, simple and direct as it undoubtedly is, must ultimately give way to some method of determination of what one speaker ingeniously termed the "hysteresis lozenge," for the latter gives the experimenter complete information, whereas the former only gives him the hysteresis loss, mixed up with that due to eddy currents, leaving the permeability curve unknown, and even the permeability at the particular induction a matter of some uncertainty; and it is curious to note in this connection with what singular unanimity the opponents of the alternate-current

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wattmeter have hauled down their flag. Not so many years ago Mr. Swinburne's was as the voice of one crying in the wilderness, Why not use wattmeters to measure alternate-current power? and the idea was scouted; but now no one thinks of measuring it in any other way. *Tempora mutantur, et nos mutamur in illis.*

ELECTRIC TRACTION REGULATIONS.—CONFERENCE AT THE BOARD OF TRADE.

On Wednesday 21st ult., a conference was opened at the Board of Trade offices, 8, Richmond-terrace, between the Board of Trade and representatives of the interests concerned, to discuss the electric regulations, (see *The Electrician* November 24th, 1893, p. 46), which have been drafted by the Board of Trade. Sir Courtenay Boyle presided, and was accompanied by Mr. F. J. S. Hopwood, Major Cardew, and Sir T. W. P. Blomefield, Bart. Among those present were Mr. A. Siemens, Mr. R. E. Crompton, Major-Gen. C. E. Webber, C.B., and Mr. W. M. Mordey, for the Institution of Electrical Engineers; Mr. Gaine, Mr. Sinclair, and Mr. Winterbotham, for the National Telephone Company; Mr. J. Clifton Robinson, for the Imperial Tramways Company; Mr. W. J. Carruthers Wain, Mr. A. Wilmslow, Mr. A. P. Smith, Mr. J. Waugh, Mr. J. Hesketh, Mr. T. Hewson, and Mr. J. G. B. Elliot, for the Tramways Institute; Mr. J. Kincaid, Mr. Manville, and Mr. A. Dickenson, for the Bristol, Birmingham, Central and South Staffordshire Tramways; Mr. R. P. Sellon, Mr. E. Garcke, Mr. J. W. Winslow, Mr. S. Sellon, and Mr. H. F. Kite, for the Traction Committee of the London Chamber of Commerce; and representatives of the Gas Light and Coke Company, the Associated Metropolitan Water Companies, the Association of Railway Companies, and the Association of Municipal Corporations.

Sir COURTENAY BOYLE, in opening the proceedings, said they had met to discuss the regulations of the Board of Trade under clauses which were in certain Bills, and which probably would be inserted in all Bills as model clauses, in consequence of the recommendation of the Joint Committee of last year. The regulations would therefore have general application, and they were discussing practically what he supposed would be instances of traction by continuous current. There were matters of great controversy involved, and most important interests were affected, and it was the sole object of the Board of Trade to arrive at the fairest possible solution of these serious difficulties that could be reached. The first amendment (see *The Electrician* February 23rd, p. 458), was an addition to the definitions proposed by the Institution of Electrical Engineers, which read:—"The expression 'line' or 'lines' means an insulated conductor or conductors used for transmitting energy from the generator or generators to the trolley wire or other conductor from which the current is taken to the motor or motors by a rubbing contact. The expression 'return' or 'returns' means the conductor or conductors uninsulated or otherwise, used for completing the circuit or circuits between the motor or motors and the generator or generators."

Major CARDEW said there had been a misconception with regard to the meaning of "insulated throughout its length." It appeared that a great many gentlemen thought this must mean insulated with india-rubber or some material covering, and that a wire suspended in air on insulators did not come within the meaning of the expression. Undoubtedly the Board of Trade considered that it did, but he thought it might be made more clear in the regulation.

Sir COURTENAY BOYLE said he would consider the proposal as a drafting amendment. The next point was that raised by the London Chamber of Commerce, who understood that the definition of current was not intended to apply to telegraphic, telephonic, and railway signalling currents. The answer to that was that the word "current" all through the regulations applied to traction current only. The Chamber of Commerce also proposed that, in the first regulation, the word "steady" in the expression "a steady continuous current" produced by a dynamo used as a generator should be defined in the definitions. Major Cardew suggested that instead of the word "steady" should be substituted "without appreciable pulsation."

Mr. SIEMENS did not see any objection to the word, because everybody knew that there were fluctuations, and that it was simply "steady" to distinguish it from the alternating current.

Major CARDEW said the intention was to go rather beyond that, and to distinguish it from such a current as that of the Brush arc lighting machine, a so-called continuous current which had very perceptible pulsation, and would very greatly affect telephones.

Mr. WINTERBOTHAM and Mr. SIEMENS thought Major Cardew's suggestion was a good one.

Sir COURTENAY BOYLE said they would put in "without appreciable pulsation" either in the regulation itself or by way of definition.

Mr. S. SELLON said they suggested that in the second regulation regarding the insulation of conductors transmitting energy from the generator to the motors the words "insulated from earth" should be substituted for "insulated." They must have bare wire in the case of an overhead conductor.

Sir COURTENAY BOYLE said they would draft some words to clear that difficulty.

Mr. MONIER WILLIAMS, on behalf of the Gaslight and Coke Company, said the returns should be entirely insulated in the metropolis "excepting places where the Board of Trade should, after a full investigation of the special circumstances, see fit to sanction the use of such returns."

Sir COURTENAY BOYLE said he would take that objection at the end. The next objection was from the Imperial Tramways Company (Limited) as to the meaning of the expression "insulated throughout its length."

Mr. CLIFTON ROBINSON said that Major Cardew's suggestion would meet their difficulty.

On the third Regulation, that where any rails on which cars run, or any conductors laid between such rails, form any part of a return, such part may be uninsulated, while all other returns or parts of a return shall be insulated, the Institution of Electrical Engineers suggested the wording, "between or contiguous to such rails."

Sir COURTENAY BOYLE asked if they would mind "within three feet of."

Mr. SIEMENS said that would do very well.

Mr. WINTERBOTHAM asked why it should not be 18 inches.

Sir COURTENAY BOYLE said he thought they would insert "or within 3ft. of" the rails. The Institution of Electrical Engineers also proposed the insertion of the words, "but the supports of all overhead wires, whether line or return, should be electrically connected to the return circuit."

Mr. SIEMENS said the object was to get all leakage currents into the metallic return with the greatest possible certainty. If the overhead line, which ought to be insulated, leaked, it would go into the metallic supports, and from the supports it would go into the metallic return.

Major CARDEW thought it was a good suggestion, but hardly the right wording. He thought they could deal with it by a fresh regulation.

Sir COURTENAY BOYLE: We will insert it as a new regulation.

Mr. S. SELLON, on behalf of the Chamber of Commerce, and Mr. CARRUTHERS WAIN, on behalf of the Tramways, objected.

Mr. DICKINSON, on behalf of the Traction interest, objected to it because it would be an unnecessary cost, and would not do what it claimed to do. It would cause a breaking up of the streets in every 50 yards, and would not do any good at all.

Mr. LANGDON said the resistance between the rails and the support of the trolley wire would be very light and slight indeed, and indeed there might be no resistance at all, it might be totally unappreciable, much less than that which the earth return would give.

Mr. DICKINSON pointed out that each support for the trolley wire was in itself an earth plate; and if there was leakage from the trolley wire it went back through the earth. All of these supports were huge earth plates. At the bottom—in South Staffordshire construction at least—they had a plate some two or three feet square.

Mr. S. SELLON said their poles were exceedingly well insulated, and if they were properly laid in concrete they were absolutely insulated in earth, and the failure of one single insulator on the whole line would absolutely destroy the whole resistance.

Sir COURTENAY BOYLE: I will consider the proposal and the objections. I think it better to be perfectly frank, and to say, Mr. Sellon, that I am rather against you at this moment on this point; but I will further consider it.

The Institution of Electrical Engineers next suggested the qualification of the word "insulated" by "unless of such sectional area as shall satisfy the Board of Trade."

Mr. SIEMENS said that was to carry out one of the regulations of the Joint Committee, who said that the best protection for all pipes against electrolytic action was to have the return conductor of a metallic section, which reduced the resistance, and so made the current principally or almost entirely go back through the metal. Under such circumstances the Committee said it should not be imposed upon the traction companies to have insulated returns.

Major CARDEW said there was certainly some reason in allowing the rails to be used as a return for facility of traction work, but he thought that that did not apply to other conductors where no extra facility was given by having them uninsulated, and where there was only possibly a small saving of expense.

Sir COURTENAY BOYLE said it was not a very convenient way of legislating to say that the Board of Trade had got to approve of the sectional area in particular cases; it had always led to disturbance.

Mr. SIEMENS said the real protection against electrolytic action was the low resistance of the return.

Mr. CROMPTON thought Major Cardew was somewhat in error when he thought that it would add very slightly to the expense of insulating the feeder part of the return. The cost of insulating multiplied the cost of the copper by at least four times, and if that was so they could afford to give four times the sectional area of copper, and so reduce the difference of potential on that portion of the return to one fourth. The point was one of extreme importance. He thought himself that a partially uninsulated return might be found impracticable, that it would localise corrosion on the point where the insulated portion joined the uninsulated portion, and greatly increase the cost of repairs to the tramways company. Further than that, it would defeat the object that the Board of Trade had in view, which was the preventing of stray currents through the earth.

Sir COURTENAY BOYLE said they would further discuss the position of non-insulation on Regulation No. 6, by treating it as a question of potential. On Regulation No. 4, which provides that when any uninsulated conductor laid between the rails forms any part of a return it shall be electrically connected to the rails at distances apart not exceeding 100ft., by means of copper strips having a sectional area of at least one-sixteenth of a square inch, or by other means of equal conductivity.

Mr. WINTERBOTHAM, for the Telephone Company, said they suggested that the same rule should apply to uninsulated returns as was embodied in Regulation 13, which provided that where there was an insulated return, whether it was overhead or underground, it should be

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within a limited distance of the outgoing conductor—3ft. when they were overhead, and 18in. when they were underground. They suggested that where the outgoing conductor was overhead the copper wire which now supplements the rails should be carried overhead too, and that it should be connected with the rails at the posts when it was underground. They believed that would practically remove the main objection to the disturbance of telegraph and telephone lines. They proposed to strike out the word "insulated" in Regulation 13.

Sir COURTENAY BOYLE said he would not decide the point on that day.

Mr. HOLROYD SMITH suggested that instead of laying the insulated feeder or supply cables underground, or supporting them on the poles, if they laid those insulated cables between the rails parallel with the uninsulated return copper that supplemented the return of the rails, and coupled that up from the insulated cable between the rails to the trolley wire above, it would accomplish electrically precisely what the Telephone Company wanted.

On Regulation No. 5, dealing with earth connections in the case of returns uninsulated in any part,

Mr. SIEMENS said they proposed that the paragraph providing for a non-conducting screen in some cases should be struck out.

Mr. MONIER WILLIAMS, on behalf of the Gas Company, suggested that no connection should be made with any water pipe if there was a gas pipe anywhere near it without the consent of the Gas Company to whom the pipe belonged.

Sir FREDERICK BRAMWELL suggested that the connection to a water main should only be made with the consent of "the undertakers supplying the water thereof."

Major CARDEW suggested after the first proviso to put in "and provided that where, from the nature of the soil or for other reasons, the Company can show to the satisfaction of an inspecting officer of the Board of Trade that the earth connections herein specified cannot be constructed and maintained without undue expense, the provisions of this regulation shall not apply."

Mr. S. SELLON believed that at Leeds, where a line had been running for two years connecting the negative terminal to the pipes, there was no question of electrolysis to be found anywhere.

Mr. SIEMENS said it was brought out before the Committee very clearly that if the water main was made the negative pole it could not possibly be electrolysed, and also if the return was made a metallic return of ample section the pipes were protected.

Mr. MONIER WILLIAMS said the penalty was not sufficient to protect the gas companies. They ought to be protected from injury to life and property.

Sir COURTENAY BOYLE said he could not legislate in a regulation.

Mr. HOLROYD SMITH suggested that it would serve the purpose of the objectors better if they asked for a regulation that where their pipes came within a given distance, say 6ft., of the return of the tramway line, they should compel the Tramway Company to connect all their pipes, which would save all danger from electrolysis whatever.

Mr. CROMPTON thought it was held by every engineer that the only protection was to connect the negative pole with the dynamo.

Sir COURTENAY BOYLE said in place of the paragraph as to the provision of the non-conducting screen, Major Cardew proposed to substitute "No portion of either earth connection shall be placed within 6ft. of any pipe except a main for water supply of not less than 3in. internal diameter, which is metallically connected to the earth connection with the consent of the owner of the main." The paragraph in regard to a connection with a water main stands with the alteration suggested by Sir Frederick Bramwell, and that reservation of the alteration suggested by the Gas Company, upon which he would take further advice.

Sir COURTENAY BOYLE: The next point is raised by the Associated Railway Companies, who say that a uniform system of joining up the generators be observed, whether the return wire be insulated or not, the object of this being to enable the block instruments to be joined up in such a manner that the traction current shall produce the "Train on line" signal, and not the "Line clear" signal.

Major CARDEW said that wherever there was an uninsulated return it was already provided by regulations that it was to be connected to the negative.

On a point raised by Sir HENRY OAKLEY as to the possible damage resulting from the reversal of an electric current on a block signal of a railway, and the danger thereby ensuing,

Major-General WEBBER thought it would be a great pity if it left that room that the electrical doctors were unable to prevent the danger that Sir Henry Oakley apprehended absolutely and entirely. The protection of the block signals of the railway companies entirely lay in the hands of the railway companies.

On Regulation No. 6, dealing with the provisions imposed upon a company in the construction and maintenance of a tramway when the return is partly or entirely uninsulated, the question raised in Regulation No. 3 was settled by substituting for the words, "satisfy the Board of Trade," the words "reduce the difference of potential as described in 6 (c)."

Mr. SIEMENS said they proposed in the paragraph (i.) "That the current passing from the earth connections to the generator shall not at any time exceed 10 amperes," to substitute for "10 amperes" "2 amperes per mile of single track without the consent of the Board of Trade." If the distance between two points, which were connected by tramways, was five miles, and it was a double track, then they should be allowed ten times 2 amperes —20 amperes leakage.

Mr. S. SELLON: As far as we are concerned we suggest not limiting it, but giving a percentage of the output—5 per cent.

Sir COURTENAY BOYLE: Surely it is better to have the relation to the length of the line.

Mr. SIEMENS suggested that perhaps it was a better way to make it as a percentage of the output because that took into calculation also the frequency of the service—not only the mileage, but the frequency. He would beg, therefore, to withdraw this amendment in favour of that proposed by the London Chamber of Commerce—"It is suggested that the current permissible should be 3 per cent. of the total output of the station."

Mr. WINTERBOTHAM objected to the withdrawal of the amendment.

Mr. MANVILLE said the fact that affected them most was the length of bare return conductor that went to earth. As to the leakage varying with the number of cars that had to be run on it, the leakage was not likely to be greater with a greater number of cars than with a small number, but the length of the return conductor that is exposed to the earth was that which affected them distinctly. He thought a given leakage per mile of single track was distinctly the one that would serve the electric traction interest best of all.

Mr. DICKENSON entirely disagreed with the conclusion arrived at.

Dr. FLEMING asked that this should not be defined simply as an absolute current, but that it should be a time average. The real thing that this regulation was intended to protect was the total leakage from the line as affecting any damage to pipes, and that total leakage did not depend upon the strength of the return at any one instant, it depended upon the total quantity that was passed. Therefore, he had asked for a modification of five amperes per mile of tramway, and that it should be, not the actual strength of current at any one time, but the average as measured by an ampere-hour meter—that the total leakage should have some relation in the first place to the length of the line, and that with every mile of length of line those five amperes should be added as measured by the ampere-hour meter.

Sir COURTENAY BOYLE asked which was the best gauge—length of the line or amount of the output.

Mr. HOLROYD SMITH said length of line was the best because they had the line, and it had an uninsulated wire supported upon insulators: the number of those insulators were the fact that determined the current which should flow. The longer the line the greater the opportunities of escaping.

Major CARDEW: Some of it might come from the line, but the idea is that the current is leaking out from the uninsulated return.

Mr. HOLROYD SMITH: That is also governed largely by the length of the line, because the longer the line in the usual custom the more the cars that would be working upon it. He would suggest that the clause be put alternatively—either so much per mile or the percentage.

Mr. CROMPTON suggested that it should be struck out altogether.

Mr. SIEMENS said the leakage current depended only on the difference of potential between the uninsulated return from the distant parts and the earth plates. The potential would not vary, because they must make the section of their return greater if they had a greater traffic.

Sir COURTENAY BOYLE said he would take both the mileage factor and the output factor; it must not exceed that which was least in either case. With regard to the quantum of the mileage and the quantum of the output, he thought "two amperes per mile of single track" would do, and 5 per cent. of the output.

Mr. WINTERBOTHAM: The minimums in each case, of course.

Sir COURTENAY BOYLE: Whichever is lowest.

Mr. LANGDON: Is there any limitation to the amount of output from the generating station?

Sir COURTENAY BOYLE: There is no limitation of the current.

The next point was the proposal of the Institution of Electrical Engineers to strike out the paragraph relating to the direction of the current, and substitute "That if at any time and at any place a test be made by connecting a voltmeter to the uninsulated return, and to any pipe which the current could reach without traversing more than 6ft. of earth, the difference of potential arising from the working of the tramway between them should not be greater than four volts if the return is positive to the pipe, or greater than one volt if the pipe is positive to the return."

Mr. SIEMENS said this was suggested to bring in the difference of potential in volts instead of reversing the current by Leclanché cells.

Major CARDEW thought, for the purposes of the regulations, it was preferable to adhere to the Leclanché cells in place of a special voltmeter such as was indicated by the Institution of Electrical Engineers. They would observe that it was an opposing electromotive force, and therefore there would be no question of the polarisation of the cells. They had only got the opposition of the electromotive force to overcome; and it was to the tramway engineers' interest to see that the Leclanché cells were in good order. There was no question of the resistance of the cells; they had only got the electromotive force. As far as regarded satisfying the water companies he must say he felt that in provincial towns they could get sufficiently good advice to tell them whether the test was *bonâ fide* if made with Leclanché cells, but it would be very difficult for them to feel certain as regarded the indications of a voltmeter. After a short adjournment,

Sir COURTENAY BOYLE said they would adopt the amendment of the London Chamber of Commerce in regard to reversing the normal direction of the current by interposing a battery of three Leclanché cells, or in the reverse direction by one cell, subject to one or two verbal alterations.

On Regulation No. 7, in regard to the testing of the electrical resistance of the return, the proposal of the London Chamber of Commerce that for this regulation should be substituted, "when the return is partly or entirely uninsulated, a record shall be kept by the company of the extreme difference of potential reached during the working of the tramway measured between the most distant part of the system and the nearest home point of the uninsulated portion of the system, and if this record shows that at any time the recorded difference of potential exceeds 15 per cent. above the value, the company shall take immediate steps to reduce the difference to the required value" was adopted, with the substitution of "seven volts" for "15 per cent."

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On the proposal of the Institution of Electrical Engineers to redraft Regulations 9, 10 and 11, in regard to the testing of insulation, as one regulation.

Mr. WINTERBOTHAM said they were going to test the cables which might have a very high insulation; but by this proposal they were going to leave out all the joint-boxes, test-boxes, &c., and, therefore, the test would be of no value.

Mr. CROMPTON said the high test of 10 megohms was solely for the cables. The real test for the insulation of the line was the leakage test.

Regulation 9 was passed provisionally.

After some discussion on Regulation 10,

Sir COURTENAY BOYLE said the words, with the suggestions which had been made, ran thus:—"The insulation of the line and of the insulated portion of the return, when both are coupled up ready for work, shall be such that the leakage current shall not exceed one-hundredth of an ampere per mile of tramway. The leakage current shall be ascertained daily before or after the hours of running when the line is fully charged, and if at any time it exceeds one-tenth of an ampere per mile, the leak shall be localised and removed as soon as practicable. The running of the car shall be stopped until after the leakage has been localised and removed. Provided always that where both line and return are placed within a conduit this regulation shall not apply."

Mr. DICKENSON thought it would be impossible to work a tramway commercially under such conditions.

Sir COURTENAY BOYLE: I will give you 24 hours—"The running of the car shall be stopped unless the leak has been removed within 24 hours."

On Regulation 13, as to the position of an insulated return, the London Chamber of Commerce suggested that it was unnecessary to vary the distance permissible between the line and return in different systems. A long discussion took place on this regulation.

Sir COURTENAY BOYLE said he would not decide the point then.

On Regulation No. 14, that "In the disposition, connections, and working of feeders the Company shall avoid injurious interference with any existing wires,"

Sir COURTENAY BOYLE: Now we come to Regulation 14, amended by these words, please,—after the word "shall" insert "take all reasonable precautions to." Now, what has anybody got to say about that?

Mr. SIEMENS said the Institution of Electrical Engineers proposed to strike out the regulation because in Clause 3, which the Joint Committee recommended, the Board of Trade was empowered to make regulations "for minimising as far as is reasonably practicable injurious interference with the electric wires, lines, and apparatus of other parties, and the currents therein, whether such lines do or do not use the earth as a return." Therefore, the whole regulations ought to give the undertakers rules, and the undertakers should be able by following those rules to comply with the recommendation of the Committee. But here, by this regulation, it was all thrown back again on the undertakers.

Sir COURTENAY BOYLE: Only feeders. I made exactly the same criticism when this rule was brought to me that it was practically doing in a rule what the whole rules themselves ought to do. But then it was pointed out to me that this only applies to a feeder.

Major CARDEW: You are not restricted in the position of the feeders to the same extent.

Mr. S. MORSE: It seems to me that this regulation simply repeats Clause 5 in the report of the Joint Committee: the clause which is to go into the Act under which the regulations were made.

Mr. WINTERBOTHAM pointed out that the difficulties which had been suggested by the traction people with regard to the points which the Telephone Company have raised before committees have always been with regard to the working of the lines themselves. The feeders were in no different position from the electric light mains, and why they should not be bound to take reasonable precautions in the running of their feeders, he could not understand. Under Clause 5, which read:—"The undertakers shall take all reasonable and proper precautions in constructing, placing, and maintaining their electric lines, circuits, and other works"—in the course of a number of years they might run these things just as they chose, and it would be a complete answer to any complaints they made that their wires were not metallic.

Mr. SIEMENS: Yes; certainly.

Mr. WINTERBOTHAM said the clause said distinctly that the Board of Trade were to make regulations minimising injurious interference with their electric wires, lines, and apparatus, "and the currents therein, whether such lines do or do not use the earth as a return." Those lines at the end showed most clearly that the Committee intended the Board of Trade to require them to minimise, as far as they reasonably and practically could, injury to their lines, even though they were not metallically looped, and he claimed under that that where feeders were dealt with no such difficulty occurred in making these proper provisions. Where they had no question of having to pick up the current by moving contact or returning the current by the rails, or anything of that kind, no difficulty occurred, and they ought to be put under proper regulations, or Clause 3 of the Act was not given effect to. In fact, by leaving out such a regulation they would be given no protection, because they had to rely upon the protection which the regulations gave them.

Mr. S. SELLON said it seemed to apply in the case of feeders to the fact that where they had feeders for a tramway they must be landed somewhere where they cut those feeders. Probably they would be told by the Local Authorities where they were to put them; but in the case of the telephone people he did not know that their business necessarily limited it; they could go inside or anywhere outside the roads. The Traction Committee could not possibly meet that objection.

Mr. WINTERBOTHAM: As to having no difficulty in running our wires where we like I may say that we have had considerable difficulties. We have no Parliamentary powers whatever, and we must put them where the Local Authorities require it.

Mr. S. SELLON: It is simply a question of inductive disturbance which, according to your own Telephone Clause, is limited to so many feet.

Mr. WINTERBOTHAM said that was the only protection that at all protected them with regard to these feeders, otherwise they would be able to run their feeders without any regard to their wires, merely responding when they claimed that their lines were not metallic looped.

Mr. ARNOT asked if it was at all necessary that the feeders should be duplicated. Did the Board of Trade not entertain the possibility of a single feeder on a short line with a rail return of a sufficient section? In that case, then, the feeder would not interfere with the wires of the Telephone Company.

Major CARDEW: If it was placed too close to them; by the regulation it is proposed that they should not be placed so close as to affect them.

Mr. ARNOT pointed out that the feeders to electric light mains all joined together at the same place, but with a tramway it might be very much to the tramway's advantage to put them at different places, so that one feeder might over-run the other for a considerable distance.

Mr. WINTERBOTHAM said the Board of Trade had suggested a modification of this in the form of "all reasonable precautions," and surely that was not asking too much.

Mr. S. MORSE said Clause 5 was made specially applicable to telephonic and telegraphic communication.

Sir COURTENAY BOYLE: So also is Clause 3.

Mr. S. MORSE thought it was rather a difficult question of construction. Of course the great fight was between the traction people and ehe telephonic and telegraphic people. But it was quite clear, inasmuch as it is said here they "shall take all reasonable and proper precautions."

Sir COURTENAY BOYLE: Mind you, it is existing wires only.

Mr. S. SELLON: The telephones are everywhere. We have got to get there.

Mr. WINTERBOTHAM, referring again to recommendation 5 of the Committee, said that was perfectly clear upon the point—though they might use these wheels and rails, they were to do it in such a manner as to mitigate as far as practicable any injurious effect to telephonic companies. They were entitled, he argued, to Clause 3; Clause 5 had nothing whatever to do with Board of Trade regulations.

Mr. S. MORSE: I think you will admit that feeders are included in Clause 5.

Sir COURTENAY BOYLE: Of the Act certainly.

Mr. S. MORSE asked, if so, what did it give more by saying that they should take all reasonable precautions to work feeders—did it limit their taking reasonable precautions to work other matters, because the expression of the one in this regulation might limit the obligation upon the tramway company as to other matters; and if the word "feeder" was limited in 5 then, he submitted, that if regulations were made which gave the Telephone Company more rights than were given by Clause 5, the Board of Trade would legislate in favour of the Telephone Company.

Sir COURTENAY BOYLE: How do you answer Mr. Winterbotham's objection as to the proviso about three years in Clause 5 of the Act.

Mr. S. MORSE said the provision of the three years, as he understood it, was merely with regard to the duplicating and twisting of their wires. The proviso was that "the undertakers should be deemed to take all reasonable and proper precautions if and so long as they adopt and employ, at the option of the undertakers, either such insulated returns or such uninsulated metallic returns of low resistance, and such other means of preventing injurious interference with the electric wires, lines, and apparatus of other parties and the currents therein, as the Board of Trade shall direct." "Provided also that if at the expiration of [——] years"—that meant to say that they must have some time given to them. Recommendation 10, he thought, said that to enable them to protect themselves a period of two years might be allowed.

Mr. SIEMENS said the clear intention of the Committee was that the telephone companies were to take care of themselves. In giving them three years to do it they gave to them three years to put up the metallic circuits.

Mr. WINTERBOTHAM said that, notwithstanding that Clause 3 was drawn, which intimated to the Board of Trade that their regulations were to minimise as far as was practicable the interference with wires whether they used the earth or not, they recognised the fact that the Telephone Company had a mass of wires in existence at the present time, and that reasonable protection should be given. He did not for a moment say that they were to have protection which put them to an enormous expense.

Sir COURTENAY BOYLE thought the regulation as amended had very little effect one way or the other. He would consider the argument, but he did not think it mattered if the regulation, amended as taking all reasonable precautions, were limited or inserted.

Mr. S. MORSE: Would you consider the question of giving a certain date for the existing wires.

Sir COURTENAY BOYLE: Yes; if we put it in.

The Conference was then adjourned to Friday.

FRIDAY, FEBRUARY 23RD.

The Board of Trade Conference was resumed to-day, Sir Courtenay Boyle again presiding.

Regulation 15, as drafted, was: "The Company shall so construct and maintain their system as to secure good contact between the motors and the line and return respectively, and they shall not allow sparking to occur at the rubbing or rolling contacts in any part." To this the Institution of Electrical Engineers proposed an amendment that "they shall not allow more sparking to occur at the rubbing or rolling contacts than is considered reasonable by the Board of Trade."

Mr. SIEMENS, in supporting the amendment, said the regulation as drafted amounted to an absolute prohibition of sparking, which was an impossible condition to fulfil.

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Sir COURTENAY BOYLE said he thought the best thing was to adopt the suggestion of the London Chamber of Commerce, and read it together with No. 17, which provided that all reasonable precautions should be taken.

Mr. WINTERBOTHAM said that the amendment of the Telephone Company should be adopted, requiring the use of brushes and other proper means. The disturbance had been vastly greater, owing to the use of a rubbing contact. As long as the contact was not practically broken they did not consider the irregularity of the contact produced most tremendous disturbances and variations in the current.

Mr. STEPHEN SELLON objected that uniform current was absolutely impossible to maintain. Dirt would get on to the brushes, and then they would not provide the perfect remedy which Mr. Winterbotham suggested. Unless they could run the wire absolutely the same distance from the rail it would be impossible to have uniform contact.

Mr. LANGDON said that with respect to railway signals it was important there should be as little disturbance and variation in current as possible. He thought something more definite than the relative term "good contact" should be adopted, but would be satisfied that it should remain under the direction of the Board of Trade.

Mr. SYDNEY MORSE suggested that the "best means available at the date of construction" should be required, as otherwise traction companies might be put to unnecessary expense in adopting what at the moment appeared to be the best means available, and then shortly afterwards be required to replace it by what was then considered to be the best means.

Sir COURTENAY BOYLE pointed out that necessarily the whole thing would be under the direction of the Board of Trade, and the penalty to satisfactorily comply with the regulations would be the withdrawal of the Board's sanction to use electricity. Therefore it did not strengthen the matter by referring to the Board of Trade at each regulation.

After further discussion, Nos. 15 and 17 were taken together and framed thus:—

"(15) The Company shall so construct and maintain their system as to secure good contact between the motors and the line and return respectively."

"(16) The Company shall adopt the best means available to prevent the occurrence of undue sparking at the rubbing and rolling contacts in any part, and in the construction and use of their generator or motors."

The next regulation ran as follows:—"In working the cars the current should be varied as required by means of a rheostat containing at least 20 sections, or by some other equally efficient method of gradually varying resistance." Upon this, the Association of Municipal Corporations observed—"The selection of 20 sections in the rheostat is perhaps somewhat too definite. What is really required is a means of varying the current continuously without sudden changes. It would be better to insist that the starting and stopping of cars shall be effected by a continuously varying resistance."

Dr. FLEMING, in support of the amendment, said that instead of binding it down to 20 sections the current could be varied by a carbon rheostat, for instance, which would prevent changes and injurious action on neighbouring lines

Major CARDEW said the regulation only prescribed the minimum number of sections, and did not prevent a larger number being used.

Mr. HOLROYD SMITH said 20 was a very great number, because if they had a car and wanted to drive from both ends of it, with 20 points in the resistance, they must have 20 wires running the whole length of the car.

Major CARDEW: You must mechanically gear your rheostat.

Mr. HOLROYD SMITH said they might put the rheostat in the middle, but would get a complication with that, especially with a bogey car.

Mr. SIEMENS said he did not think the wording of the Board of Trade could be improved upon.

Sir COURTENAY BOYLE: You do not think 20 sections is too many?

Mr. SIEMENS said he thought they were too few, because the steps ought to be so that the difference in voltage from one step to the other was very low, otherwise sparking would occur. If the steps were too large, when they put in the resistance an arc would come between the two steps instead of the current going through the resistance, which would upset all the arrangements, spoil the switch, and bring about an accident. There was no practical difficulty in putting the switch in the middle and having a cord from each end of the car to manipulate it.

Sir COURTENAY BOYLE said he could not go too deeply into the details of the construction of the rheostat. The regulation was an elastic one and must stand.

On Regulation 18, with the insertion of suggested drafting amendments by the Institution of Electrical Engineers, the first part was agreed to as follows:—

"Where the line or return, or both, are laid in a conduit, the following conditions shall be complied with in the construction and maintenance of such conduit.

"(*a*) The conduit shall be so constructed as to admit of easy examination of and access to the conductors contained therein, and of all insulators and their supports.

"(*b*) It shall be so constructed as to be readily cleared of accumulation of dust or other *débris*, and no such accumulation shall be permitted to remain."

Sub-section (*c*), as drafted, was: "It shall be laid to such falls, and so connected to sumps or other means of drainage, as to automatically clear itself of water without danger of the water at any time reaching the level of the conductors." The Institution of Electrical Engineers proposed to strike out the words "at any time."

Mr. SIEMENS stated that if there was a sudden flood or anything of that kind they could not prevent the water reaching the conductors. In the interests of the Tramway Company every precaution would necessarily be taken, but the regulation as it stood imposed an impossible condition.

Sir COURTENAY BOYLE said that *force majeure* was always allowed to prevail against any regulation.

Major-General WEBBER said that the interpretation of the regulation might require the construction of a conduit of exaggerated depth.

Mr. HOLROYD SMITH said that at Blackpool sometimes a wave would sweep over the whole promenade and over the line, but it was away in two seconds.

Major CARDEW said of course a momentary contact was not any source of danger, but if the conductors were to remain in contact with water for an hour or two it was a different matter.

Mr. HOLROYD SMITH said that then the working would be stopped as the current would be gone.

The words "at any time" were struck out.

Sub.-Sec. (*d*), as drafted, was: "If the conduit is formed of metal, all separate lengths shall be so jointed as to secure metallic continuity for the passage of electric currents, and where the rails are used to form any part of the return they shall be electrically connected to the conduit by means of copper strips having a sectional area of at least one sixteenth of a square inch, or other means of equal conductivity at distances apart not exceeding 100ft. Where the return is wholly insulated and contained within the conduit the latter shall be connected to earth at the generating station through a high-resistance galvanometer suitable for the indication of any contact or partial contact of either the line or the return with the conduit." It was decided this should follow the same lines as the drafting of No. 4, which had been reserved by the Board.

Sub.-Sec. (*e*) read: "If the conduit is formed of any non-metallic material not being of high insulating quality and impervious to moisture throughout, and is placed within 6ft. of any pipe, a non-conducting screen shall be interposed between the conduit and the pipe, of such material and dimensions as shall provide that no current can pass between them without traversing at least 6ft. of earth." The Institution of Electrical Engineers proposed to substitute for this the following paragraph:—"The leakage current shall be ascertained daily before or after the hours of running, when the line is fully charged, and if at any time it shall be found to exceed half an ampere per mile of track the leak shall be localised and removed as soon as practicable."

Major CARDEW thought the provision of the sub-section rather important. It was only in case of the conduit being formed of material which was not metallic, but which at the same time was not of high insulating quality and not impervious to moisture. It was that particular class of material which it was so difficult to deal with electrically, and those partial conductors which gave trouble in leakage.

Mr. MONIER WILLIAMS, on behalf of the Gas Company, protested against any alteration of the sub-section, which had no doubt been inserted by the Board of Trade, after due consideration, for the protection of the companies having pipes in the streets.

Major CARDEW proposed an addition which he thought might satisfy the traction people:—"Or the conduit itself shall in such case be lined with bitumen or other non-conducting damp-resisting material in all cases where it is placed within 6ft. of any pipe."

Mr. MANVILLE observed that the most non-conducting of substances when entirely buried in the earth became practically no obstruction to the passage of the current. He had tried some experiments with asphalte underground, and it was apparently a good conductor. Once it was buried in the earth he believed it would be practically impossible to put a shield between the conduit and the pipe that would prevent a current passing into the pipe just as if that shield did not exist.

Major CARDEW said the current would pass, but not at that place. Mr. Manville had not quite got into his mind the idea that where there was a pipe very close to the conduit, they wanted to prevent an electrical current at that place. He quite agreed that it would be impossible to insulate the current entirely by any such means, but they could prevent the current damaging the pipe.

Major-Gen. WEBBER said the regulation would practically prohibit a line being constructed in any narrow street, because it must run for a considerable distance within 6ft. of gaspipes.

Sir COURTENAY BOYLE said there was no subject in which the public were more interested than in the prevention of danger to the gaspipes by leakage.

Major CARDEW pointed out the various alternatives: First, they had the option of making the conduit of iron or other metal; secondly, of making it of a material of a highly insulating quality, and impervious to moisture; thirdly, if the material were not highly insulating and impervious to moisture, of placing a screen as proposed in the regulation (*e*); and, fourthly, of lining the inside of the conduit with a damp-resisting material. Surely out of those four a practical way of getting along could be found.

Mr. MONIER WILLIAMS and Mr. COLLINS expressed their preference for the clause as it stood, and Mr. LANGDON said that he saw no difficulty in it.

Mr. STEPHEN SELLON and Mr. MANVILLE agreed with Major-Gen. Webber's view of the matter.

Mr. SIEMENS thought that with the addition proposed by Major Cardew, and the alternatives he had shown them, the clause was acceptable, and that there was no great difficulty or expense in lining a conduit with bitumen.

Sir COURTENAY BOYLE said he would let the regulation stand with Major Cardew's addition.

Mr. SYDNEY MORSE said that with reference to sub-section (*d*), the London Chamber of Commerce observed, "It does not seem satisfactory to electrically connect lengths of conduits together, especially where a complete metallic return is used, on the grounds that a fault might cause a complete breakdown in the whole system, if metallic continuity was insisted upon, instead of only a partial one." He proposed that the commencement of the sub-section should read, "If the conduit is formed of

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metal, all separate lengths shall," adding the words, "save where both line and return are laid within the conduit," "be so jointed," &c.

Major CARDEW said he was afraid they could not accept that wording. They had had a good deal of experience of the dangers affecting metallic conduits which were not metallically connected throughout.

Sir COURTENAY BOYLE said they could not accept the amendment.

Mr. SIEMENS, on behalf of the Institution of Electrical Engineers, proposed that the paragraph relating to leakage currents, which was originally proposed in substitution of (e), should be adopted as a separate sub-section (*f*).

Mr. WINTERBOTHAM suggested that whatever was done with Regulation 10 as to the stopping of cars should be done here.

Mr. SIEMENS: Yes, that would be all right.

Sir COURTENAY BOYLE said that 24 hours would be given to remedy the leak, or the running of the cars must be stopped.

Several drafting amendments having been considered,

Sir COURTENAY BOYLE read a new Regulation, which had been drafted by Major Cardew, as follows: —"Where in any part of the tramway the line is erected overhead by means of insulators to iron or other metallic supports set in the ground, and the return in such part is uninsulated, bases of each support shall be electrically connected to the return by means of a metallic conductor, which will not be appreciably heated by a current of a hundred amperes."

Mr. DICKENSON said he had been back to South Staffordshire, and temporarily connected seven poles three miles distant from the generating station. The result was that immediately they were connected there was a rise of 10 amperes from their earth-plate connections. That brought them over the limit allowed by Regulation 5 as to the quantity of current that they were permitted to collect from their earth-plates. If that regulation were amended so as to permit of the quantity of current being collected from the earth-plates he had no objection at all, but if they connected the whole of the poles in the South Staffordshire system it was equal to putting in 6,000 superficial feet of earth plate. The regulations generally prohibited the return being connected. It must be separated from the general mass of earth, but this regulation connected them to the general mass of earth, and he believed if the whole of their poles were connected they should get quite three-fourths of their current back through the earth. It depended upon the conductivity of the earth in the district, and also upon the form of the line. If the line was a complete circle, and the generating station was in the middle, and the whole of the poles were connected, of course the current would take the shortest path and the path of least resistance, and practically none of it would come back through the rails. If Regulation 5 as to the earth connections to be made were insisted upon, they would only get 5 per cent. of the output of the generating station back through the return.

Mr. LANGDON submitted that this proved that the rails were not performing their duty. The Joint Committee said that these open returns were to be of such a capacity as would carry the current back without injuriously affecting the interests of other people.

Mr. DICKENSON said they were of such a capacity. Their returns were properly metallically connected. In addition to having a copper strip across them they had a special fish plate which the joint of the rail rested upon, and clipped it at the side, and the section of the rail would permit of eight or ten times as much current going back with the resistance allowed by the Board of Trade. The experiment clearly showed that it went back through the earth in spite of all this when they were connecting to the earth, although just before they did that they were well within the limit of the Board of Trade.

Mr. LANGDON said they had been very seriously affected at Walsall by these currents getting into earth and passing on to their wires.

Mr. SINCLAIR thought that when the two rails were properly and electrically connected together as forming the return, all would agree that it was impossible for the current to leave these rails and go into the earth and come back by it only in proportion to the resistance offered by the combined rails.

Mr. SIEMENS pointed out that it was quite impossible to prevent the electricity going into the earth by lowering the resistance of the return conductor. Electricity, if it had different ways to choose between two points, would always follow all the ways, and would be inversely to the resistance of the different ways. If the resistance was 99 times greater than the other, then the higher resistance path would take a hundredth of the electricity, and the low resistance conductor would take 99 parts. Therefore his experiment conclusively proved that the path through the earth was made easier for the electricity by making the connections which Mr. Langdon proposed, and therefore a greater part of the electricity was diverted through the earth by providing better means for the current to enter the earth. He would also call attention to a point which the railway companies did not talk about. It really took three manipulations before a block signal was interfered with. A stray current from the tramway or an ordinary earth current could possibly give in one station a signal which would indicate that station A wished to ask station B whether the line was clear. That might induce the signalman in B to answer back that the line was clear, but that would not lower the signal; the signalman at A would simply say "What did you give me 'line clear' for? I did not ask you for that." As long as the railway used earth, any current, meteorological or otherwise, would interfere with them just as much as any stray current from the tram line could do. Moreover, in these regulations they had laid down that the difference of potential between the extreme point of the tramway return and the station should be 6 volts. If Mr. Dickenson had brought down his difference of potential to 6 volts he would not have had 10 amperes.

Sir COURTENAY BOYLE said, to his mind, there was a great deal in the point that three operations were required before they got in danger on a railway.

Mr. LANGDON said when a train was about to be started to a point the signalman rang a bell at the station to which it was about to advance, which told the man there. He replied on the bell, and by-and-by they gave a tick on the needles of the instrument by pushing over the handle to one side or the other, as the case might be; then that was answered, and if that answer was correct that enabled the man at the other end simply, without ringing the bell again, to pass the needle of the instrument over to either "block" or "clear." It was just at that point where the difficulty came in. Supposing just at that instant when the man was about to give the line "block" signal a tramway current passed upon the wire and gave the line "clear" signal, an accident might happen.

Major-Gen. WEBBER said this new regulation was practically bringing to the test the possibility of insulating the line as carried on the poles at the point of the insulating supports. They knew that no insulation ever had been put upon poles which would resist what was called weather leakage, and that in times of heavy rain the mass of the current would return directly from the return into the line. He thought it would be very unwise to introduce a regulation to protect railway companies when they could protect themselves so thoroughly. By connecting the rails when they were used as an uninsulated return to the iron poles they would cripple the construction of all their possible future country electrical tramways.

Mr. S. MORSE said evidence was given before the Joint Committee of an accident having arisen at Walsall when, as the result of some leakage, "line clear" was given when there was a train on the line. It was also proved that the railway companies could get over the difficulty at a small expense.

Mr. SIEMENS said the Committee clearly indicated that the telephone and railway companies ought to protect themselves by adopting metallic returns.

Sir COURTENAY BOYLE thought they had discussed the point very fully. It was impossible for him to decide the question, which was an absolutely scientific and electrical one. He must act on the advice of the electrical expert attached to the Board of Trade, Major Cardew, and he thought the best thing would be for Major Cardew to go down to Staffordshire, and see exactly what was the nature of Mr. Dickenson's experiments, and to consider how far those experiments justified his contention. Major Cardew should then submit a further draft of the clause, which the Board of Trade would consider, if necessary, in further consultation with Mr. Langdon and the gentlemen affected by it. It was possible they might have to have another meeting merely for this, only the thing must be done quickly, as they were getting very short of time.

Mr. SIEMENS proposed the addition of a regulation providing that where overhead lines are used the company should erect a guard wire, to prevent any previously erected wires from coming into metallic connection with the conductors carrying the tramway current.

Sir COURTENAY BOYLE thought they might be perfectly sure that the guard wire would be there, whether under this regulation or not. He would undertake that with the words "where necessary" it should be inserted somewhere.

On a suggested regulation by the associated railway companies, that the most effective means of preventing interference with the railway wires would be found in laying the line and "return" traction wires on insulated supports within a metal culvert,

Sir COURTENAY BOYLE said his hands were tied by the report of the Joint Committee on that point.

The Gas Light and Coke Company suggested the advisability of inserting a prohibition forbidding connections with gaspipes.

Mr. MONIER WILLIAMS said the point was one of great importance to them.

Sir COURTENAY BOYLE thought they were bound by the report of the Joint Committee. He was afraid the Board of Trade had no power to insert a "damage" clause, though he would further consider it.

Mr. MONIER WILLIAMS suggested, as a proviso to Regulation 5, with regard to the making of earth connections: "Provided always that, before allowing any departure from your modification of this regulation, such officer of the Board of Trade shall give to any company owning pipes in the vicinity an opportunity of objecting thereto, and of appealing to the Board of Trade, who shall hear and adjudicate upon its objection by an arbitrator appointed by the Board in the usual way."

Sir COURTENAY BOYLE said he was perfectly ready to make it the duty of the officer of the Board of Trade to consider any objections that were sent to him, but did not think the officer could be asked to go about hunting up objections. He would consider the point.

Mr. SYDNEY MORSE understood that these regulations in their present form were to be added to clauses to be inserted in future Bills.

Sir COURTENAY BOYLE: I am not sure about that.

Mr. S. MORSE: There are a great many tramway companies which have electrical powers with Bills which were passed previously to the Joint Report. These regulations would be rather difficult to interpret if they were put by themselves to those tramways when they come to equip themselves electrically, unless the clauses were incorporated into the regulations, and the whole thing applied to those tramways.

Sir COURTENAY BOYLE: I am considering this point with the authorities of the House at the present moment. I think that the clauses will have to be inserted in every future tramway Bill or Provisional Order, but I do not think the regulations ought to be scheduled to the clauses.

Mr. S. MORSE asked how the case of a tramway company would be dealt with who had already acquired their Act without these clauses when they came to equip themselves electrically.

Sir COURTENAY BOYLE: I think we shall recite the clauses in the regulation.

Mr. S. MORSE: Making the two—the clauses and the regulations—applicable?

Sir COURTENAY BOYLE: I cannot make the clauses applicable; Parliament must make them applicable.

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Mr. S. MORSE: May I ask the Board of Trade to consider whether they will introduce a general Bill which would make these clauses applicable to the Acts already in force where the clauses are not inserted. There are, I think, over a hundred.

Sir COURTENAY BOYLE: That is such a very important question; in these days it is not very easy to get a general Act about anything, but if there is sufficient desire on the part of tramway companies at present having Acts, and desiring to equip themselves electrically, that there should be a general Act embodying these clauses, the Board of Trade will further consider it, but until the pressure comes before us in sufficient quantity I think that we should hardly be able to act.

Mr. S. MORSE said there was this difficulty, that the tramway companies without these clauses were in great trouble as to how they were to carry on their business without actions from the Telephone Company.

Sir COURTENAY BOYLE: Then they had better apply to us for regulations, and we will recite the clauses and impose the regulations.

Mr. S. MORSE: Then, sir, we do not get the protection of the clauses.

Sir COURTENAY BOYLE: Then why do you not go to Parliament?

Mr. S. MORSE: Because when it is a question of a hundred companies or corporations going one Act might not cover the whole question.

Mr. WINTERBOTHAM submitted that the parties having these Acts had no *locus* to come in now and ask the Board of Trade to put an end to agreements which they had submitted themselves to.

Mr. S. SELLON: I understand you must have a large number of applications for driving home the question.

Sir COURTENAY BOYLE: I think we must. It is very possible we may have to have a general Act. If the pressure arises to a certain amount we may do something.

Mr. WINTERBOTHAM: I hope I shall be able to do something on the other side.

Sir COURTENAY BOYLE then thanked the members of the Conference for the assistance they had given the Board of Trade, and the Conference terminated.

ON METHODS OF TESTING THE MAGNETIC QUALITIES OF IRON.*

BY GISBERT KAPP.

The industry generally comprised under the term "heavy electrical engineering" has of late years made such rapid progress that the question as to the kind of materials to be used has become of great importance. As regards the copper wire required in the construction of electrical machinery, certain standards regarding the size and conductivity have from the very first been adopted. The metal of commutator plates, size of wearing surface, type and number of brushes, dimensions of resistance coils, and other purely electrical parts of the machinery, have also, as a rule, been specified; but as regards the iron used, no attempt was at first made to define it by specification. Makers of dynamos, for instance, broadly distinguished between cast iron and wrought-iron field magnets, and got out their designs with reference to the magnetic properties each of these two kinds of iron was assumed to possess; but there was no certainty that the iron obtained did actually possess these properties. If the machines turned out according to design, well and good; if not, then the speed or excitation had to be altered so as to get the output right. This was the old and unscientific method of building electrical machinery. The modern method is very different and far more certain. The manufacturer of a dynamo knows exactly what kind of iron he is using, and he is thus able to predetermine the performance of the machine with a degree of accuracy which formerly was impossible. This is especially of importance in large machines, as experimental runs to determine the characteristic at full load are not easily made, and are always expensive. In such cases it is preferable to cut a sample from the magnets, test it magnetically, and use the results of this test in designing the winding.

In some cases it is not even necessary to cut off samples and test them, as the manufacturers of forgings and castings for magnets offer now to supply these so as to conform to a certain magnetic standard, commonly defined by means of a curve in which the abscissæ represent magnetising force and the ordinates induction. Provided, then, the iron maker supplies exactly the material which he has promised, the winding of the machine can be designed without any preliminary experimenting. Iron makers are now keenly alive to the importance of this subject, and produce most excellent material. The testing of iron plates intended for use in alternators and transformers is another of those questions which had to be faced by manufacturers who wished to attain perfection in their work. As regards transformers, it will probably be admitted by all that the quality of the iron is the most important factor in the whole design. To make a good dynamo with inferior iron is still possible; we need only use enough of it, and spend enough money on the copper to make up for the deficiency in the iron. With transformers this cannot be done. If the iron is bad, no increase in its bulk and no amount of money we may spend on copper will enable us to turn out a good transformer. The important point with transformer plates is not the higher or lower permeability, but the waste of power by hysteresis and eddy currents; although to a certain extent the two go together, in the sense that a very soft iron having high permeability also has, as a rule, a small hysteresis loss. Plate makers, recognising the importance of small hysteresis, now offer their material with a guarantee that the loss with a given induction and frequency shall not exceed a certain amount per pound.

Admitting, then, the necessity for magnetic tests of iron, the question as to method arises. There can be no doubt that the methods adopted by Dr. Hopkinson and Prof. Ewing in their classical researches give the most accurate results; but the very perfection of these methods forms a drawback to their adoption in engineering works where highly trained experimenters cannot be found. I have therefore adopted other methods, which do not aim at absolute accuracy, but which can be used by any one of the staff generally found in the test room of electrical engineering works. The apparatus required is on the table, and I venture to bring it before you because it has been in use for some years, and has given results which were always found sufficiently accurate for all practical purposes.

It will be convenient to divide the subject into two parts—one dealing with the testing of magnet iron, and the other with the testing of transformer plates.

Testing Machine for Iron Bars.

This is shown twice full size in the wall diagram (Fig. 1)*. For the principle on which it is based I am indebted to a little instrument devised some four years ago by Prof. Silvanus Thompson, and called by him a "permeameter." In it the induction through the sample bar is measured by the force required to pull the bar away from another piece of iron; and, as the induction is proportional to the square root of this force, it is clear that any small error in the measurement of this force results in a still smaller error in the determination of the induction. Thus, if his spring balance were wrong by 2 per cent., the error in estimating the induction would only be 1 per cent. So far, then, as the determination of B was concerned, the permeameter appeared to be an exceedingly accurate instrument; but this alone is not sufficient. We must have the relation of B and H, and, as part of the total ampere-turns applied is required for the magnetic circuit outside of the sample, certain corrections must be applied in the determination of H. It was mainly with the object of making these corrections both small and definite that I altered the design of the Thompson permeameter and made it in the form shown on the diagram. The instrument consists of a heavy rectangular frame, made of the best Lowmoor iron, well annealed. Within the frame is fixed a solenoid with subdivided winding, so that a variable, but known, number of turns can be placed in circuit by using the various terminals provided on the instrument. The object of this arrangement is to keep the current within such limits as will ensure the greatest accuracy in its measurement, whilst the magnetising force is varied between very wide limits. A reversing switch is inserted to facilitate the investigation of the complete cycle.

The sample consists of a bar accurately turned, and faced at the lower end. The bar is kept larger at the upper end, where it passes through a hole in the frame—a fairly tight fit—and it is centred near the lower end by a little gunmetal ferrule. Below the bar is a soft iron plunger, guided in a hole in the frame, and provided with an attachment for holding a scale-pan and weights. The plunger is made larger than the bar, and has a fine hole drilled through it to ensure good contact over the rest of the surface. The dimensions of the plunger and the hole in the frame being accurately measured, it is, of course, quite easy to determine by calculation how much of the ampere-turns provided is required to overcome the resistance of the annular air space; and this is the only important correction required. The other corrections, such as the magnetic resistance of the frame, or that of the joint between the sample and the frame at the top, are quite trifling. Even the correction for the resistance of the air space is only important for low inductions. For inductions above 10,000 it becomes relatively small, and above 15,000 quite negligible. The method of using the instrument is as follows:—The sample, with its end carefully faced, is inserted from the top, and a small current sent through the solenoid, using the smallest number of turns. The plunger flies up against the sample and sticks there. The scale-pan is attached, and weighted until the plunger comes off. The exact point at which the weight overcomes the magnetic attraction is best determined by slightly varying the current by means of a rheostat; and I may mention that it is necessary to use a storage battery to provide the current. To work directly from a dynamo is impossible, as the slight variation in current produced by the irregularity in speed of the engine, or the flicking of a belt, is quite sufficient to make the tearing-off point uncertain.

* Paper read before the Institution of Electrical Engineers, Thursday, February 22nd.

* We have not received copies of the diagrams illustrating Mr. Kapp's Paper, and Figs. 2 and 3 are from sketches made at the meeting. [Ed. E.]

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The current, number of turns in the solenoid, and the weight are now increased step by step, then decreased again to zero. The current is then reversed, and the operation repeated, so as to obtain the complete cycle. The values recorded are ampere-turns and tearing-off weight, in which is, of course, included the weight of the plunger and scale-pan. The greatest weight supported by a half-inch sample bar of good iron is about 45lb. I need not detain you by giving in detail the calculations for finding the relations between ampere-turns and H, or weight and B, nor the values of the corrections*, since these are purely elementary matters, and can be worked out for any testing machine of this type if its dimensions are known. The time occupied in testing a sample through a complete cycle is about an hour; one man manipulating the weights, and the other the current. The latter also books the readings.

I have used the apparatus before you in testing large numbers of samples of cast iron, wrought iron, and mild steel submitted to me for investigation by different iron makers, and some of the curves obtained are on the table. For obvious reasons, I do not mention any particular maker of magnet steel; but I may say generally that the samples of steel submitted to me were very good, and in some cases better than wrought iron. The good qualities of mild steel, as revealed by the testing machine, were fully confirmed when the same material was used in dynamos, and thus tested on a large scale.

Testing Machine for Transformer Plates.

My first attempt to make such a machine was a failure; but, as failures are sometimes as instructive as successes, I have placed the machine on the table for your inspection. In this machine I did not measure the power lost in the sample, but endeavoured to get an approximate means for comparing the permeability of different samples. An iron ribbon is coiled up to form a closed ring, and this is wound on opposite sides with coils so connected as to produce consequent poles over the two sides kept free from winding. The sample is made up of narrow strips into a flat bar, which is laid across the poles to form a magnetic bridge. The sample is surrounded by a pilot coil, and this is connected with an electrostatic voltmeter. If the same current is always sent through the main coils, and at the same frequency, then the volts produced by the pilot coil are supposed to give, roughly, an indication of the comparative value of the samples. The method was a

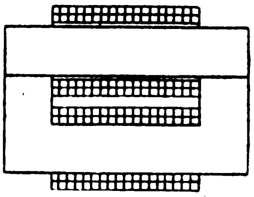


Fig. 2.

failure, partly because permeability is not an absolutely reliable guide in estimating hysteresis loss, but chiefly because the uncertainty in estimating the magnetic resistance of the joints completely swamped any small differences that might have existed in the permeability of the samples. I therefore promptly abandoned this instrument, and set to work on another which would give directly that what we want to measure—namely, the losses at given inductions.

This instrument, which I finally adopted, is shown on the table, and in the diagram (Fig. 2). It consists essentially of a closed magnetic circuit of rectangular shape, the two longer limbs being enclosed in exciting coils. One long limb and the two uprights are composed of plates in one piece; the other long limb is formed by the sample plates, which are laid together so as to make up a certain weight, and are then bound together with tape and inserted through the top coil. The sample is fixed by wooden wedges. The coils are connected with a source of alternating E.M.F. (sine function) through a wattmeter, and the instrument is thus ready for use without further preparation beyond making up a bundle of plates into a sample bar and inserting the latter. The instrument is calibrated once for all by making the sample and the fixed part, or yoke, of the magnetic circuit out of the same quality of plates, measuring the loss of power at different inductions, and apportioning the losses between the yoke and sample according to their weights. When testing other samples the total loss is measured by the wattmeter, and from this is deducted that portion of the loss which is occasioned by the iron which forms part of the instrument, the remainder being the loss in the sample. A correction must be made for the loss of power resulting from the ohmic resistance of the two coils, but this is exceedingly small. The induction is found from the E.M.F. applied to the coils and the frequency. In order to have a wide range of induction, and yet keep the measurements of current and E.M.F. within the limits most convenient for the instruments at hand, the coils are subdivided, and suitable terminals are provided. The resistance of the joints between the sample and the yoke is immaterial, as it influences only the current, but not the power.

The upper curve in Fig. 3 shows average results obtained in testing samples of plates furnished by several different suppliers of transformer iron. I say advisedly "suppliers," and not makers, because iron merchants are, as a rule, disinclined to give the name of the maker. In fact, I have had a case in which two samples supplied by rival merchants gave precisely the same curve, and on making inquiries I found that the iron came indeed from the same maker, but was sold under different names. The lower curve in Fig. 3 shows the results obtained with the best sample I ever tested. As it is not my purpose, and as it would indeed be improper to advertise any particular maker in a paper of this kind, I trust you will not expect me to give his name. The curves are, for convenience in use, plotted under the supposition that the frequency is 100. The abscissæ give induction, and the ordinates loss of power in watts per pound of iron. The thickness of plates varied between 10 and 13 mils. Within these limits I believe that the thickness has only a very small influence on the

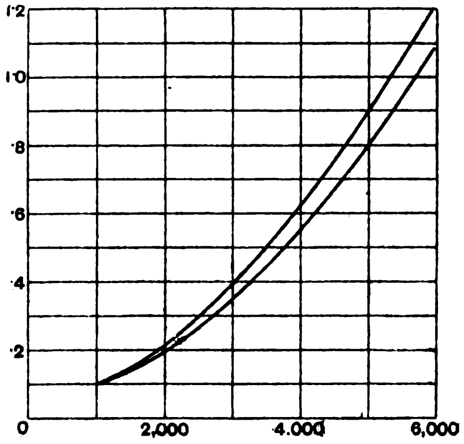


Fig. 3.

loss—at any rate, I have not been able to detect any such influence; and this confirms an admirable investigation by Prof. Ewing, in which he showed, on theoretical grounds, that a reduction of thickness below about 13 mils is of no advantage. It is, of course, quite easy to test transformer plates by taking a known weight of stampings and making them up in a transformer with only one coil (preferably a low-pressure coil). If the same coil be always used for this purpose, the results will be perfectly reliable. The method is, however, tedious when a number of samples has to be tested, as time is wasted in building up and taking to pieces again the plates between each set of tests. With my testing machine all the samples can be prepared beforehand, and slipped in quickly one after another, so that the whole series of tests can be performed under the same conditions and by the same men. The facility with which samples can be changed is also of value if it should be necessary to verify any doubtful point in the curve obtained in a previous test.

There is another and very obvious method of testing transformer iron, and that consists in making up a complete transformer with the sample plates to be tested. Apart from the waste of labour entailed if the iron should turn out bad, this method is very uncertain. The reason for this uncertainty is that we test, not the iron alone, but the complete transformer, and we are thus left in doubt as to how much of the measured loss is really due to the iron. Theoretically the whole loss is due to the iron, but in practice this is seldom the case. When testing a transformer immediately it is completed, and again after some weeks during which it has been regularly at work, you will find that its losses have become less. This I believe to be due to the coils having become thoroughly dry, and their insulation higher. A very small electrical leak in the high-pressure winding may easily lead to a waste of power, which, although small in itself, and not capable of doing any damage, is still appreciable when compared with the true iron loss. Take,

* In the instruments exhibited, the corrections for top of sample, frame piston, and air-resistance collectively, amount to $\frac{2·37}{1,000}$ B ampere-turns, to be deducted from the total ampere-turns. Thus, for B = 12,000, which would be the lowest induction of practical importance, 28·5 ampere-turns would have to be deducted from a total of about 300; whilst for B = 15,000 the corrections would be 35·5 to be deducted from a total of about 1,500, and for higher inductions the correction becomes quite negligible. If P is the tearing-off weight in pounds, $B = 2,973\sqrt{P}$; and if X represents the corrected ampere-turns, $H = \frac{X}{20·2}$.

for instance, a 4-kilowatt transformer wound for 2,000 volts. Its iron loss would be about 2 per cent., or, say, 80 watts. Suppose, on testing this transformer, you find that the loss is not 80, but 100 watts. You might then conclude that the iron has 25 per cent. more loss than it ought to have, and you would condemn the sample. This might, however, be an unjust verdict. The extra 20 watts measured might very well be due to a general leakage of current across the turns of the high-pressure coil. The leakage surface is large, and the pressure is large, so that the current density of the leak is very small, and no damage will be done. The leak vanishes as the transformer gets dry, and thus may be explained the curious fact that transformers get better after use. The moral of this is that to do justice to a transformer the final test should only be taken after it has been at work for some time.

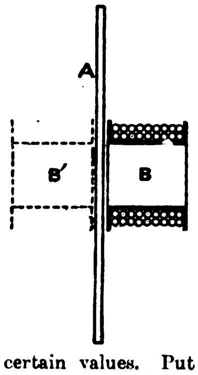
In conclusion, I wish to express my thanks to Messrs. Johnson and Phillips for the loan of the testing machines here exhibited.

DISCUSSION.

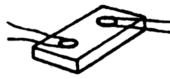
The following is an abstract of the Discussion which followed the reading of Mr. Kapp's Paper; speakers whose remarks are prefaced by an asterisk, have returned their proofs revised :—

* Prof. HUGHES said he had not had any experience with the high induction of iron, as all that he had been working at with iron was with very feeble currents. But the method of testing in this machine was one which he had adopted in his printing telegraph instrument. The armature was held by the standing magnet, and it was let loose by the current reversed to it. In that case they had the holding power just as in this, and it was a measure of the current. But they had this difficulty, that if the surfaces were not perfectly exact there was always a slight variation in the regulation. With the printing telegraph instrument, if they took it to pieces there was always a variation in the adjustment, and they had to readjust it; and as the armature in Mr. Kapp's arrangement would have fresh surfaces brought into contact at each different test, he would like to ask Mr. Kapp if he had met with this difficulty, and what means he employed to ensure an absolute similar contact throughout different tests.

Prof. S. P. THOMPSON said Mr. Kapp had referred to his instrument, which he devised some four or five years ago. The second form of instrument that was made for him by Messrs. Nalder Brothers, was very much better, in fact, so much better than the first that he was inclined to believe that it was a little better than Mr. Kapp's. As the Institution existed for the criticism of Papers read, Mr. Kapp would not object to his criticising his instrument. Whilst it was quite true that they might make corrections for various sources of possible error, such as the magnetic reluctance of other parts of the apparatus than that under measurement, yet still it seemed better to him that when instruments of that kind had to be designed they should be designed so as to avoid all sources of correction that could come in afterwards to add to the calculations. In designing a metre-bridge it was necessary to take care that all the brass-work was very thick and conducting compared with the wire stretched along and which was to serve as the standard resistance, in order that the corrections, the very quantities which might have to be applied as corrections, should in themselves be so small as to be for all practicable purposes negligible The cross-section of the mass of iron surrounding the coil and plunger was in his instrument 200 times as great as the cross-section of the rod that served as plunger. Then again, his plunger, which was in itself the test-piece, was made longer and thinner in proportion than was the case in Mr. Kapp's instrument, for the express purpose of eliminating the error due to possible badness of contact. It would be remembered that in Dr. Hopkinson's method of testing the magnetic qualities of iron he had a large massive block of soft iron of a rectangular shape with a rectangular hole slotted out, very much like Mr. Kapp's block, only more massive, and the test-pieces to be examined were two bars that met in the middle. It occurred to him in going through Dr. Hopkinson's researches that the effect that he sought to measure by pulling the two test-pieces apart, and measuring the flow of magnetic lines from one to the other by the little exploring coil pulled out sideways, might quite as well be measured, for commercial purposes, by the mere pull of one test-piece on the other. And having got as far as that, measuring the pull of one test-piece on the other, he said to himself, "Why should I take the trouble to make two test-pieces when exactly the same result can be obtained by having one piece and having the contact piece against the yoke?" He did not adopt that method without investigating it to see if it made very much difference. He took two test pieces and let one stick up against the yoke at one end and the other against the second test-piece in the middle of the coil, and then tugged at the test piece. Sometimes the iron separated at one end, sometimes in the middle; so there was not much difference in the two attractions which overcame the magnetic lines. So the simpler method, which he finally adopted, was quite adequate for the purpose. He would further say, about Mr. Kapp's second instrument, that he congratulated him upon having given them such an excellent instrument for measuring the magnetic properties of sheet iron. He thought the same criticism might be passed upon this instrument as upon the other. If the cross-section of the instrument could be enlarged very much indeed he thought it would simplify matters, especially as the hysteresis question came in to cause further complication. He was engaged in research on the behaviour of masses of iron such as were used in the first of Mr. Kapp's instruments, for the purposes of serving as yokes, yokes having no magnetic resistance, and he had arrived at a most interesting point of view, viz., that a large sheet of iron, so large as to be negligibly different from an infinite sheet, not less than 10 mm. thick, acted towards all things that might be placed in front of it as a magnetic mirror, giving, however, only negative images, and not positive mages. Suppose A (Fig. 1) to be a large sheet of good soft iron; then let there be a coil, B, placed anywhere on one side of it, say a hollow bobbin with some wires wound upon it, the current circulating round that coil had a certain magnetising effect through the coil. If no sheet of iron were there the magnetic forces round the coil, through the interior of it



and outside, would have certain values. Put the sheet there, and the effect was precisely the same as if the sheet were absent, and the coil were double the length, that is, if the coil and its image, B_1, were both at work. A little exploring coil placed hard up against the iron showed that the action of the iron was simply to double the action of this magnetising coil, and not only when hard up against the iron, but in any other position. Now, suppose a sheet of iron in that way at one end of a coil, and a second sheet at the other end. Then they had the same problem optically as if they put a candle between two mirrors, producing an endless row of candles; they got an endless row of coils. The effect of placing two large sheets of soft iron at both ends of a coil was practically to make the coil endless; in fact, they arrived at the conclusion that the ampere-turns on this coil, multiplied by 4π divided by 10 and divided by the length in centimetres, was a true expression for the intensity of magnetic force right down that line, as it was down an infinitely long solenoid. One thing he would like to suggest to Mr. Kapp, whether he could not suggest to them some way of getting at the magnetic properties of iron not in a rod or sheet, but in a block—a cubic yard, say. It ought to be possible. Let there be a thin strip of ebonite; drill in that two round holes, lay in those round holes two small coils, the one to receive a current, the other to give



a current to a galvanometer, a sort of transformer with no coil at all. Lay this on a block of iron and apply a magnetising coil. Some lines would come up through the hole, depending upon the goodness of the iron below. A complete magnetic circuit might be made by another block of iron on the top. Then they had the permeability, the magnetic reluctance between the two blocks, and a small air-gap between the two blocks. In that way they might have a method of measuring the permeability of iron in the mass.

Mr. STEELE: With regard to the permeameter, just one precaution should be taken in making out a sample bar. If, in the case of cast-iron or steel, a small sample was taken, sufficiently large, or turned to the required diameter, the results obtained on testing the sample in the instrument might prove considerably worse than the results obtained in actually testing the dynamo. This was due to the fact that the skin had not all been turned away. This took some time, and, as Prof. Hughes had remarked, an error might be made unless the end of the sample was placed properly against the plunger, and was placed in the right position. This difficulty of facing the ends might be got rid of by using a small cap carefully faced at the end, this to be used for every sample. The three-voltmeter method was used for testing the loss of the iron. The tests were accurate enough, but the results required laborious working out. The wattmeter now used required much less work, and yielded equally accurate results, quite consistent with the old three-voltmeter tests. The facility in making tests of this sort had helped in a large degree to reduce the losses in the transformer, and the efficiencies obtained now were quite high as compared with the efficiencies of a year or eighteen months ago.

The loss was only 0·95 per cent. of full-load, and the full-load efficiency was 97·4, which he thought, they would agree was fairly high.

Kapp Transformer—100 frequency.

Size.	Per cent. Iron loss.	F. L$^{d.}$ Efficiency.
3 KW	1·74	96·4
6	1·34	96·9
12	1·13	97·25
20	0·93	97·4

Very often an actual fault in the transformer might be due to the partial short-circuiting of the primary or secondary coils. This would increase the magnetising current greatly, and also increase the watts. It was difficult at times to localise the fault. The method they had found to answer was to suspend a rod of iron horizontally, and move it in the direction of the leakage lines of the transformer. If any of the turns were short-circuited, magnetic leakage would be produced, and this piece of iron would suddenly dip and be attracted towards the place where the coil was short-circuited. The fault thus localised, the difficulty might be to find out whether it was in the primary or secondary coils. This could be

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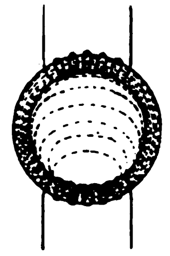
met by sending a current through each coil and repeating the experiment, when the position of the fault would at once be shown.

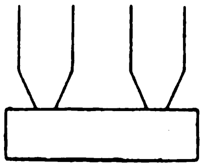
* Dr. FLEMING was not sure that it was always certain that unless you tested the iron in the form in which it was going to be used you were able, from experiments on small samples, to deduce what were the total losses in the iron. Laminating below the thickness of 10 or 13 mils. might eliminate eddy currents in certain iron masses; but it did not follow when worked up into a transformer, eddy currents would not be produced. The form which it might have might be such as to produce eddy currents circulating in the plane of the strip. Take one form which did exist—though it was the worst possible arrangement—and imagine a very thin strip of iron an inch or two wide wound up edgeways; now put on a couple



of coils, primary or secondary, and they could predetermine the loss in the iron at no load. Nevertheless, when working the transformer at full load there would be considerable magnetic leakage, and those lines of induction would sweep backwards and forwards perpendicularly to the iron, and that would create eddy currents in the plate however thin it might be, and that would produce eddy-current loss. There was an extra loss which might ensue if the transformer was not dry that in some cases was very marked. He thought in all cases the cores of transformers ought to be baked to a fairly high temperature before being wound, and then, of course, care must be taken that they were not in any way spoiled before they were tested. There was another thing which it was also important to bear in mind, although one must hesitate about speaking too confidently, and that was that the loss in the iron seemed to depend upon the form of the E.M.F. curve. He had recently had some correspondence with Mr. Blathy, in which that question had been raised. Mr. Blathy tried the experiment of taking the same transformer and testing it on a machine which gave a true sine E.M.F. curve, and then trying it on another machine in which it was known that the form of the E.M.F. curve was very different from the simple sine curve, and the result was that the transformer when tested on the simple sine curve gave a markedly higher loss than when tested on the other. Manufacturers found some difficulty in repeating the quality of their iron. They would specify for a particular quality, and make up certain transformers with it, which came up to the specification or standard; they repeated that order, and were unable to get it, and had to confess themselves disappointed in their iron. Nothing would be more practically important than to ascertain whether it was possible to get rid of hysteresis altogether, and whether it was not a thing which might some day be abolished. The question was partly an electrical one, partly a chemical one, and partly a mechanical one.

* Mr. SPARKS wished to ask very much the same question. When Mr. Kapp tested his sample bar, did he find the results obtained in practice anything like those obtained during the experiment? Because the sample had to go through the operation of being drawn out, it was forged to a greater extent than an ordinary magnet block, and there was also a chance of its being better annealed. The working up in a lathe would affect the sample differently to a large block, it being machined in another way. Under those circumstances one would imagine the results obtained would differ very greatly in the experimental bar from those which would be obtained when the iron was made up in the form of the field of a dynamo. He had made a great many experiments on samples, but the great difficulty seemed to be that even in testing one sheet there was an enormous difference between the results of different parts of the sheet.

Prof. PERRY thought Prof. Thompson's method was not a good one for testing iron in block. It was air resistance which was tested, and there was no saturation and no permeability at all. With regard to a remark made by Prof. Hughes as to the reason why bad fitting produced such very evil results, it might not be known to those who had not to make to sell, that if you wanted great lifting power in a permanent magnet all you had to do was to have the area of contact between copper and magnet ridiculously small. On every square centimetre of area the attraction was proportional to the square of induction. For only a small area there was far greater intensity of induction. If they diminished the area, having the

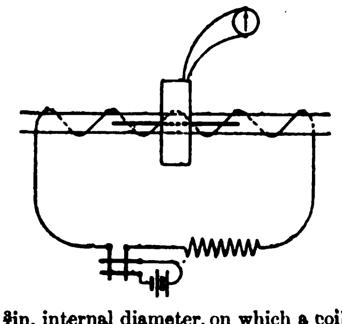


same total amount of induction, they would have an exceedingly increased force. In connection with this subject, some of them may have been astonished at some results of his published some time ago on the permanent magnet induction that could be obtained in steel. He believed he gave results three times as great as anybody else had given. They could get an enormous induction if they properly shaped their magnet.

Mr. MORDEY congratulated Mr. Kapp on the practical style of his instruments. He would ask him whether he had experimented with testing-bars on the effect of time in changing the carrying power of the bars. Another point which was of interest to dynamo builders was the fact that the bars were not true samples of bulk—small test bars. One often found that iron differed a great deal in the piece. He had seen a dynamo in which the armature always pulled to one side; there seemed to be no reason for it, but on investigation it was found that there was such a difference in the quality of the iron of one end of the bars and that of the other, that an actual pull was exerted in one direction. He had had a great deal of trouble on account of the inability of iron manufacturers to supply iron of anything like even quality, and the statement of Mr. Kapp, that iron makers are now offering iron that will conform to definite specification as to watts per pound, was probably the result of the efforts of the Brush Company to obtain iron in that way. As a matter of fact, they ordered and obtained their iron to a specification of that sort, and as the specification was public property he saw no reason why he should not mention the terms of it. The standard taken was 2,500 lines per centimetre, and the loss at 100 periods was 0·38 of a watt per lb.; that was a standard very easily worked to, and the quality was exceeded to the extent of iron being obtained of 0·25 and 0·28 of a watt per lb. On the other hand, it varied 60 per cent. above that standard frequently, even out of the same case of iron. That was a very awkward circumstance for all of them. The interests of all were identical in this matter, and they should all do everything they could to encourage ironmakers to face this subject, and endeavour to ascertain the reason why iron sheets varied so enormously. They were facing it after a fashion, but the iron people did not understand electrical and magnetic quantities at all; they looked upon the thing as a kind of sacred mystery, and shrugged their shoulders when asked to give iron of definite quality—or had done so until lately. As far as his experience went, chemical analysis was absolutely no guide whatever to the quality of the iron. That would seem to indicate that it was a physical question, a question of condition, and not of chemical composition. He did not know what arrangement was made in connection with this instrument to show how the power factor varied. It was an extremely curious thing, this variation of the power factor in connection with iron under alternating currents. The power factor might vary all the way from 0·6 to 0·9, but the hysteresis might be practically the same. The power factor might vary very considerably; as a rule it did not vary more than 6 or 7 per cent., but it might vary through those limits, and that meant that any test taken of current was valueless. It was extremely interesting to endeavour to find out what was the reason of this variation of the power factor of transformers. As far as he knew there was no information at their service on the point. At one time he thought it had to do with the electrical resistance of the iron, but from some tests he had made he did not find any connection there. It was a very important effect, because it affected central station engineers in the outgoing current in the daytime. He was rather surprised to hear that he found very little difficulty with the contacts in the testing instrument. He (the speaker) had found a great deal of difficulty with the contacts, and in the specification to which he had alluded they made it a rule to make that specification apply to the particular form in which they used the iron. The iron had to be used in certain transformers of certain types, and therefore the test was made applicable to the particular type of stamping. They found that in varying the contacts even slightly they could not get anything like the same results.

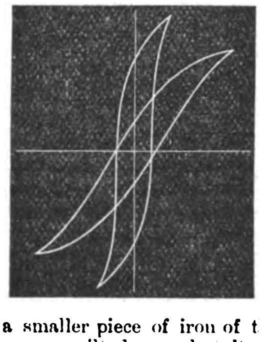
Mr. RAVENSHAW thought the importance of testing armature iron was as great as that of testing transformer iron. The losses were larger in large dynamos very often than in small ones. Iron varied very much indeed, and cases had lately come under his notice where it was desired to test iron, and difficulty was found in getting it done rapidly; a simple form of apparatus like that would have been of the greatest value for the purpose. A case had come under his notice where the hysteresis losses in iron were exactly twice in bulk what they were in the samples.

* The PRESIDENT (Mr. Alexander Siemens) remarked that Mr. Kapp said in his Paper that the method devised by Dr. Hopkinson and Prof. Ewing gave most accurate results, but the very perfection of those methods formed a drawback to their adoption in engineering works where highly-trained experimenters could not be found; and then in another place he said the sample consisted of a bar accurately turned and faced. Judging from the remarks of Prof. Hughes and Mr. Mordey, Mr. Kapp had simply shifted the difficulty from being an electrical one into a mechanical one, because to produce those beautifully turned bars required a long time and a good deal of mechanical skill. He wished to show them the way in which they tested the magnetic qualities of iron at Woolwich. They would at once see that it was a very much simpler and safer method than Mr. Kapp's. The apparatus was based upon that of Prof. Ewing, and consisted of a brass



tube 3ft. long and ⅜in. internal diameter, on which a coil was wound which was in connection with a rheostat, a double key, with a battery which gave about 10 volts, and there was an exploring coil on the first coil which was

connected with an ordinary galvanometer. Now what was done was to plot out the hysteresis curves of the various sorts of iron. When a piece of iron was put in care was taken that it was not as long as the brass tube. Then a current was sent through the coil, varied by inserting more or less resistance by the help of the rheostat, and the kicks which the galvanometer gave each time the resistance was altered were plotted down. The double-current key gave them the opportunity of reversing, so that they could get the complete curve. The area of the hysteresis at once gave the



quality of the iron. If a smaller piece of iron of the same quality were used, the hysteresis lozenge was tilted over, but it remained of the same area. There was no fitting in this whatever. They need not make the samples of the same length to compare with them, but merely cut off a strip of iron from the block they wanted to test, put it in the brass tube, and make the curve, which one man could do in a quarter of an hour, and they knew at once quite accurately what quality of iron was before them.

Mr. KAPP, in replying, said Prof. Hughes had really struck the keynote of all the important objections to the instrument, and that was the difficulty of getting the surface so true that they could rely upon its contact. They must not forget that this instrument was not for testing inductions of 2,000 or 3,000, in which case the question of surface would be of more importance, but for testing inductions of 10,000, when it did not matter if the surface did not lie on quite flat. He had taken the trouble to spoil one of the samples for the purpose of ascertaining that. He was a little disappointed that Prof. Thompson left off at the most interesting part of his remarks. Had he succeeded in making the corrections in his permeator smaller than in his (the speaker's)? But the difficulty was that it must have fairly good contact where it went through the top yoke. His (Mr. Kapp's) object in pulling away the plunger was to keep the sample tight and confine his corrections to one plunger and the same piece in every experiment. It was important, of course, that there should be a definite quantity of iron under test. Supposing they had a definite quality of sample. Let them make the enormously big bottom yoke. Would Prof. Thompson, or anybody else, tell him the length of the sample he was testing? It was utterly impossible. In Fig. 3 they had two curves, both taken by the testing machine. The top curve had an average of about five different suppliers' iron—not five samples, but a lot supplied from five different sources. The bottom one was supplied by a merchant who kept his maker very secret; it was very excellent, but he had never been able to reproduce it. It was interesting to find Mr. Mordey's specification tallying so well with his average; his was about 0·35 and Mr. Mordey's 0·38. As to the power factor, he had made no experiments.

THE LIVERPOOL OVERHEAD RAILWAY.*

BY J. H. GREATHEAD AND F. FOX, M.M.INST.C.E.

The Paper began with a history of the undertaking, which was the practical solution of a difficulty first experienced 40 years ago, namely, the provision of better communication for passengers along the frontage (now extending to 6½ miles) of the Liverpool Docks. The elevated railways in New York had been highly successful in meeting the wants of the travelling public, but were attended by several inconveniences. There were no parapets and no floors, the sleepers being placed directly on the top flanges of the girders. The result was that, as the railways were worked by steam locomotives, cinders, oil and water dropped into the street; fine shavings from the rails and tires fell on the foot-passengers, and in one case, at least, a locomotive had fallen bodily into the street. Mr. A. G. Lyster, who had minutely studied the New York system and reported thereon to the Liverpool Corporation, had expressed himself in favour of an overhead electrical railway, and after some delay an Act was obtained in 1882 by the Mersey Dock Board for the construction of a double line of 4ft. 8½in. gauge. The estimate for this, fully equipped and worked by electricity, was £466,000. The structure was intended to consist of plate girders, with overhanging continuous footways having parapets of iron lattice-work, with the rails laid upon greenheart planking; the whole being supported by columns of partial lattice-work placed in the normal structure, one on each side of the lines of dock-railway. Owing to the fact that many influential members of the Dock Board were unwilling to embark upon railway management, the undertaking was in 1887 leased to the present Liverpool Overhead Railway Company, by which the line was constructed.

The length of railway at present worked was 5 miles, but would ultimately be 6½ miles. In the structure decided upon the columns were placed vertically under the ends of the main girders, about 22ft. apart from centre to centre, allowing sufficient width for two lines of standard gauge with the usual 6ft. way, and admitting the use of carriages 8ft. 6in. wide. Local circumstances in many cases did not, however, admit of the columns being placed immediately under the main girders, and the latter were then carried upon cross-girders outside the line of columns. For considerable lengths, also, the columns had to be embedded in the boundary and warehouse walls. Owing to the presence of the dock lines below, cross-bracing of the piers in the usual way was impossible, and it was necessary to give to the columns and to the shallow cross-bracing connecting them at the top sufficient strength and rigidity to resist the lateral stresses due to wind-pressure, and, on curves, to the centrifugal force resulting from the motion of the trains.

In carrying out the works no special difficulties arose in connection with the foundations of the piers. In places where rock was not reached, masses of concrete were deposited of sufficient extent to insure the maximum load on the base not exceeding one ton per square foot. In excavating for the foundations the sill of the first dock made in Liverpool was discovered, and several lengths of old water pipes, consisting of trunks of trees bored out and fitted together, were brought to light. Owing to the railway being placed immediately over the dock-lines, the latter were in many cases diverted, straightened and improved. The columns supporting the viaduct consisted of two steel channel bars riveted to two steel plates, forming a box column with all the rivet-heads outside. These columns were grouted into cast-iron sockets bedded in and bolted through the blocks of concrete. Cast-iron bumpers filled with cement-concrete protected the columns from injury from passing waggons. The normal span was 50ft., but longer spans up to 98ft. and shorter ones of about 30ft. were required in some cases. Up to 75ft. span, the height of the girders above the rail level did not exceed the platform height, and plate-girders were used. In longer spans bowstring-girders were used. Between the girders was fixed Hobson's arched-plate flooring, consisting of $\frac{5}{16}$-in. plates bent to a radius of 12-in., with a flat surface 6in. wide on the top, riveted to intervening T-bars, and made water-tight by asphalt run in the V-channels between the arches. The structure was so designed that the spans could be put together and riveted up with floor complete at one or both ends of the railway, and be then transported over the completed portion of the structure to be placed in position. A special form of erecting-machine was provided, consisting of two lattice-girders standing upon legs resting on the ground at the front end, and at the hinder end upon a carriage running on rails on the viaduct. These girders were placed at such an altitude as to allow the trolley carrying the succeeding span to be rolled along underneath them. On these lattice-girders were placed two travelling cranes, so arranged as to lay hold of the spans on arrival, run them forward, and deposit them in their permanent position upon the columns which had been erected in advance. The average time occupied by this operation was one hour per span.

In the course of the work several opening bridges had to be provided which were described and illustrated in the Paper, as were also the stations, permanent-way, and rolling-stock.

The total quantity of iron and steel in the structure was about 22,000 tons. The total capital cost, including equipment and all other charges, had been £550,000, or about £90,000 per mile of railway. The line was formally opened by the Marquis of Salisbury on February 4, 1893, and was opened for traffic on March 6th following. The electrical system of working was completely successful, a five-minute service of trains being maintained with perfect regularity and without mishap of any kind. On the last August Bank Holiday about 40,000 passengers were carried in the space of eight hours.

* Abstract of a Paper read before the Institution of Civil Engineers, Tuesday, February 27th.

BOOKS RECEIVED.

Journal of the Institution of Electrical Engineers. Price 5s. (London: E. and F. N. Spon. February, 1894.)

"The Engineer's Year-Book of Formulæ, Rules, Tables, Data and Memoranda." By H. R. Kempe. Price 8s. (London: Crosby Lockwood and Son.)

"Taschenbuch für Monteure elektrischer Beleuchtungsanlagen." By S. Freiherr V. Gaisberg. (München: R. Oldenbourg.)

"Die Vertheilung der elektrischen Energie in Beleuchtungsanlagen." By Ferdinand Neureiter. (Leipzig: Oskar Leiner.)

"Thermodynamics of Reversible Cycles in Gases and Saturated Vapors." By M. J. Pupin. (London: Kegan Paul, Trench, Trübner and Co., Limited.)

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CORRESPONDENCE.

THE GRIFFIN ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Seeing a letter under the heading of "Double-Acting Gas Engines" in your issue of February 16th, in which reference is made to the "*obsolete Griffin engine*," we shall feel much obliged to you if you will kindly point out in an early edition of your paper that the "Griffin" *gas* engine is an entirely different machine to the "Griffin" *oil* or *hydro-carbon* engine, for which we hold sole licence to manufacture in this country, and which is now being placed upon the market, and giving unqualified satisfaction.

We draw your attention to this point because, perhaps, in the hurry of reading a letter of this character, the two engines might be somewhat confused.

In respect to Mr. Griffin's *gas* engine, we have no doubt that he will take up this matter himself in due course.

Thanking you in anticipation of your kind attention to above.—Yours, &c., SAMUELSON AND CO. (LIMITED).

Britannia Works, Banbury, England,
February 23rd, 1894.

LEGAL INTELLIGENCE.

M'Carthy v. Electric Construction Company (Limited).

This was an action in the Lord Mayor's Court, before the Recorder (Sir Charles Hall, Q.C., M.P.) and a special jury. It was a claim by the plaintiff to recover the sum of £2,600, being the proceeds of the sale of 605 shares in the defendant Company, by whom the plaintiff was formerly employed as clerk and bookkeeper.

In opening the plaintiff's case, Mr. PYKE, Q.C., stated that the proceeds of the shares in question had been received by the defendant Corporation. The Electric Construction Corporation was founded, promoted, and formed in the year 1889, at the instance of the Building Society Securities Corporation, at the head of which was Mr. Jabez Spencer Balfour. Mr. J. S. Balfour was a Director, and the shareholders included Capt. Dibley, Henry Granville Wright, Hobbs, and Newman, all of whom became shareholders in the Electric Construction Corporation, and some of whom were Directors of both companies. In 1889 there were allotted to Capt. Dibley 1,712 £10 shares in the Corporation which purported to be fully paid up. That being so in 1891 Dibley transferred 1,500 of these shares to a Mr. Tarver, who was, in fact, the Building Securities Company, of which he was the secretary, for the large consideration of £10. Shortly before the crash of the Balfour companies came, the shares which Dibley had transferred to Tarver were re-transferred to the defendant Company in the names of Sir Daniel Cooper and Mr. A. Courtney for the consideration of 5s. On October 18th, after the collapse of the Balfour companies, 500 of these shares were transferred to a Mr. Brownham, a clerk in the firm of Messrs. Bonsver, Wright and Company, of which the well-known Henry Granville Wright was a partner. Those shares were sold within a few weeks by the defendant Corporation for the sum of £2,234. 7s. 6d. The sum was paid by a cheque drawn to M'Carthy, or bearer, and was paid by the Corporation into their bank. The plaintiff's case was that, having taken the risk attaching to those shares, he was entitled to the sum which they realised. The contention of the defendants was that the shares were put into the hands of the plaintiff for sale as trustee of the Corporation, but plaintiff's counsel contended that this was no defence in law, as the Corporation had no power whatever to deal in its own shares. The plaintiff, as the holder of the certificate, was the legal owner of the shares, and entitled to the proceeds of the shares. On November 14th 105 more shares were transferred to Mr. M'Carthy in the same way, and the proceeds of those shares, amounting to £414, were kept by the Corporation, they having been sold, and these sums together made up the plaintiff's claim.

After the plaintiff had given his evidence, it was submitted on behalf of the defendants that there was no case to go to the jury, and, after hearing the address of counsel, the jury intimated that they had made up their minds, and they returned a verdict for the defendants.

The RECORDER said that he was not in the habit of making remarks on the verdicts of juries, but he must say that in this case he thought it only fair that the defendants' counsel should have been allowed to give explanations, and he also thought that there been an unjustifiable use of names in the case.

Carboid Oilless Bearing Company (Limited) v. Planet Electrical Engineering Company (Limited).

This case was tried on Monday in the Westminster County Court (London), before Judge Lumley-Smith. It was an action brought to recover £12. 17s. 4d. for electric fuses supplied.

Mr. CANTLEY, for the plaintiffs, called Mr. RUDKIN, Manager to the plaintiff Company, who said that Mr. Scott called from the defendants in August, 1892, to ask the price of patent fuses. On the 12th he again called, and in the end plaintiffs had an order for 584 fuses. Witness explained to Mr. Scott that the eyelet holes were rather large, and he said they must be the size ordered, as they had their terminal fitttings made. The order was completed by September 6th, and after invoices had been sent plaintiffs took legal proceedings. The fuses were made of tinfoil and mica fixed together with two brass studs and would carry 300 amperes.

Mr. MADDISON, for the defendants, said plaintiffs had not supplied what was ordered. The fuses were for the Railway Clearing House, and were to carry 300 amperes, and they went before 150 was carried. They were tried in the Railway Clearing House, a place where light was absolutely necessary, and they went out. Plaintiffs were complained to, and only answered to the effect that if they were not paid they would go to law.

The JUDGE: Do you say they were useless for low pressure?

Mr. MADDISON: Yes.

Mr. SCOTT, secretary of the defendant Company, said about August 9, 1892, his firm got the order for the fuses. He went to the plaintiffs' place at Westminster, had an interview with Mr. Rudkin, and on the 12th took the order and specification. The fuses were supplied. Plaintiffs called for payment, and witness pointed out that the goods were not up to specification.

Defendant Company's ENGINEER said he went to the Clearing House. The fuses he found got very hot. They would not carry 150 amperes. He had the lights turned on in batches.

The JUDGE: Are the fuses stamped with the amount they are supposed to carry?

WITNESS: Yes; some of the fuses went near endangering the installation. Defendants only objected to the 300-ampere fuses. The Clearing House engineer objected to the others. He believed there was an arbitration with the Clearing House about the lighting. They were still using the low-pressure fuses at the Clearing House. They were there on sufferance. The larger the tinfoil the more would the fuse carry. It all depended on the sectional area of the tinfoil. There was a counter claim for £20, and the witness said that this was made up of £7. 16s., his and the manager's expenses, and new fuses and expenses, £13. 4s.

Mr. LANGDON, engineer to the Railway Clearing House, said he complained to the defendants about the fuses. He corroborated the defendants' engineer as to the failure of the fuses.

The plaintiffs called Mr. HEDGES, who said he was the inventor of the fuses. There was no fault with the fuses supplied by the plaintiffs. Similar fuses were supplied to the Midland Railway. All but five of his fuses he had seen in use at the Railway Clearing House.

The Jury found for the plaintiffs both for the amount claimed and on the counterclaim.

His Honour gave judgment accordingly.

Town Council Prosecution.

At Windsor, Alfred Edward Farrow, engineer to Messrs. Roger Dawson and Co., was summoned for having broken up the paving and roadway in High-street on January 2nd, without having first obtained permission to do so. The proceedings were taken under Section 149 of the Public Health Act, 1875.

Mr. G. H. Long, town clerk, prosecuted. The defendant admitted the offence, regarding which evidence was given by the borough surveyor and the road foreman to the effect that the roadway and paving in High-street were broken up on January 2nd, during the night, for the purpose of laying electric wire. A man in the employ of the defendant said he opened the road by defendant's orders. The Mayor said that if the defendant had applied for permission to break up the road he did not think it would have been refused. The Chairman said they had taken a very lenient view of the case; it was not to be tolerated for men to come into the town and set the authority at defiance. A fine of £2 was imposed, and £1 costs and 3d. for each square foot of roadway disturbed, or £3. 10s. in all.

The Storage of India-Rubber Solution.

A case of considerable interest to the india-rubber and cycle trades was decided at the Birmingham Police Court on Thursday last week. The India-Rubber, Gutta-Percha and Telegraph Works Company (Limited) was summoned, under the Petroleum Act of 1874, for storing without a licence, at their depot in Albert-square, Birmingham, 1,277lb. of india-rubber solution, which contained 84·8 per cent. of naphtha. It was contended that this commodity came within the meaning of the Act, and that a licence was required for its storage. It gave off inflammable vapour at 54°F., instead of at 73°F.

Mr. A. YOUNG, for the defendant Company, contended that the Act was never intended to apply to petroleum in combination with an article of commerce, but merely to petroleum and other oils specified, pure and simple.

After hearing the evidence, the Bench fined the defendants the nominal penalty of 40s. and costs, intimating that in future similar offences would be more heavily dealt with. They, however, expressed the hope that the solution, which was valued at £100, would not be forfeited if defendants made the required provision for its storage.

McGeagh v. Elmore's Foreign and Colonial Patent Copper Depositing Company (Limited).

This case which, as reported in our last issue, was adjourned, was disposed of in the City of London Court by Mr. Commissioner Kerr. Judgment was given for the plaintiff, Mr. McGeagh having during the adjournment (it is stated) agreed to go into the scheme of reorganisation of the French Company.

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In re Adamson.

In the Bankruptcy Court last week Mr. Justice Vaughan Williams heard a motion *in re* Adamson, a bankrupt, in which a Mr. Pembroke was a creditor for £150, and his proof, lodged in May, 1892, stated that he had no security for his debt "except 50 shares in the International Cable Company, which are of no value." That Company was then in liquidation, and it was not anticipated that there would ever be any value in the shares. A year afterwards, however, certain litigation in which the Company were engaged was settled in their interest, and the shares became of a certain value. The trustees now applied to have the shares handed over for the general purposes of Adamson's estate, on the ground that Mr. Pembroke's proof declaring the value of the shares to be nil amounted to a surrender of them.

It was contended for Mr. Pembroke that he might, under Rule 13, at any time amend his proof on showing that his original valuation of the security was based on a mistaken estimate.

Mr. Justice VAUGHAN WILLIAMS held that the trustee might, immediately on Mr. Pembroke's first proof being made, have demanded the shares, but as he had not done so, and Mr. Pembroke having now filed an amended proof, the shares must remain in his (Pembroke's) hands as a security for his debt. Rule accordingly.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

Our readers are reminded that the 1894 Edition of "THE ELECTRICIAN" Electrical Trades' Directory and Handbook is NOW READY. This valuable book contains 1,000 closely-printed pages, and several new and useful features have been added. The price of the Directory and Handbook is 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.) A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). prospectus on application to the Publisher.

"ELECTROMAGNETIC THEORY," by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application to the Publisher.

TENDERS INVITED.—It will be seen by our advertisement columns that the Corporation of Royal Leamington Spa invite tenders for the erection of five short lines of telephone wires, and for the supply and fitting up of six sets of telephone apparatus. Tenders must be sent in to Mr. H. Consett Passman, the town clerk, before noon on the 12th instant.

———— The Corporation of the Borough of Brighton invite tenders for the supplying and laying of armoured and lead-covered cables, of which specifications can be obtained on application at the office of Mr. Francis J. Tillstone, the town clerk, Town Hall, Brighton, to whom tenders have to be sent in before 10 a.m. on Monday, the 12th inst. Some further particulars appear in our advertisement columns.

———— The Technical School Committee of the Bury Corporation invite tenders for electric light fittings, which must be in by March 10th.

TENDERS RECEIVED.—The Directors of the Northern Co-operative Company have received tenders for the installation of the electric light throughout their large premises at Aberdeen, and have appointed a committee to classify and arrange the offers.

TENDERS ACCEPTED.—The Hull Corporation have accepted the tender of Messrs. W. H. Allen and Co., for a surface condensing plant at £759; and from Earle's Shipbuilding and Engineering Company for supplying and laying 400ft. of 10in. cast-iron suction and delivery pipes, for £284.

———— The Directors of the Yorkshire House-to-House Electricity Company (Limited) have let the contracts for the extension of their electricity works as follows: For buildings, Messrs. William Nicholson and Son; for plant, Messrs. Hick, Hargreaves and Co. (Limited), and Messrs. John Fowler and Co. (Leeds), Limited.

———— The Norwich Town Council have accepted the tender of Messrs. A. Pank and Co., of Norwich, to provide and fix fittings for lighting the Guildhall and municipal and sanitary offices by electricity for the sum of £290. 17s.

PLANT FOR SALE.—Messrs. Wheatley Kirk, Price and Goulty advertise a quantity of second-hand electric lighting and other plant for sale, including dynamos, boilers, engines, lathes, &c. Further particulars are given in our advertisement columns.

BANKRUPTCY.—The discharge of Thomas Fletcher, electrician, of 188, Broadhurst-gardens, West Hampstead, has been suspended until a dividend of not less than 10s. in the £ has been paid. The bankrupt is to pay the Official Receiver £120 a year, in monthly instalments, with liberty after two years to apply for a modification of the terms.

DISSOLUTION OF PARTNERSHIP.—Mr. John A. Edmondson, of the Globe Electrical Works, Bradford, and of Leeds and Huddersfield, notifies that the partnership hitherto subsisting between Harris Ullathorne and John Alfred Edmondson has been dissolved, as from February 24th, and that Mr. J. A. Edmondson will in future carry on the business alone, in his own name, at the same addresses.

———— We are informed by Mr. Harris Ullathorne that he has entered into partnership with Mr. Arnold Hartley, and that they will in future carry on business as electrical engineers at the Crown Electrical Works, 19A, Charles-street, Bradford.

———— Notice is also given that the partnership hitherto subsisting between Mr. Sheard Charlesworth and Mr. Joseph Platt Hall at Richmond Hill Ironworks, Oldham, under the style of Charlesworth, Hall and Co., was dissolved on February 26th, Mr. Hall having purchased Mr. Charlesworth's interests in the property, and assets of the firm. Mr. Hall continues the business under the style of J. P. Hall and Co.

LIQUIDATIONS.—At a meeting held on February 12th of Fowler's Engineering Company (Limited) it was resolved to wind up the Company voluntarily, and Mr. P. Holman, 11, Queen Victoria-street, E.C., was appointed liquidator.

———— It was resolved at a meeting of the Platinum Plating Company (Limited) held on February 23rd, at 27, Clement's-lane, E.C., to voluntarily wind up the Company, and Capt. R. W. Shackel, Elmhurst, Mitcham Common, was appointed liquidator.

———— A meeting of the Freedman Battery Company (Ltd.) will be held at 66, Berners-street, W., on March 31st, at 3 p.m., to receive an account of the winding up.

TRADE ARBITRATION BOARDS.—It is announced that the French Minister of Industry and Commerce has communicated with prominent English labour leaders, asking for particulars *re* trade arbitration boards, as the French Government are about to legislate in this direction.

MESSRS. BENNETT AND DRUCE.—This firm have received instructions from Messrs. Frisby, Dyke and Co., of Liverpool, to instal the electric light throughout their extensive premises. The plant will consist of a special high-speed Otto gas engine, a compound-wound dynamo, and about 250 incandescents distributed over the shop and premises, from which gas is to be entirely excluded.

ELECTRIC CRANES, &C.—Messrs. J. G. Statter and Co. have recently received an order from the South-Western Railway Company of Russia for the supply of three electric cranes and the necessary plant for generating station for the harbour at Odessa. The cranes are to be similar to those supplied to the Southampton Harbour Board and to the London and India Docks Joint Committee.

MESSRS. MILLER AND WOODS.—This firm send us an illustrated price-list and catalogue of electrical accessories, including a transformer for heating medical cauteries, a sub-divided transformer for obtaining a higher or lower pressure than the normal from alternating-current street mains, a pressure reducer for continuous current, and a specially-designed focussing lamp.

BAMBOO FITTINGS.—Mr. W. Bowker, of Messrs. Bowker Bros., Preston, has had on show in London a number of examples of bamboo worked into various artistic and plain designs for electric light fittings. The examples shown included brackets, three and six-light electroliers, &c. It is claimed that bamboo lends itself to easy treatment for almost any design for such fittings as are required in either temporary or permanent lighting installations. The specimens of Messrs. Bowker Brothers' work shown were remarkable for their lightness and portability, and it was stated that the fittings can be supplied at a much cheaper rate than metal fittings; that they can be made to be taken to pieces readily, and are easily packed. For temporary installations or for festive gatherings very artistic effects can be produced in a comparatively short time at trifling expense. The bamboo can be easily painted, bronzed, gilded, or varnished. It is stated that in the neighbourhood of Preston, where the firm's works are situate, many of the principal hotels and several private houses have been installed throughout with these fittings. It is especially pointed out that the fire insurance companies have passed the fittings, which will, of course, neither tarnish nor corrode, and are easily cleaned. They can be readily adapted to surrounding decorations.

ABERDEEN.—Mrs. Stewart, the wife of the Lord Provost, on Tuesday night switched on the electric current to the ten electric lamps of about 2,000 c.p., which have been erected in Castle-street, Union-street, and St. Nicholas-street, Aberdeen.

ABERYSTWYTH.—The Town Council have received the proposal of the Bourne and Grant Electricity Supply Company (Limited) with reference to the lighting of the Marine front. The proposal

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is to place 20 arc lamps along the Parade, and the Company offer to lay the mains free of charge on a lighting contract being agreed to for a term of years. A committee meeting of the whole Council was held yesterday, and a confirmatory meeting is to be held to-morrow.

ACTON (MIDDLESEX).—At the last meeting of the Local Board the Finance Committee reported that the surveyor had provided information concerning the probable cost of establishing a system of electric fire alarms and calls throughout the district, and the Committee had requested the surveyor to supplement these particulars with further information from the Willesden and Ealing districts. The Works Committee have made some alterations to the agreement regarding the electric lighting of the district, and have returned this to Mr. Medhurst for reconsideration. If the alterations are accepted the conditions of lease and schedule are, we understand, to be considered.

ASHFORD.—It has been arranged to light the grounds of the Trades and Inventions Exhibition, shortly to be held at Ashford, by the electric light, the contract for which has been placed with Mr. King, of Maidstone.

BOURNEMOUTH.—A question was asked at the Town Council meeting last week as to whether the time had not arrived when consideration should be given to the subject of lighting the borough by electricity. After some discussion the Council decided that they were not prepared to consider the question at present.

BRISTOL.—A public meeting of the inhabitants of St. George was held last week, at which it was unanimously decided to ask the Bristol Town Council to afford every possible facility to the promoters of the electric tramway scheme from Kingswood to St. George. It was announced that under the scheme the Tramways Company were prepared to spend between £2,000 and £3,000 in widening the main roads of the district. At the last meeting of the Bristol Corporation it was agreed to grant the Tramways Company the powers asked for to enable them to proceed with the construction of the electric tramways, which the Company estimate will entail expenditure amounting to about £50,000.

CHELSEA (LONDON).—At the meeting of the Vestry the Hall and Electric Lighting Committees reported that they had again considered the advisability of lighting the Town Hall by electricity, and had obtained thirteen estimates for wiring, &c., varying from £225 to £500. Before finally accepting any estimate, it will be necessary to arrange with an electrical engineer to superintend the work during its execution, at a fee of £26. 5s., or to inspect the installation, after completion, at a fee of £15. 15s. The Committee recommended that the Vestry undertake the work themselves, and that Mr. Morgan Williams, of Messrs. Morgan Williams and King, Victoria-street, London, S.W., be appointed to superintend the work. After some discussion, this proposal was agreed to.

CHURCH LIGHTING.—The church and churchyard of St. Mary-at-Hill, London, has for some time been closed. The church has now been fitted with the electric light, and was reopened by the Lord Mayor and Sheriffs in state last week. The installation has been carried out by Messrs. Smeeton and Page.

CROYDON.—At the meeting of the Corporation on Monday the General Purposes Committee presented their report, recommending that the Council proceed with the lighting of the compulsory area, under the Order already obtained, and that application be made to the Local Government Board for sanction for a loan of £25,000 for this purpose. In January of last year a recommendation of the Committee that the Council should carry out the lighting of the compulsory area at an estimated cost of £22,500 was referred back, and later the Committee again brought the recommendation forward with the amount of estimated expenditure fixed at £25,000. This was again referred back, and now again comes up as a recommendation from the Committee. Councillor Miller, in moving the adoption of the report, said that there was no question as to the demand for the electric light in Croydon, and obstacles should not be placed in the way of obtaining it. The Chairman of the Electric Lighting Company at Bradford had told him that, even supposing their electric lighting works were doubled, they would be unable to meet the demand for the light. With reference to the lighting of their new Town Hall at Croydon, this was estimated to cost £500 per annum, but he felt sure that in a short time the building would be lighted at 25 per cent. less than the sum which would have to be paid if gas was utilised. Mr. Preece's estimate for installing the light in the Town Hall was about £3,500, but he said that if the Corporation had the light from the central station it would only cost £1,500. The tradesmen of Croydon wanted the light, and surely, as the principal ratepayers, they deserved consideration. The proposal was strongly opposed by Councillor Martin, who in the course of his remarks stated that "even now the electric light was in an experimental stage," and that "they were asked to spend £25,000 on an experiment which might result in failure!" After a long discussion the motion was rejected by 22 to 19, and was again "referred back."

EDINBURGH.—The Lord Provost's Committee of the Town Council have recommended the Council to refuse their consent to the proposed agreement between Messrs. Dick, Kerr and Co. and the Edinburgh Street Tramways. The object of this agreement was to carry on, as far as possible, the tramways concern as one undertaking. Regarding Messrs. Dick, Kerr and Co.'s proposal to form a new organisation and to transfer to themselves the control and management of the tramways undertaking, the Committee decided to recommend that no action be taken in this matter.

FRIEDRICHSRUHE (GERMANY).—Prince Bismarck's castle has just been fitted up for the electric light by the Hamburg branch of the Elektrizitäts-Gesellschaft vormals Schuckert and Co. The power is derived from saw mills belonging to the Prince situated at a short distance from the castle.

HULL.—Mr. A. H. Gibbings, the Corporation electrical engineer, has presented his estimates for the coming year, amounting to £4,387, which includes £2,000 for additional capital, making a total capital outlay of £37,000. The Chairman of the Electric Lighting Committee expressed his satisfaction at the working of the electric lighting station for the past year. After paying working expenses and interest about £100 is left to the good. The Committee had every reason to feel confident, and there was no necessity to ask for assistance from the rates, as the income would quite meet the expenditure. For the nine months they had been working they had supplied 75,000 units, and the demand was still increasing. They were working as cheaply as any company in England.

ISLE OF MAN.—The Directors of the Isle of Man Tramway Company have submitted to the shareholders an offer made by the Douglas and Laxey Electric Tramway Company for the purchase of their undertaking for £38,000, and recommend the acceptance of the offer.

KEIGHLEY.—The Gas Committee have recommended the Town Council to give instructions for the necessary notice, and to make application to the Board of Trade for an electric lighting Provisional Order to supply electric current throughout the district. The proposal came before the Town Council at their last meeting, and was approved.

LIVERPOOL.—At a meeting of the members of the Junior Reform Club, the sub-committee elected to consider the question of electric lighting, recommended the adoption of a new system now in use in Paris, but which had not, their report stated, been tried in this country. The proposal was adopted. The estimated cost is about £1,000.

LLANDUDNO.—The Gas Committee of the Improvement Commissioners, who have been discussing whether the Commissioners' sanction should be given to the proposal of a projected electric lighting company in their application for a Provisional Order, have recommended that the Board sanction the scheme and consent to the company's application, satisfactory terms being first agreed upon between the Commissioners and the proposed company with respect to the sale to the Commissioners within a specified time of the undertaking. After discussing the Committee's proposals, the Commissioners have referred to a Committee of the whole Board and the promoters of the proposed company the question of electric lighting and water supply.

LONDON COUNTY COUNCIL.—At the meeting of the Council, on Tuesday last, the Highways Committee's report, recommending that the Victoria Embankment be lighted by electricity from the centre of the roadway, the work being carried out by the Works Committee, was postponed.

MANSION LIGHTING.—Sir Thomas Lucas has entrusted Messrs. Drake and Gorham with the work of electrically lighting his house at Kensington Palace-gardens, for which 370 lights will be required. The decorations are very elaborate, and the house is built in an exceptionally solid manner; all the more credit, therefore, will be due to the contractors when the work is satisfactorily completed. The existing fittings have been adapted for the electric light.

MOSS SIDE.—At the last meeting of the Local Board the minutes of the General Purposes Committee, concerning a draft licence authorising the Board to supply electricity within the Township, were referred back to the Chairman and the Clerk for further consideration in detail.

NEWARK.—A proposal has been before the Urban Sanitary Authority in regard to the lighting of the district by electricity. The authors of the proposal have, evidently, not secured the interest of the Mayor, who, at the last meeting, stated that "in London the electric light was produced at a loss." He thought that they would be ill-advised to permit a company to work at Newark, and proposed that the application which they had received be not granted, which proposal was carried.

OSSETT.—A meeting has been held of the Tradesmen's Association of Ossett and Horbury, in order that serious complaint might be made of the quality and price of gas supplied by the local gas company. The meeting was largely attended, and many sugges-

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tions were made, one of which was that an effort should be made by the Ossett Corporation and the Horbury Local Board to acquire the gas works. A Mr. Fothergill stated that he himself had installed the electric light owing to the very bad gas supplied, and he was of the opinion that the Ossett Co-operative Society would shortly put in the electric light. He further stated that, unless the Corporation were prepared to apply for a Provisional Order a local company would take the matter up, and endeavour to supply the district with electric current. After a long discussion, in which the suggestion was made that the electric light should take the place of gas for public lighting, it was finally decided to wait on the gas company, and place the matter before the Directors for their consideration.

Peterborough.—The Corporation have deposited £50 with the Board of Trade on the understanding that this sum is to be forfeited if the electric light in the city is not completed within two years. The *Peterborough Express* is responsible for the statement that "only certified electrical engineers will be permitted to make the electrical connections."

Rochdale.—A successful installation of the electric light has been made at the new church of St. Andrew, Dearnley, near Rochdale. The work has been carried out by Mr. James Wilcock, of Littleborough, near Manchester, to the entire satisfaction of the Building Committee. A 4-h.p. Crossley gas-engine is included in the plant, which provides current for 60 incandescents.

St. Pancras (London).—At the meeting of the Vestry on Wednesday, the Electric Lighting Committee recommended that they be empowered to obtain the loan required for electric lighting purposes elsewhere than through the London County Council. The Committee's recommendation was approved. The reduction by the London County Council of the period of time for repayment asked for by the Vestry has given much dissatisfaction.

Staff Dinner.—The staff dinner of the National Telephone Company will be held this (Friday) evening at the Holborn Restaurant, under the presidency of Mr. W. E. L. Gaine, the General Manager.

Stoke Newington (London).—At a meeting of the Vestry complaint was made of the price charged by the Gas, Light and Coke Company for supplying the district with gas. It was pointed out that the only way to compete against this monopoly was to encourage the electric light. The neighbouring district of Hackney has obtained a Provisional Order, and members of the Vestry favoured a similar course being adopted by the Stoke Newington authorities.

Suicide.—Mr. George Edward Forrest, aged 70, who assisted his son, Mr. James Forrest, in his electrical engineering business at Great New-street, Fetter-lane, E.C., committed suicide last week by shooting himself with a revolver. At the inquest, a verdict of temporary insanity was returned.

Theatre Lighting.—The Chairman of the Empire Palace, Leicester-square, London, announced to the shareholders at their meeting on Wednesday that the electric light had been installed throughout the large building and outbuildings adjacent belonging to the Company.

Tynemouth.—The Borough Surveyor has reported to the Trade and Commerce Committee of the Town Council on the proposed electric lighting scheme. A sub-committee's report states that Messrs. C. A. Parsons and Co. were the only tenderers for the carrying out of such works as were necessary to retain the powers conferred by the Provisional Order; that the tender for laying mains in Saville and Howard-streets amounted to £1.355, dynamo and accessories £445, and for lighting the Town Hall buildings £162, or a total of £1,962 in all. The sub-committee recommended that application be made to the Local Government Board for sanction to borrow £2,000 to carry out the scheme, but that only £1,355 be at present expended for cables. After some discussion, this report was adopted.

Toxteth Park.—The Local Board have just issued a scale of charges for testing, which are as follows:—

		s.	d.
Insulation of main	Each test	5	0
Conductivity of main	„	7	0
Insulation of service lines	„	2	6
Conductivity of service lines	„	4	0
Efficiency of joints	„	3	6
Tests of instruments of undertakers, per instrument		1	0
Tests of electric lines of undertakers other than mains and service lines		2	6

Warehouse Lighting.—The extensive new premises of Messrs. R. Maule and Sons, in Princes-street, Edinburgh, have just been completed, and were opened for business last week. The building occupies the old site of the Scottish Liberal Club, facing the Caledonian Station, and forms one of the largest blocks of business premises in Edinburgh. The buildings are lighted throughout by the electric light, and the installation includes an electric lift, worked off the lighting dynamo, which is a Siemens' 200 ampere. The plant includes a 28-h.p. Crossley gas engine. Altogether there are 38 150-c.p., 5 100-c.p., 2 50-c.p., and 36 16-c.p. incandescents. The lift has been put in by the Otis Elevator Company.

Wolverhampton.—At a meeting of the Wolverhampton Victoria Hotel Company, at which the Mayor of Wolverhampton was present, he said that, as Chairman of the Lighting Committee of the Corporation, he looked with great favour on the electric lighting scheme. He had used the electric light in his own house and at his works for a long period, and he would not be without it if it cost four times the price of gas. There was no comparison between gas and the electric light, regarding which he had prepared certain figures which would shortly be issued in printed form. He believed that if the electric light were used with care, and without waste, it was not more expensive than gas. He strongly advised the Directors of the hotel to instal the electric light in their handsome building. With regard to the new theatre to be built on land adjacent to the hotel, that also should be installed with the electric light, and he hoped that this would be ultimately decided upon. The Chairman of the Company, Lieut.-Col. E. Pritchard, said that it was the intention of the Directors to introduce the electric light into the hotel, as they were fully agreed as to the advantages of that illuminant over gas.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by Mr. J. C. Chapman, Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.

APPLICATIONS FOR PATENTS.

January 23, 1894.

1,491. J. B. Barton. London. Improvements in arc lamps. (W. Jandus, United States.)

1,495. W. L. Wise. London. Improvements in commutator brushes. (O. Hering, Germany.)

January 24, 1894.

1,532. E. G. Pink. Dublin. An improved system of metering electric currents.

1,542. H. W. C. Cox and R. J. Crowley. Queenstown. Improvements in or relating to *facsimile* telegraphy.

1,582. F. Stone. Derby. Apparatus and process for converting heat into motive power or electricity (or both), and for cooling and refrigerating.

January 25, 1894.

1,657. H. P. Holt. London. A method of and apparatus for communicating electricity to vehicles.

January 26, 1894.

1,686. R. Kennedy. London. Improvements in propelling locomotives by electricity and in apparatus therefor.

1,695. S. D. Williams. Newport, Mon. Improvements in telegraph signal codes and apparatus therefor.

1,698. R. Steenberg. Newcastle-on-Tyne. Improvements in telephone-transmitters.

1,701. C. R. G. Smythe and A. H. Dunnachie. Glasgow. Improvements in and connected with electric conduits.

1,744. W. S. Rawson. London. Improvements in electrodeposition.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d. each.

1892.

18,039. Hargreaves and Bird. Electrolytic cells and diaphragms.

1893.

583. Wright. Electric meters.

982. Brookes (Dibble). Telemeter systems.

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1,355. Forbes. Electrothermal plates, tubes, &c.

1,539. Pfluger. Arc lamps.

1,697. Binswanger and Coates. Electric clock.

2,010. Scott. Electricity meters.

2,203. Gwynne. Arc lamps.

4,691. Lithanode and General Electric Co. (Limited) and another. Battery elements.

4,793. Brooke. Electric bells.

5,101. Fletcher. Electrically interlocking signals and points.

5,778. Boult (Kroefler and another). Bleaching solutions by electrolysis.

5,782. Marsh. Telegraph poles.

6,605. Parker. Diaphragms for use in electrolytic processes, &c.

6,723. Snedekor. Electric conductor coverings.

7,703. Johnson (Lattig and another). Electric signalling for railways.

10,623. Murray. Printing telegraphs.

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COMPANIES' MEETINGS AND REPORTS.

Telegraph Construction and Maintenance Company (Limited).

The thirtieth ordinary general meeting of the members of the Telegraph Construction and Maintenance Company (Limited) was held at the offices, 38, Old Broad-street, on Tuesday, under the presidency of Admiral Sir George H. Richards, K.C.B., F.R.S.

The MANAGING DIRECTOR (Mr. William Shuter) read the notice calling the meeting and the minutes of the twenty-ninth ordinary general meeting and of the last half-yearly meeting. The minutes having been approved and signed,

The CHAIRMAN said: Gentlemen, before we proceed to the business for which we are met, I should like, with your permission, to offer a few remarks to the meeting. Many things have happened very closely concerning us since we last met, and although these events cannot have had any possible effect on our present position, nor, I trust, are they likely to affect us in the future, and although they are recorded in the report, yet I feel that you would scarcely expect them to be passed over without some remarks from the Chair. The first of these events I have to notice is a melancholy one, the death of our late Chairman. As you all know, Sir George Elliot was one of the first Directors of the Company—in fact, he was one of the proprietors of the business which formed part of our work subsequently, and therefore he always took a deep interest in the affairs of the Company, and he was always keenly alive to its success. I can only say that we regret his loss very much here, and we believe that you will share this regret. At the same time, it must be said that Sir George Elliot died full of years, after a long and useful career. Perhaps this is the time when I ought to say a few words as regards my own position as Sir George Elliot's successor here. They shall be very few, but I should like to give you the reason for it. My colleagues were of opinion that my long connection with the management of the Company probably rendered me one of the most fit persons among us to represent your interests as Chairman, and as this was their unanimous wish, and as I felt also that it was the wish of the chief officers and staff with whom I had been in connection so long, there was only one thing for me to do, which was, to accept the honour they were good enough to offer me, and I can only hope that their expectations will be fulfilled. The third point which I have to mention is also a painful one. I cannot but advert to the death of a very old officer of the Company, who served us faithfully for nearly 30 years—I refer to Captain Halpin. I have no doubt that Captain Halpin was well known to many present. He was the captain of the "Great Eastern" for many years, and of many of our ships, and latterly he was our marine superintendent. Capt. Halpin was, no doubt, one of the pioneers of cable laying, and his great skill as a seaman, and his knowledge of telegraphic engineering, enabled him to do very good service for this Company in its early years. Capt. Halpin may be said to have died in the prime of his life and his usefulness, and we all very much regret his death. Now, I think we may turn to the consideration of the report, and any business that may arise in connection with it. I have no doubt that you have all read the report, and that you will take it as read. You will have seen there that we have done a very fair year's work, both as regards cable manufacturing and laying and as regards our general business in gutta percha at Wharf Road. You will have seen that in various parts of the world we have laid cables covering a distance of nearly 4,000 miles, and we have laid them very successfully; and you also see that we have done a great deal of work in our regular business. This really is the gist of all that I have to tell you. I do not see that I need refer to any of the causes that have produced commercial depression in almost every department, since we have been free from it. I will, therefore, not say anything more at present, but if you desire any further information that I may be able to give you I shall be very happy to do so. I now propose

"*That the report and accounts of the Directors to December 31, 1893, submitted to the meeting be and are hereby received and adopted, and that a dividend of 36s. per share in addition to the 12s. per share, interest or interim dividend paid to June 30, 1893, be paid upon all shares of the Company for the year ended December 31, 1893, and that such dividend be paid free of income-tax.*"

Mr. PHILIP RAWSON: I have much pleasure in seconding the motion.

Mr. CATER inquired what remuneration the Managing Director received, and whether it was an annual sum or was influenced by the work done by the Company, as was the case with the Directors. He saw an item of over £6,000 in the balance-sheet for remuneration to Directors, but as that was exclusive of the Managing Director's remuneration and there was no information in the balance-sheet to tell him what the Managing Director received, he would be glad of the information he had asked for. He also presumed that the £6,000 was divisible among five Directors.

Mr. LITTLE desired to know whether the item of debts owing to the Company, £269,861, was for cables laid last year only, or prior to that.

General TREVOR said that the item of debts owing by the Company and reserves for insurance, debentures, and contingencies, amounted to £564,000. How much of that sum was really a reserve for debentures and contingencies he did not know, nor was this shown in the balance-sheet. Of course, the debenture interest must be paid, and therefore some money must be reserved safely for this purpose. With reference to the reserve for contingencies: "contingencies" was a wide word, and it might include the contingency of a bad year's business, when no profits were made by the Company. He wished to know where this safe reserve was invested, not only to meet debenture interest, but also to meet the shareholders in a year when nothing was earned, and when the shareholders would expect to receive something. The next item in the balance-sheet was called "reserved fund," £50,000, but the shareholders would like to know whether that amount was also safely invested, and whether it was in Consols, in stocks, or in a liquid stock which one could take out directly in the event of a bad year. On the other side of the balance-sheet nearly half a million sterling was taken credit for for value of property, among it being stocks and stores. The auditors' certificate, which he thought was drawn up in a slovenly way, said that they inspected "the inventories of the various stocks on hand of stores, materials, &c." Inspecting an inventory was an ambiguous phrase. The auditors did not state that they were satisfied themselves that the value of the stocks in this inventory was properly calculated or represented a sum of money, which he could not name because it was mixed up in the sum of £475,860. They also said that they had inspected the several securities held by the Company, but they did not say that the £470,520 was really of that value to-day. The questions he desired to ask were, therefore, four. First, where was the reserve for debentures and contingencies invested, and where also was the reserve fund of £50,000 invested; secondly, how did the auditors ascertain the actual value of the stocks on hand and materials, and how did they ascertain that the actual value of the sundry securities was £470,000. Was that Stock Exchange value, or not? The auditors sought re-election. The auditors were always re-elected by the shareholders, and if they were present he would remind them that once they accepted that position they became the servants of the shareholders, and they ought to draw up the accounts in a satisfactory way, and not lump up items in a manner which might be—he did not say it was so in this case—satisfactory to the Directors only. It would depend on the answer he received to his questions whether he moved a resolution.

The CHAIRMAN: In reply to Mr. Cater's question, I have to say that the Managing Director is paid an annual salary, and not on any amount of profit that may be made. Formerly there were two Managing Directors, but there is now only one. The Managing Director's duties are very onerous indeed, and his salary is in accordance with that state of things. It is not necessary to show it. I ask whether any gentleman here, if he held this business as a firm, would like these particulars handed to the public. You are surrounded by safeguards. You have a most eminent firm of accountants and your own auditors, and I say that you cannot be more secure than you are. It is a very difficult thing to ask me to go into details of accounts which ought not to be submitted to the public. The Directors' remuneration is settled by the Articles of Association of the Company. The Directors are empowered to pay the servants of the Company what salary they think fit. You may ask us the salary of every member of the staff, but it would not be a proper thing to state.

A SHAREHOLDER said he thought there could be no reason for withholding from them the Managing Director's salary.

The CHAIRMAN: I do not think it is in accordance with custom. There is no objection to it, but I do not think it is a matter that should be made public. You have economised your Managing Director's salary by one man doing the work of two. Mr. Cater asked among whom the Directors' fees were divided. They are divided among seven Directors. With reference to the question about the reserves. the ordinary reserve of the Company is £50,000, which is invested in Consols, and is available whenever it is wanted. We are authorised by our Articles of Association to make reserves for anything we deem fit. In a Company like this you are obliged to make reserves. You are working, not like a railway, above ground, but under the water, and are liable to all sorts of accidents. You therefore have a reserve for insurance, for the refitment of your ships, and for a variety of things, but I think it would be very wrong to make all these particulars known to the public. The shareholders get their dividend. If we paid you no dividend, and made a large reserve, these questions might be asked.

General TREVOR observed that his question was what would the Directors do in a year when the Company earned nothing.

The CHAIRMAN: That question has never arisen. We have always paid good dividends, and probably because we make these reserves. If we earned a large sum and paid you nothing you might ask such a question, but such a thing has never happened. I should have thought the meeting would have been satisfied with a good dividend, and have allowed the Directors to make such arrangements in the future as would ensure their receiving a good dividend. That has been the arrangement of the Directors for years, and I think that until last year you had the same dividend as we propose to pay you now. You must not, however, regard this Company as if it were a railway company or a company whose results are more or less certain every year. This Company is uncertain in every way, and it is only by great caution that the Directors have been able to do as well as they have done and to make no mistakes, and to make sure of paying a dividend. This is what we have always done so far. I am sorry that any one should ask questions which cannot be for the benefit of the Company, and which may be very much to its disadvantage.

A SHAREHOLDER: I regard it as a covert censure on the Directors to put such questions.

General TREVOR said that he had put four questions, one of which the Chairman had replied to, and he desired answers to the other three questions before any other shareholder addressed the meeting. At the request of the Chairman he repeated his other three questions.

The CHAIRMAN: Perhaps I had better ask our accountant to reply to them.

Mr. SHUTER, in answer to Mr. LITTLE, said that the £270,000 owing to the Company represented trade debts, and they were all perfectly good. The greater part of them were incurred last year.

Mr. DEVER said he had been asked to explain how the auditors satisfied themselves as to the value of the stocks on hand. The auditors were not present, but on that occasion he would reply to the question, as being the head of the clerical staff of the Company. His firm acted as accountants to the Company, but not as auditors, but he was able to tell

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the meeting how the auditors satisfied themselves that the figures were accurate. The stocks were taken—and he was sure every man of business will admit that this was the only correct and possible way to take them—by the staff of the Company, and the head of each department weighed, measured or counted the quantity of stuff he had on hand. These calculations were afterwards put into the form of an inventory. It was not the duty of auditors—and he thought it was hardly a duty that any body of shareholders would try and cast upon professional auditors—to check the stocks of a manufacturing concern like theirs. The auditors had no practical knowledge of the items; they would hardly know their names and scarcely recognise their existence if they saw them, and they would utterly fail in putting any value upon them. The shareholders might depend upon it that the best way of checking them was to have the items dealt with in the manner he had stated by those who understood them. His firm used these inventories after submitting them to such checks as they could before the auditors saw them. That check went to a sort of examination of the prices attached to the items where the knowledge of the head office might be brought to bear, and went to the clerical accuracy or otherwise of this very large and complicated stock sheet. The accountants gave to them as much check as they felt could be given to them in estimating their value. The second question was how did the auditors satisfy themselves—or did they satisfy themselves at all—as to the value of the securities held by the Company. They did so, and the accountants did so before the statement came to the auditors. The accountants prepared a most elaborate schedule of the investments of the Company, and they submitted that to the auditors priced out in two different ways. There were two classes of securities held by the Company. One was solid investments of the Company's funds. These were held up at cost, and it might be interesting to the meeting to know that the value at that moment of the securities held up at cost was very largely in excess of the figure at which they appeared in the accounts. The other section of the securities was made up of shares, bonds, stocks and other securities coming into the hands of the Company by way of payment for work done. These were held up at market prices and could be realised very quickly. He assured them that there was no fear that the investments of the Company were not both very good and very liquid, and were held up at fair and realisable figures. Speaking for the moment for the auditors, he should say that the form in which the accounts were presented to the shareholders was not the affair of the auditors at all. An honourable proprietor had, he thought, passed a slight degree of blame on the auditors for submitting the accounts in their present form, but he repeated that that was not the auditors' business. The accounts were rendered to the Directors in the form in which they had been accepted and agreed to by the shareholders themselves. Year after year the accounts had been presented in their present form. It had been considered by the Directors, without doubt, that this was the best form, but it had always satisfied the shareholders. It was not for him to say one word in favour of giving either more or less information, but the Board and the shareholders had to settle this matter between themselves The shareholders had—he thought wisely—determined that this form was most complete and fair, and studied the real interests of the Company itself. If the shareholders desired something else he thought it would rather tend to display a want of confidence in those who were managing the Company's affairs. Much was kept back from the accounts, and he thought wisely kept back. The shareholders had never pressed for it, and he thought they had acted wisely in this, and he would advise them not to do so, because it would not be for the general interests of the Company.

General TREVOR thought that as they had been told that the reserved fund of £50,000 was in Consols it might be stated so in the balance sheet in future. It would save questions from being put.

The CHAIRMAN: It would be very easy to answer such a question by stating that the reserved fund was in Consols.

Mr. GEORGE W. CAMPBELL said that it had been invested in Consols for the last 25 years.

Gen. TREVOR said that nothing could be more satisfactory than this statement.

Mr. CAMPBELL, continuing, said that if it was stated that the reserve fund was in Consols they would only be asked what the other investments were in, and they could not mention all their investments.

Mr. RAWSON remarked that it had not been the policy of the Company to enter into details because it had been thought that it would be inadvisable to do so. Hitherto the shareholders had had confidence in the Directors, and he thought wisely. All their reserves were in the best conceivable securities, they were all liquid, and were not mixed up in the general business of the Company at all.

Mr. WHISH said it was very strange to him that such a severe inquiry should have taken place that day, in view of the fact that from year to year the shareholders had accepted without a single murmur the statement of Sir George Elliot that it was advisable, in the interests of the Company, to keep certain things in the background.

The CHAIRMAN then put the resolution, and it was carried unanimously.

Mr. CAMPBELL afterwards proposed the re-election of the retiring Directors, Admiral Sir George H. Richards and Mr. Philip Rawson. The Directors, who had had the opportunity of knowing Sir George Richards and seeing him at work for the last twenty years, considered it a great advantage to have that gentleman not only as a Director but as their Chairman.

Mr JAMES PENDER, J.P., seconded the motion, which was carried unanimously.

Mr. BLANFORD then proposed the re-election of the auditors, Mr. John Gane and Mr. Patrick A. Glegg. He thought they might congratulate themselves on the exceedingly interesting statement they had had regarding the auditors' work.

Mr. HEWAT seconded the motion, which was adopted.

Mr. RAWSON said he desired to thank the shareholders for their renewed confidence in re-electing him. It would be impossible, he added, to find any Company in London that was sounder than theirs in every way. Nothing could exceed the care which was taken on every point, and the shareholders might leave the meeting perfectly satisfied that every item in the report was perfectly honest and safe.

Mr. BLANFORD then proposed a vote of thanks to the Chairman and Directors, which was seconded by General TREVOR.

Mr. WHISH said he thought that some expression should come from the shareholders' side of the table regarding the loss which had been sustained by the Company in the death of their late Chairman, Sir George Elliot, who was a most gifted man. He also thought that the shareholders should accord a hearty welcome to Sir George Richards in the position which was now filled by that gentleman.

The resolution was carried by acclamation.

The CHAIRMAN: On behalf of my colleagues and myself I return you our best thanks for your kind vote. Our great object is to have your confidence, and without that I do not know that we should care particularly to fill the position we do.

The proceedings then terminated.

Notting Hill Electric Lighting Company (Limited).

The seventh ordinary general meeting of the Notting Hill Electric Lighting Company (Limited) was held at the Company's Registered Office, Bulmer-place, High-street, Notting Hill, on Tuesday last, Prof. Wm. Crookes, F.R.S., presiding.

The SECRETARY (Mr. R. G. Rawkins) read the notice convening the meeting, and the report of the Directors and statement of accounts were taken as read.

The CHAIRMAN then said:—Gentlemen, before I refer to other matters let me take the earliest opportunity of congratulating you on the success of the Company's working during the past year. The result achieved has quite come up to our expectations, and I hope this will also be the opinion of the shareholders. I will briefly go over the accounts as they are before you. They are published in such detail that little explanation is needed, but there are one or two items about which a few words of explanation and comment may not be unnecessary.

Share Capital.—Little need be said on this account. As a certain portion of the capital expended by way of preliminary expenses, &c., was unremunerative and not balanced by any visible asset, this portion is represented by the £5,500 Founders' shares, leaving the rest of the capital practically all represented by the visible assets of the Company. The Directors consider this to be a proper and business-like way of arranging the capital account. As to the Loan Capital Account would draw attention to the fact that according to this statement the Company is free from any mortgage or debenture debt, and the whole of its freehold and other properties are uncharged. In fact, our only debts amount to £926. 19s. 3d., and consist of certain monies advanced by consumers to pay for small extensions of mains which the Company has agreed to allow to be taken out in current, thus preventing any risk being incurred by the Company undertaking speculative extensions. It has been the object of the Company to make the subscribed capital represent the actual amount of capital expended. It will be seen from this account that this has practically been done. The item of £744. 10s. appearing against mains in this account has been spent during the year in making small extensions to connect up houses requiring the light, and in most cases a satisfactory return on the capital outlay has been guaranteed. Another item of £522. 11s. 11d. for patents has been explained fully in the report. The expenses incurred by the losing side for costs and licence were necessarily heavy, and were agreed to be divided rateably between the defending companies. The £522. 11s. 11d. represent the proportion which we had to pay. For this we have a licence to use the three-wire system through the whole of our area. It is estimated that the extra cost of construction, had this system not been adopted, would have amounted to between £5,000 and £6,000.

As to Revenue Account the figures for the year 1892 have been printed in the margin of this account, to enable shareholders to compare the amounts of receipts and expenditure for the two years. The cost of coal during the past year is seen to be identical with that of the previous year. The amount burnt, however, has been larger and the revenue from the sale of current is about £1,000 more than before. This is due to various causes. Notwithstanding the protracted coal strike the price paid was some 3s. per ton less than that paid in 1892. On the first rumours of a strike, in consequence of the energy and foresight of our manager (Mr. Schultz), sufficient stock was laid in to carry us over any time of anxiety. Had this not been done the Company might have been seriously affected, as at one time coal was not at all obtainable. Consumption of coal has also been saved by various alterations in machinery. The engines were not worked up to their full power in 1892; indeed, we have not yet got them working to their full load, and it may, therefore, be estimated that next year the increase of revenue from current will be still larger in proportion than the expenditure for coal. The Directors have decided, in order to keep the fixed charges on as low a basis as possible, not to increase the engineer's salary, which is only £250 per annum, but, in order to remunerate him more in accordance with the market value of his services, have decided to pay him every year 5 per cent. on the amount of money distributed in dividend. I need hardly say that this will give Mr. Schultz an interest in the success of our undertaking (although, as he has proved by his services, it was not required), and at the same time will help to reduce the dead weight of fixed charges. The Directors would call attention to the enormous amount of rates and taxes, which come to £225. 15s. 11d., mainly caused by the very high valuations put upon the Company's works and mains. The Directors consider that the valua-

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tion for machinery used in the earning business should be fixed at a reasonable rate, and not at such an amount as would bring the rates and taxes up to 3s. in the £ on the net revenue of the Company. Householders live in houses of which the rent is one-tenth of their income, and on the same basis the total rateable value of the buildings and machinery, &c., of the Company should not be fixed at more than one-tenth of its gross income.

Rents payable.—This item will drop out in future accounts.

Directors' remuneration.—The Directors, who have already on former occasions proved their willingness to help the Company by concessions in respect to their fees, again do not propose to draw the full amount they are entitled to, viz., £1,000 per annum, until the Company can properly bear it, but in order to enable the Company to start the new year free from all liability, they have agreed to take £440 in full discharge of fees due to them, amounting altogether to £2,125.

Auditors.—During the past half-year the Directors have had the accounts submitted to a running audit by Messrs. Fox, Sissons and Co. In addition to this there has been the annual audit by Messrs. Deloitte, Dever and Co., as well as another annual audit by the auditors appointed by the Board of Trade, for which last item there is a charge of £24. 18s. 0d. Messrs. Deloitte, Dever and Co., recognising the fact that this triple audit was unnecessary, have voluntarily suggested that they should not again present themselves for re-election, and recommend that Messrs. Fox, Sissons and Co., who have a very intimate knowledge of the Company's accounts, should continue the system of running audit on behalf of the shareholders if the shareholders decide to elect them, leaving the annual audit to the officials of the Board of Trade. This would relieve the Company of considerable extra expense, and at the same time will provide for the shareholders the additional security of a running (*i.e.*, a continuous) instead of merely an annual audit.

Law Expenses.—The Directors call attention to the fact that the law expenses last year were only £13. 13s. As all questions of forms, agreements, and technical matters had been settled during the first two years of the Company's formation it was possible to make great economies on this item.

You will see that the profit on the year's working amounts to £1,481. 7s. 1d., a sum which compares most favourably with that of the previous year, when a loss of £137 would have resulted but for a fee of £250 from the New Telephone Company. The year before the actual loss was £554. 18s. 6d.

Net revenue account. — As you will see, the balance of profit appearing in the net revenue account, after writing off the loss of £347. 16s. 4d. brought forward from the last account, and allowing for a small amount of interest, amounts to £1,081. 16s. 1d. Out of this balance the Directors recommend the payment of a full dividend on the Preference shares to December 31st last. I must say I am extremely pleased to have the opportunity of proposing the payment of the Company's first dividend. The proportion of increase of revenue is about 10 per cent. less than the increase in the number of lights. Basing an estimate on the exact number of lamps on our mains on December 31, 1893, and without allowing for any increase whatever during the whole of 1894, a careful estimate shows a net revenue of £2,500, a sum which will enable about 2½ per cent. to be paid on our Ordinary shares at our next annual meeting. Any increase in the number of lamps or in their productiveness (and it is hardly necessary to mention that further applications have been received since the turn of the year) would be an addition to this revenue.

In regard to depreciation fund, the Directors have not passed any money to this account, but they have expended out of revenue and charged against the year's expenses sums amounting to £617. 5s. 6d., equal to about 1 per cent. dividend on the Ordinary shares, in the way of renewals and reconstruction. The Directors did not consider that it was a proper thing to put this amount to capital expenditure and then to write off, say, 1 per cent. on the capital for depreciation fund account; it would have had the same effect, but would have unduly augmented the capital account. The whole of this work has been carried out by our own efficient staff under the engineer's supervision, and the cost has been considerably less than would have been paid had others been called in to do the work. All our work is now concentrated under one roof, and the expenses all round have been reduced to the lowest point consistent with thorough efficiency. The saving will be more apparent during the current year. The mains and machinery have done their work well during 1893, no accident of any kind having occurred except the flooding of a small part of the culverts with water on two occasions in January, owing to a fire plug being blown out, causing a loss of about 250 units. It is gratifying to note that the London County Council, probably in consequence of the representations made to them by this Company, have replaced the whole of the old-fashioned plugs at a considerable expense, and up to the present with very satisfactory results, as no case of the kind has occurred so far during the present winter. The lamp patent expired in November last, and very good lamps can now be bought at 1s. to 1s. 6d. each. This will materially reduce the cost of installations, and should be some inducement to householders not at present using the electric light to take it. As you see by the Report the mains at the present time run past or opposite to 980 houses which are not yet taking a supply of current.

The number of lamps on our mains have increased by 2,715 during the year. This must be considered satisfactory, although the previous year's increase was 3,382. A large number of these were from the Phillimore extension. The average lamp earnings for the year still shows a tendency to sink, being only about 6s. 6d. per lamp. This can be partly accounted for by the exceptionally bright weather during the last quarter of the year, and the almost total absence of fog, the majority of our customers having consumed less than for the corresponding period of the previous year. Another fact showing that the bright weather was responsible for the reduced consumption is that although the number of lamps during the last quarter was about 25 per cent. more than the previous year, the corresponding increase in current consumed was only about 15 per cent.

The Company's sheer cost per unit is lower than that shown in accounts published in 1893 of any other London company. This is all the more remarkable inasmuch as our output is the smallest. At very little additional cost we could supply considerably more current, thus still more reducing the cost per unit. In conclusion I can assure you that the Directors will continue to do the best in the interests of the shareholders. But the fact that we hold over £16,500 of the capital in our own names is I think a sufficient guarantee of this, and now we have turned, and more than turned the corner, you will agree with me that the future success of our Company is assured. I now beg formally to propose:—

"*That the report of the Directors and the accounts to the 31st of December, 1893, submitted to this meeting be, and at the same time are, hereby approved and adopted, and that a full dividend to the 31st December, 1893, on the Preference shares be and is hereby declared, payable forthwith.*"

Mr. ALEXANDER HOWDEN seconded the motion.

Mr. J. S. BEALE, in supporting the resolution, paid a tribute to the Chairman and Directors for the very satisfactory manner in which the business of the Company had been carried on since it was started. He thought that the future of the Company was assured, and that the increase of revenue in time to come would be in a far greater ratio than the expenditure. He suggested that it might be advisable to convert the Founders' into Ordinary shares, so as to obviate a divided interest between the two classes.

The CHAIRMAN, while thanking Mr. Beale for his compliment to the Board, said that the suggestion of converting the Founders' shares was somewhat complicated, but it would be borne in mind and dealt with as opportunity offered.

The resolution was carried.

Mr. REEVES proposed, and Mr. MATTERSON seconded, the re-election of Mr. A. Howden and Mr. J. T. Jervis to their seats at the Board, which was agreed to unanimously.

On the motion of Mr. BRADFORD, seconded by Mr. DUTTON, Messrs. Fox, Sissons and Co., were appointed auditors for the current year at a remuneration of thirty guineas.

Mr. DUTTON proposed a vote of thanks to the Chairman, Directors and staff, and suggested that the Directors might increase the business of the Company by endeavouring to get more street lighting to supply, which he thought would be a very good advertisement for the Company amongst private consumers.

The CHAIRMAN, in expressing his acknowledgment, said that the idea of being advertised in the manner referred to by Mr. Dutton was one which they all liked, but it would not do for the Company to lose money by it. They had asked the Vestry to allow them to light the streets at cost price, but that body could not see its way to fall in with the proposal.

The proceedings then terminated.

Liverpool Electric Supply Company (Limited).

The ordinary general meeting of this Company was held last Friday in the Saleroom, Exchange Station-buildings, Mr. A. H. Holmes presiding. In their eleventh annual report the Directors were again able to announce a satisfactory increase in the number of lamps supplied from the Company's mains, the total number connected on December 31st last being equivalent to 25,784 16-c.p. lamps, as against 20,254 on December 31, 1892. The balance to the credit of the profit and loss account, including £4,851. 19s. 1d., paid for interim dividend in September last, was £12,710. 16s. 6d. This sum included the balance brought forward from 1892, and the sum of £297. 8s. 7d. received for premiums and interest on share account. The Directors recommended the payment of a dividend for the half-year at the rate of 5 per cent. per annum, absorbing £5,308, adding £1,000 to reserve fund and carrying forward the balance of £1,550 to next year's account.

The CHAIRMAN, in moving the adoption of the report and accounts, said they proposed to pay what he hoped they would think was a good dividend. They had had a very calm and usual year. He had nothing sensational to report. There had been the coal strike, which he thought had affected every industry in the country. It had affected not only private companies but public industries, and it certainly had affected their own Company by slightly reducing the balance due to them. The exceptionally fine weather in the autumn prevented as much light being used as had been used in previous years. Another unusual thing had been the extension of the city boundaries contemplated by the Corporation. This, he supposed, they might now consider to be almost an accomplished fact. They had made satisfactory arrangements with the Corporation, but he need not enter into them, as the change in the boundaries, although decided upon, would not come into existence until, at the very earliest, the end of this year. The Company had maintained their contract with the public, and had given them good and efficient light. They had had fewer complaints than they had ever had before, and he thought they might now say that the electric light throughout the city was certainly as much to be relied upon as the gas was. Such complaints as they had had were mostly owing to causes entirely beyond the control of the Company. There was still the question of cost. They had been accused of charging exorbitant prices for their light. He thought that a glance at their balance-sheet would show that the dividend they paid was not an exorbitant one, but was one they were entitled to expect. As a matter of fact they had considerably reduced the price to their customers. If they had charged the same price in 1893 as they did in 1891, it would have given them £27,000, as against £25,000. Therefore, taking the two years they had given to their customers the sum of £2,365.

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There had also been a considerable saving in the lamps. In November the Edison and Swan patent came to an end, and the lamps which they used to supply to their customers at 3s. 6d. they were now supplying at much lower prices. They had a new lamp which he was sorry to say was a foreign lamp, and made in Holland. They gave a good lamp for 1s., and the light from it was much superior to that of the old lamp. They had thus saved to their customers an amount of something like £1,500. At present they could not do anything towards further reducing the cost to consumers. They anticipated a large increase in the number of lights, and with that increase they would be able to charge a lower price. The increase in the number of lights had been a very satisfactory one during the past year, being over 26 per cent. There was no doubt they would have a great many more lights in future, and it would be absolutely necessary to extend their premises, and provide new boilers at two of their stations. Many of their most fashionable shops in Lord-street and Church-street were now lighted by electricity, and he thought the time was coming when most of the shops in the principal streets would be similarly lighted. The rulers of the city did not seem to see their way to use the light for public purposes. He regretted that their streets and all the public buildings belonging to the Corporation were not lighted by electricity ; still he hoped that this would come in time. The expenditure on capital account during the year, including a proportionate charge for general expenses, had been £53,777. They now proposed to spend something like £29,000, and in order to do that they had issued a circular calling up the remaining 10s. per share. They continued to write off a considerable amount for depreciation, and they had put £2,000 to the renewal fund, and they had also increased the reserve fund from £2,500 to £3,500. The total depreciation they had written off since the Company commenced amounted to £26,000, which was neither too little nor too much.

In reply to Mr. James Lister, the CHAIRMAN said originally the time fixed for the acquirement of the property by the Corporation was 1900, but a new arrangement had been made in connection with the city boundaries extension scheme, which would give the Company an additional 42 years.

The report was duly seconded and adopted.

Messrs. Samuel H. Holme and J. C. Vaudrey were re-elected Directors.

Mr. JAMES LISTER proposed that 750 guineas, free of income tax, be placed at the disposal of the Board of Directors as remuneration for their services during the past year. They owed to the Directors and shareholders a debt of gratitude for having introduced this system of lighting into a great city like Liverpool.

Mr. J. GIVEN seconded the motion, which was agreed to.

Mr. W. L. JACKSON was re-appointed auditor.

A vote of thanks to the Board of Directors and to the officials of the Company concluded the proceedings.

Cambridge Electric Supply Company (Limited).

The following is the report of the Directors to be submitted to the second annual general meeting, to be held at the offices, 2, Sydney-street, Cambridge, on Tuesday next, the 6th inst., at 12 o'clock :—

Your Directors have pleasure in reporting that the prospects of the Company are satisfactory. During the last twelve months, lamps equivalent to about 6,000 lamps of 10 c.p. have been connected to the Company's mains, making a total at the present time equal to 8.000 lamps of 10 c.p., and there is every prospect that the number will be largely increased during the present year. The plant, during the last three months, has been fairly loaded, and has worked to the satisfaction of the Directors, but owing to the coal strike in the autumn, a considerably increased price had to be paid for fuel.

It seemed to your Directors that it would be inexpedient to commence a profit and loss account, in respect of supply of energy, with only a small portion of the machinery at work, and they have therefore deemed it advisable to carry all receipts and expenditure under this head up to June 30th last to capital account. The Company has made a profit of £268 to December 31st last, and it is anticipated that with the additional lamps lately connected, and those which will shortly be connected, your Directors will be able, at the next annual meeting, to advise the payment of a substantial dividend for the current year.

Your Directors have thought it necessary to apply to the Local Authority for their sanction to the temporary suspension of the supply of current, between the hours of 2 a.m. and 5 p.m. in summer, and 2 a.m. and 6 a.m. in winter. A supply during these hours would involve the shareholders in heavy additional expenditure at the present early stage of the Company's operations, without any corresponding benefit to the general public. Your Directors, however, hope that the applications for current will shortly be sufficient to justify them in making the supply continuous, and it will be their endeavour to effect this at the earliest opportunity.

The Rev. G. B. Finch and Mr. J. B. Simpson retire by rotation ; the latter is eligible and offers himself for re-election. The Directors also recommend the election of Dr. P. W. Latham and Mr. W. C. Hall.

Birmingham Electric Supply Company (Limited).

The report of the Directors, to be submitted at the ordinary general meeting of the Company, at the offices of the Company, 14, Dale-end, Birmingham, on the 8th inst., at 12 o'clock, is as follows :—

The amount of net profit, including the balance of £264. 1s. 8d. carried forward last year, is £5,247. 16s. 8d. ; out of this the Directors recommend the payment of a dividend of 4 per cent., absorbing £2,715. 6s. 7d., placing £1,872. 18s. 1d. to the credit of the depreciation reserve fund, and a further sum of £250 towards the general reserve fund, and carrying forward the balance, £409. 12s., to next year's account. The capital expenditure during the year amounts to £5,356. 10s. 9d., and includes the addition of one new steam engine and dynamo machine, and further extension of the Company's mains and services. The total number of 16-c.p. lamps or their equivalent on order on December 31, 1892, was 8,329, and on the same date in 1893 the number was 10,223. The demand for the light still continues to increase, and the additions since the close of the financial year bring the total up to 11,034. The Directors venture to think that the progress made during the year that has passed will not be considered unsatisfactory, taking into consideration the depressed condition of trade, the prolonged coal strike, and the phenomenally clear days throughout the winter months.

At the last annual meeting your Directors reported that they considered, owing to the demand for the light in some of the outlying districts, that it would be an advantage to the Company to extend its operations to Edgbaston and the jewellers' quarters. The necessary statutory notices have been given, and a draft of the new Provisional Order for the additional areas is now under discussion with the Corporation.

Two Directors, Mr. Henry Buckley and Mr. J. F. Albright, retire by rotation, and, being eligible, offer themselves for re-election ; as do the auditors, Messrs. Sharp, Parsons and Co.

City of Bath Electric Lighting and Engineering Company (Limited).

The following is the report of the Directors of this Company to be presented at the third annual general meeting to be held at the works, Dorchester-street, Bath, on Wednesday next, the 7th inst., at 2.30 p.m. :—

In submitting the balance-sheet and profit and loss account for the year ending December 31, 1893, the Directors are pleased to be able to state that the year's working shows a substantial improvement over 1892. The receipts for the current sold are increasing satisfactorily, the total income from this source being £4,621, as compared with £4,301 for 1892. The number of lamps installed has risen from 6,420 to 7,070, and the Directors anticipate considerable additions during 1894. The policy of charging by meter only has been steadily pursued, a plan alike fair to the consumer and the Company.

The Directors have appointed Mr. G F. Metzger as engineer and manager, and he commenced his duties in May. With his help considerable economies and improvements have been effected, whilst the efficiency of the station and the plant has been fully maintained.

These economies have resulted in a profit for the past six months of £464, notwithstanding the additional expenditure involved by the coal strike. Had it not been for a loss on the first six months of £276, and the loss of £277 brought forward from last year, the profit for the year would have been very satisfactory. As it is not anticipated that similar losses will again occur, the Directors look forward with every confidence to 1894.

It may be satisfactory to the shareholders to be informed that the existing machinery and plant are capable of a largely increased output of current without materially increasing the running expenses.

The financial position of the Company has also been considerably improved since the last report, and since the closing of the year's accounts the unpaid balance of purchase-money, amounting to £1,242, has been paid.

Since the last meeting Mr. E. Garcke, Major-General J. G. Jervois, Mr. H. N. Garrett, and Mr. H. G. Massingham have retired, and the Directors have elected Mr. B. H. Van Tromp and Mr. J. B. Wood to the Board. The following Directors retire, and offer themselves for re-election :—Mr. Alfred Pitman, Mr. Ernest Pitman, and Mr. J. B. Wood. The Directors waive their fees for the past year.

NEW COMPANIES, STATUTORY RETURNS, &c.

In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1894, pages 274-300, *&c., &c.*]

ALDERSON'S PATENT DAY AND NIGHT CLOCK COMPANY (LIMITED).—This Company was registered on February 21st, with a capital of £5,000, in £1 shares, to carry on the business of manufacturers of, and dealers in, timepieces of every description, and of lamps of all kinds, and also of apparatus connected with the manufacture, consumption, supply, and distribution of electricity, whether for illuminating clocks, or for light, heat, or motive power.

J. HOPKINSON AND CO. (LIMITED).—This Company was registered on February 24th, with a capital of £40,000, in £10 shares, to acquire the business of mechanical engineers and boiler makers carried on at Huddersfield by J. Hopkinson and Co., and to carry on the business of mechanical and electrical engineers, machine and engineering tool makers, boiler and boiler mountings makers, electrical, hydraulic, and pneumatic apparatus manufacturers, &c. The first Directors are :—John A. Hopkinson, Joseph Hopkinson (life Directors), Frank A. Hopkinson, and Robert A. Hopkinson.

M'DOWALL, STEVEN AND CO. (LIMITED).—This Company has been registered in Edinburgh to take over the business of M'Dowall, Steven and Co., ironfounders, in Glasgow. The capital is £200,000, in 4,000 Preference and 16,000 Ordinary shares of £10 each.

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AKESTER ELECTRIC SYNDICATE (LIMITED).—The annual return of this Company, made up to January 12th, has been filed. The nominal capital is £15,000, in 300 shares, of £50 each: 177 of these have been taken up, and 100 have been issued as fully paid. Upon the remaining 77 a call of £37. 10s. per share has been made, resulting in the payment of £2,837. 10s., and leaving £50 in arrears. Nine shares have been cancelled since last return.

CHAGFORD AND DEVON ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company, made up to January 11th, has been filed. Out of a nominal capital of £2,000, in shares of £1 each, 1,074 have been taken up, and 750 issued as fully paid. The full amount has been called and paid on the remaining 324 shares.

CHELMSFORD ELECTRIC LIGHTING COMPANY (LIMITED).—The annual return of this Company, made up to January 3rd, has been filed. The nominal capital is £10,000, divided into 7,500 Preference and 2,500 Ordinary shares of £1 each, 5,507 Preference and 2,378 Ordinary shares have been taken up, and the full amount called on each, resulting in the payment of £7,878, and leaving £7 in arrears.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—The annual return of this Company, made up to June 26, 1893, was recently filed. The nominal capital was then (since reduced) £307,545, divided into 75,000 £6 per Cent. Preference shares of £1 each, 224,850 Ordinary shares of 14s. each, and 75,150 Ordinary shares of £1 each. 27,637 Preference and 224,850 14s. Ordinary shares have been taken up, the full amount called, and £185,032 paid.

CROMPTON ELECTRIC SUPPLY COMPANY OF AUSTRALIA (LIMITED). The annual return of this Company, made up to January 3rd, has been filed. The nominal capital is £50,000, divided into 9,500 "A" and 500 "B" shares, of £5 each. 3,115 "A" and 500 "B" shares have been taken up, and the whole of the latter issued as fully paid. Upon the "A" shares the full amount has been called, resulting in the payment of £15,275, and leaving £300 in arrears.

WOODFIELD SYNDICATE (LIMITED).—The annual return of this Company, made up to November 7, 1893, was recently filed, when the whole nominal capital of £12,000, in Ordinary shares of £1 each, was taken up and fully paid. A return for 1894, made up to February 13th, and filed with the foregoing, exhibits no change.

CITY NOTES, &c.

BELL'S ASBESTOS COMPANY (LIMITED).—A dividend at the rate of 5 per cent. per annum, free of income-tax, has been declared by the Directors of this Company. The amount carried forward is £1,781.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended February 25th were £945, as against £943 in the corresponding period of last year, being an increase of £2. The total receipts for the half-year amount to £7,610, as against £7,743 for the corresponding period of last year, a decrease of £133.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The prospectus is issued, and will be found in our advertisement columns, of an application for subscriptions for £100,000 Five per Cent. Debenture stock (forming part of a total issue of £400,000) of the City of London Electric Lighting Company (Limited), the price of issue being £115 per cent., redeemable by the Company at £125 per cent., by six months' notice after December 31, 1910. Subscriptions for this issue will open to-day, at 10 a.m., and will close for both town and country at 4 p.m. on the same day. Instalments are payable: £10 on application, £25 (including the premium of 15 per cent.) on allotment, £40 on April 30th next, and £40 on June 30th next. Interest for the period ending June 30th will be calculated from the dates of the respective instalments (exclusive of premium), and will subsequently be payable half-yearly on Jan. 1st and July 1st in each year. The whole of the 40,000 Ordinary and 40,000 Preference shares of £10 each in the Company have (the prospectus states) been issued, and are fully paid. The Debenture stock is constituted by a trust deed made between the City of London Company and the Electric and General Investment Company (Limited), as trustees for the debenture holders, and will operate as a first charge, by way of floating security, upon the whole undertaking and property of the Company, subject to the conditions set out in the prospectus, but cannot be redeemed, except at £125 per cent. Gross revenue, at the estimated rate of £64,000, is now being earned by the Company, of which £13,000 is derived from public lighting and £51,000 from private lighting, and it is anticipated that the fourth section of the main buildings of the Company's generating station, at Bankside, will be completed in March current, offering accommodation for plant sufficient for nearly 300,000 8-c.p. lamps. Application must be made on the forms accompanying the prospectus, which must be forwarded to the bankers, the London and Westminster Bank (Limited), Lothbury, London, E.C., from whom application forms can be obtained, as well as from the brokers, Messrs. Foster and Braithwaite, 27, Austin Friars, E.C., or from the Offices of the Company, 1 and 2, Great Winchester-street, E.C.——Dividend warrants on all the Preference shares of this Company have been posted to shareholders.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have decided, subject to audit, to recommend the payment of the dividend at the rate of 10 per cent. per annum on the Preference shares, and a dividend at the rate of 4 per cent. per annum, free of income tax, on the Ordinary shares, both for the half-year ended December 31st last.

ELECTRO-CHEMICAL COMPANY (LIMITED).—We are informed that letters of allotment for this Company's application for capital were posted on Tuesday last. We are asked by Messrs. A. Norman Tate and Co., of Liverpool, to state that the Mr. Walter Tate referred to in our note last week, as "of Messrs. A. Norman Tate and Co.", is not connected with that firm.

GENERAL HYDRAULIC POWER COMPANY (LIMITED).—The annual meeting of this Company was held on Wednesday last. In moving the adoption of the report, the Chairman stated that the number of the Company's machines contracted for to December 31st last showed an increase of 177 over the previous year. At Liverpool they were making satisfactory progress. They had incurred a large expenditure on capital account in connection with the City-road, London, pumping station and the new mains connecting it with the general system. When this was completed they would have an additional capacity of 40 per cent. With regard to the electric light, they had decided in the first place to light up their London pumping station, and he believed they would be able to supply the light with advantage to the consumer.

GREAT NORTHERN TELEGRAPH COMPANY.—The list is issued of 100 debentures of £100 each, series "B," 1883, which have been drawn for payment on March 1st by Messrs. C. J. Hambro and Son, 70, Old Broad-street, London, E.C.

KESWICK ELECTRIC LIGHT COMPANY (LIMITED). — The annual report of this Company has just been issued. The Directors state their inability to recommend a dividend, being obliged to declare a loss on the past year's working of £69. 5s. 7d. The use of steam instead of water (which the Directors have been unable to avoid) is of itself sufficient to account for loss of profit, but the Directors have confident expectations of being able very soon to use the whole water power of the river, without which success is impossible. The trade of the past year shows an increase of 51 lamps, representing £66. 9s. 3d. in receipts. There appears to be a decided disposition in the neighbourhood for people to avail themselves of the light, but as the output is restricted the Directors cannot push business as they would like to do. Were ample machinery supplied for procuring the current they feel confident of a fairly satisfactory result; but to obtain this result it will be necessary to procure more capital. Considerable additions to and alterations in plant, wiring, &c., will be necessary to work an increased and remunerative trade, which cannot be expected from the present small station.

LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The half-yearly coupons, falling due on March 1st, of the £100,000 Six per Cent. Debentures of this Company will be paid by Messrs. Glyn, Mills, Currie and Co., 67, Lombard-street, London, E.C., on and after that date.

MAXIM-NORDENFELDT GUNS AND AMMUNITION COMPANY (LIMITED). A meeting of this Company was held last week, at which Admiral Sir Edmund Commerell, V.C., G.C.B., presided, and in dealing with the prospectus of the Company he stated that sometimes they were very busy in their regular business of gun-making, but at others they found it difficult to find employment for their numerous staff. They had therefore decided to take up outside work. They had already taken up the subject of electricity, and found that their workmen could turn out electrical plant of as good quality and workmanship as the Maxim guns. The Directors, therefore, considered that electricity offered them an excellent field for employment in the future, and they were determined to take up anything that presented itself in this branch of industry.

MERSEY RAILWAY COMPANY.—At the meeting of shareholders, held last week, a question was put to the Chairman as to whether the Company would not benefit considerably if electricity were used as the motive power on the line. The Chairman, in reply, said that he, personally, did not think the application of electricity to their line of railway would be successful, but the question was one well worthy of consideration.

MORECAMBE ELECTRIC LIGHT AND POWER COMPANY.—The Directors report that the revenue account from November 16, 1892, to December 31, 1893, shows an expenditure of £1,361, and revenue £1,546, leaving a gross profit of £189, which is reduced by £92. 2s. for interest on borrowed capital, and bad debts £9. 3s., leaving a balance of £88, which the Directors recommend to be applied to the payment of a dividend of 2 per cent. per annum on the paid-up share capital.

MUNTZ'S METAL COMPANY.—The Directors of this Company recommend a final dividend at the rate of 15 per cent. per annum, making a dividend of 10 per cent. on the past year's working.

A. AND J. STEWART AND CLYDESDALE (LIMITED).—The Directors of this Company recommend a dividend at the rate of 7 per cent. per annum, the transfer of £10,000 to depreciation fund, carrying forward £8,169.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee to allow £150,000 First Mortgage Debentures to be quoted in the Official List.

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MEXICAN TELEGRAPHS.—It is stated that a syndicate of Mexican and American capitalists has been organised for the purpose of constructing a Pan-American telegraph line to extend along the Pacific coast from Victoria, British Columbia, to Santiago, Chili.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of the Company for the week ended February 23rd (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company (Limited), were £3,181.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Feb. 21.		Price Wednesday, Feb. 28.		Rate per Cent. Yielded. (£ s. d.)	Dividend Due.	Business Done During Week Ending Feb. Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	13/6	Anglo-American	42	44	42	44	5 13 8	Jan., Apr., July, Oct.	..	..
£2,932,680	Stock	27/0	Do. Preferred	78½	79½	79	80	6 5 0	"	79½	77
£2,932,680	Stock	5/0	Do. Deferred	7	7½	7	7½	..	..	7⅛	7
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	100	103	100	103	3 17 8	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	11¼	12	11½	12	5 10 8	Mar., June, Oct., Dec.	11⅞	..
£18,700	£100	4%	Do. 5 per Cent. Bonds	99	102	99	102	4 18 0	January and July ..	..	–
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	..	
10 000,000	$100	7%	Commercial Cable Capital Stock	135	145	135	145	4 16 7	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine xd	12	13	12	13	6 3 1	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent. xd	18½	19½	18	19	5 5 3	"	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2	3	2	3	5 6 8	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8	9	5 11 1	"	..	..
60,710	20	8/0	Direct United States Cable, 1877	10⅜	10⅝	10⅜	10⅝	6 2 8	Jan., Apr., July, Oct.	10⅝	10⅜
400,000	10	2/6	Eastern	14¾	15¼	14¾	15¼	4 5 11	" "	15¼	14⅞
70,000	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16¼	3 13 0	" "	16¼	15⅞
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	116½	114½
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	106	109	106	109	4 11 9	February & August	..	..
250,000	10	2/6	Eastern Extension	15⅜	15⅝	15⅜	15⅝	4 9 7	Jan., Apr., July, Oct.	15⅝	15⅜
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	114	117	114	117	3 8 5	February & August	115½	115
£62,700	100	5%	Do. 5 p. c.(Austln. Gov. Sub.) Debs 1900	102	105	102	105	4 15 2	January and July ..	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	102	105	102	105	4 15 2	" "	103½	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103	105	103	106	3 15 6	February & August	..	..
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	107%	110%	107%	110%	3 12 9	May and November	109	108
180,227	10	1/3	Globe Telegraph and Trust	8½	8¾	8½	8¾	5 2 10	Jan., Apr., July, Oct.	8¾	8⅝
180,042	10	6%	Do. 6 per Cent. Preference	15⅛	15⅜	15⅛	15⅜	3 18 [illegible]	" "	15 5/16	15½
150,000	10	5/0	Great Northern	21	22	20½	21½	3 19 1	Jan., April, and July	21	20¾
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	105	108	105	108	4 12 7	March & September	..	..
17,000	25	12/6	Indo-European	42	45	42	45	5 11 1	May and November	44¾	44
37,548	10	4/0	London Platino-Brazilian	4	6	4	5	..	" "	..	–
£100,000	100	6%	Do. 6 per Cent. Debentures	107	110	107	110	5 9 1	March & September	..	–
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red 1942	102	105	102	105	3 16 2	..	..	..
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	..	..
3,381	£100 Cert.	25 0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	" "	115	114½
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July ..	..	..
£249,900	100	5%	Do. 5 per Cent. Debentures	100	103	100	103	4 17 1	March & September	102	..
30,000	10	2/0	West Coast of America	2	2½	2	2½	..	January and July ..	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	101	97	101	7 18 5	June and December	97½	..
88,321	10	1/0	West India and Panama	1¼	1⅜	1¼	1⅜	..	..	1¼	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10¼	9¾	10¼	5 17 1	May and November	0⅜	1
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	105	108	105	108	4 12 7	June and December	..	..
64,242	15	4/6	Western and Brazilian	6½	7	7	7½	..	May and November	7½	6¾
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5½	6	5½	6	..	..	5 13/16	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¾	2¼	1¾	2¼	..	..	1⅞	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	104	107	104	107	5 12 2	February & August	..	..
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	104	107	104	107	5 12 2	" "	..	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	102	105	103	106	5 13 2	March & September	105	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	–	–	–
22[illegible],500	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
220,000	£1	4·76d.	Oriental Telephone and Electric (11s. paid)	½	¾	½	¾	5 6 5	Yearly	..	–
484,597	5	2/6	National	4½	4¾	4½	4¾	5 5 3	June and December	4¾	4½
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½	15½	14½	15½	3 17 5	" "	15⅜	15½
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	14	15	14	15	4 0 0	" "	14 5/16	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¼	5½	5¼	5½	4 10 11	..	5½	5¼
925,017	£100	4½%	Do. Deb. Stk. 4½%	113	115	113	115	3 18 3	January and July	114¾	114
58,000	5	1/0	United River Plate	1½	2	1½	2	..	" "	–	–
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	–	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	10	11	10½	11½	–	..	11⅜	10⅜
20,000	10	6,0	Do. 6 per Cent. Cumulative Pref. (fully paid) xd	12¾	13¼	12¾	13¼	..	–	13⅜	13
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	–	–
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	–	–	–
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	–	–
8,322	£5	..	House to House Electric	..		..		–	–	–	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		..	–	–	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	–	–
30,000	£5	..	Liverpool Electric Supply (£4 10s. paid)	5½	5⅝	5 7/16	5 9/16	..	–	–	–
15,000	£5	..	Do. (fully paid)	6½	6⅝	6½	6⅝	..	–	..	–
111,000	5	..	London Electric Supply	¼	¾	¼	¾		..	..	–
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	8	8½	8	8½	2 5 7	..	8¼	
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	104	108	106	109	4 11 9	June and December	108	107
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½		–	..	–
19,980	£5	4/6	St. James' and Pall Mall	6½	7	6½	6¾		–	6 7/16	6⅝
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	–	8 7/16	–
59,900	5	1/6	Westminster Electric Supply (fully paid)	5¾	6¼	5½	6	2 18 4	–	6 1/16	
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering xd	2⅝	2⅞	2⅝	2⅞	6 5 4	–	2 13/16	2⅝
90,000	2	1/2⅖	Do. 6 per Cent. Pref. Non-Cumulative. xd	2⅛	2⅜	2⅛	2⅜	5 1 1	–	2 3/16	..
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures xd	105	107	104	107	4 4 1	March & September	107	..
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	3	4	3	4	..	January and July	..	..
12,139	5	..	Edison and Swan United	–		–		–	–	–	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	–	–	–
120,000	2	..	Electric Construction	¼	¾	¼	¾			..	..
12,845	2	..	Do. 7% Cumulative Pref.	1½	2	1½	2	..	..	..	–
91,195	2	10/0	Elmore's Patent Copper Depositing	9/16	11/16	9/16	11/16	–	–	⅝	
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	–	..	–
50,000	10	15/0	India Rubber, Gutta Percha &c., Works xd	24	25	23	24	5 4 2	February & August	24½	23½
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	102	104	103	105	4 5 9	March & September	104½	103
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	–	–	–	–
16,000	£10	..	Do. 8 per Cent. Preference	–		–		–	December and June	–	..
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	3/16	5/16	⅛	¼	..		–	–
78,949	5	3/6	Swan United (£3. 10s. paid)	2	2½	2	2½	–	May and November	..	
37,350	12	36/0	Telegraph Construction and Maintenance xd	40	42	39	41	4 7 10	March and July	41⅜	39½
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	..		–		..	January and July	..	..
37,514	£5	–	Woodhouse and Rawson Ordinary (£3. 15s. paid)	–		–		–	–	–	–
41,098	£5	–	Do. Preference (fully paid)	–		–		–	–	–	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	5%	City and South London Railway xd	27	32	27	32	4 5 11	May and November	28	..
37,500	£10	..	Liverpool Overhead Railway	5¼	5½	5¼	5½	–	–	–	–

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NOTES.

The action, " Muirhead *v.* the Commercial Cable Company," the hearing of which concluded at 10 o'clock on Wednesday night, after having occupied the attention of Mr. Justice Kennedy for seven days, contained several features of interest. The point at issue was briefly this: The Commercial Cable Company, a licensee under the Muirhead duplex telegraph patents, sought to show that it was exempt from payment of further royalties on the ground that an American patent, taken out in 1880 by Dr. Alexander Muirhead, and under which the Company was bound to pay royalties until 1897, had expired simultaneously with the English patent taken out in 1876 jointly by Mr. John Muirhead and Dr. Alexander Muirhead. By American law, an inventor who takes out a United States patent *after* a foreign one has his American patent limited by the duration of the shortest-lived foreign patent. The argument of the Cable Company was that the United States specification of 1880 was nothing more than a detailed description of one of the many methods of duplexing set forth in the English specification of 1876; hence the American patent, instead of running on until 1897, had *ipso facto* expired in 1891 with the English patent. The case thus gave rise to the somewhat unusual spectacle of an English court discussing an obscure point of American law, and of a patentee trying to show that he had not been anticipated by himself. In addition, the Court was treated to an interesting *résumé* of the early history of submarine duplexing; and last, but not least, the sum involved (£45,000) was by no means small, even when reckoned in English pounds sterling instead of American dollars.

The noble army of experts mustered in great force, and the Judge was ably instructed in the elements of electricity and the complexities of duplexing by Profs. Silvanus Thompson and John Hopkinson. The exact meaning of the term "rheostat" proved, indeed, somewhat of a stumbling block, and though the definitions, "a *readily* adjustable resistance," and then "a *continuously* adjustable resistance," were offered, it required a good deal of wearisome examination and cross-examination to make it clear that a rheostat was not necessarily a low-resistance apparatus. The army of experts is already dichotomous; better far that it should become trichotomous and give the Court the benefit of a portion of its learning from the bench instead of from the expert witness-box. A number of instruments were produced to illustrate the proceedings. Why should not instrument makers, on such occasions, hold a small exhibition of their wares? They would be much more intelligently appreciated than at *conversazioni*.

At the meeting of the City Commission of Sewers, last Tuesday, the recommendation of the Streets Committee that an electrical inspector should be appointed at a salary of £300 per annum was briskly discussed in regard to the amount of salary. It appears that while, on the one hand, the gas inspector to the Corporation received £400 a year, on the other hand Mr. Preece—"the greatest electrician of the day"—had advised that the salary of the electrical inspector should commence at only £200. It was argued by some members of the Commission that "electricians were now almost as plentiful as blackberries"—a sad analogy at a time when brambles are leafless and destitute of berries; and that "some electricians were without shoes owing to lack of employment." Ultimately it was decided to adopt the usual but inane process of compromising, the salary being fixed at £250. And a reliable man, fully competent to inspect 48 miles of electrically-lit streets in the wealthiest city in the world, is expected to be obtained for this pittance, because, forsooth, there are shoals of unreliable and incompetent men, falsely called electrical engineers, flooding the profession.

The Paper by Messrs. Barr and Phillips on the "Brightness of Light," which we publish this week, fully illustrates the difficulties met with in the accurate measurement of light. A number of ingenious methods, which have been proposed from time to time with the object of making optical measurements more reliable, are described. None of these efforts have, however, met with any real success. The fact is that no instrument can be found to replace the eye, simply because light is merely the effect of radiation on the optic nerves, and the law which governs the sensitiveness of the eye to light of various colours and intensities seems at present to be quite an arbitrary one. Perhaps the most striking example of this given in the Paper is shown in the curves of luminous and visual intensity shown in Fig. 2. Apparently the kind of light which is most efficient in making an object appear bright or luminous is not the kind of light which produces most effect in enabling the eye to perceive small print distinctly. But, paradoxical as this result may appear, it is not so striking as another fact which has been brought out recently by the researches of Capt. Abney and Gen. Festing. These experimenters found that, if two surfaces were illuminated to an equal

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brightness by means of red and green light respectively, and if then the light falling on the surfaces was diminished in the same ratio for each, the two luminous patches no longer remained of the same brightness as judged by the eye. In fact, on reducing the red light to such an extent that the red patch was no longer appreciable, the green patch remained distinctly visible, in spite of the fact that the light in each case had been reduced in the same proportion. This shows the impossibility of getting any indicator to replace the eye in the judgment of illumination. In spite of colour difficulties often met with when comparing light, and in spite of the want of sensitiveness of the eye, it is necessary to rely on our powers of vision when different light sources have to be relatively estimated.

THE discussion on the photometry of search lights, which was started by a casual remark in our columns nearly six months ago, has been continued at intervals in the French electrical journals up till last week. Hitherto the matter has been dealt with from the theoretical side, and the mirror or lens being assumed to be theoretically perfect, and the source of light to be placed exactly in the focus, the theoretical rays behaved theoretically, and it was conclusively proved that certain theoretical measurements might be made. Over the initials "P. G." some more mathematical investigation of the subject is contributed to *L'Industrie Electrique*. The interesting theoretical fact is brought out that at very short distances, the illumination at a point on the axis is constant, but at greater distances the law of inverse squares is (theoretically) rigidly obeyed. Some experiments carried out by M. FERY at the optical laboratory of the École de Physique et de Chimie Industrielles at Paris are described. An achromatic lens, 78 cm. focal length and 7 cm. in diameter, was used; the source of light was a circular diaphragm 1·4 cm. diameter; and the distance of the photometer varied from 0·78 to 15·78 metres. The experiments so far confirmed the theory that, but for errors of 12 to 16 per cent., the illumination was constant up to about 4·28 metres, but the next reading at 5·28 metres yielded only 68 per cent. of the theoretical illumination, and at further distances was only 45 or 46 per cent. The explanation of these errors is probably simple, but if with all the appliances, adjustments, and refinements of an optical laboratory such discrepancies occur, what are we to expect from an ordinary search-light projector? Our original objection was, that a minute inaccuracy of adjustment of the arc would so alter the character of the beam that photometry would become useless, and that slight imperfections of the mirror would give rise to very great errors. The first of these difficulties, at all events, ought to be easily avoided in a laboratory, and the general result of these experiments confirm the views which we have put forward on previous occasions.

IN a report by M. COHN on artificial lighting, in *La Lumière Electrique*, a description is given of a reflector invented by Herr HRABOSKI for the uniform distribution of light. A dish or pan-shaped reflector is used in conjunction with a prismatic ring of glass. The sloping sides of the reflector subtend a zone of only about 30deg., the rays falling at a greater angle than 45deg. with the horizontal are intercepted and partly reflected by an opal shade hung below the lamp. The rays of less than 25deg. incidence fall directly on the reflector, and those between 25deg. and 45deg. are refracted by the prismatic ring, and are directed upon the reflecting zone. As this glass ring appears from the illustration to be from 14in. to 18in. diameter, a focussing lamp would be necessary. The arrangement appears to have been designed with some regard to optical theory, but the whole usefulness of the calculated curve of the reflector is at once defeated by painting it white. We very much doubt whether a mathematically-designed reflector, which, of course, must be of metal or silvered glass, would be worth using. The requirements of a whitened reflector, as we pointed out in connection with Mr. B. A. DOBSON's Paper on the lighting of workshops, are merely that it should be large, and should subtend a large angle to the light. Its form or curvature is quite inoperative, for it is the property of a dead white surface that light falling on it from any direction is always reflected in one and the same manner, the direction of greatest intensity being always normal to the surface.

THE agreement between the observed value for the voltage just sufficing for the decomposition of an alkaline salt, and that calculated from thermo-chemical data, which has been demonstrated by the researches of M. NOURISSON, described by Mr. BERTRAM BLOUNT a few weeks ago in this journal, has long been recognised, although not in the same sense of precision as at present. Claims of priority in this line of investigation were, therefore, to be expected, and a recent number of the *Comptes Rendus* contains two such communications. The first is by M. LE BLANC, whose name is well known in connection with electrolytic research, and who cites Papers of his own published in the *Zeitschrift für physikalische Chemie*. He quotes figures obtained by experiment with normal solutions of the chlorides, bromides, iodides, sulphates, and carbonates of the alkalies and alkaline earths, and of ammonium, the concordance with those of M. NOURISSON being generally good. Ammonium salts give rise to divergencies from the calculated values according to both M. LE BLANC and M. NOURISSON, such irregularity being readily intelligible on the grounds adduced in the article in *The Electrician* already referred to.

THE other claim of priority is one by M. BERTHELOT, whose work has an earlier date than that of either of his colleagues in the same field. The subject was dealt with by him in a memoir appearing in 1882, and printed in the *Annales de Chimie et de Physique*. This work owes nothing to the theoretical consideration of the actual mechanism of electrolysis, but rests solely on the comparison of the observed critical voltage and thermo-chemical data experimentally obtained. The concordance of the results of the two investigators is again good. Incidentally M. BERTHELOT points out that the salt selected for experiment should not yield an acid or a base as the main products of electrolysis, which are capable of oxidation or reduction under the conditions of the experiment. That even such a salt as an alkaline sulphate might fail to comply with this requirement on account of the comparative

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ease with which persulphates are formed by electrolysis was indicated in Mr. BLOUNT'S article, the accuracy of agreement between calculated and observed values being impaired by want of knowledge of the total chemical energy involved. The following table of comparison will be found interesting :—

	Potassium chloride.	Potassium bromide.	Potassium iodide.
M. Berthelot (1882)...	1·98 volt	1·73	1·16
M. Le Blanc (1891)...	1·96 „	1·60	1·14
M. Nourisson (1894)..	1·94 „	1·74	1·15
Calculated value	2·01 „	1·74	1·16

COMMENTING on the circumstances attending the lamentable explosion of a steam pipe on the German cruiser "Brandenburg," the *Daily Chronicle* says that "The fault appears to lie with a new copper steam pipe, which gave way with a pressure of 7,200 horse-power, when a previous pipe had sustained a pressure equal to 10,000 horse-power." This enterprising newspaper is gradually but surely evolving an entirely new system of scientific units, which, with commendable modesty, it is publishing by instalments. The amount of editorial brain-cudgelling which must have preceded this, the latest addition to its stock, must have been prodigious. The value of expressing everything in terms of the *horse-power* ought to be appreciated by the engineer. The only question is—Can it be done? Still, with the aid of the "newspaper scientist" we ought not to despair of its ultimate attainment.

The Differential System of Charges.—At a meeting of the Edinburgh Corporation Electric Lighting Committee it was agreed that the charge for electricity should be 6d. per unit for lighting, and 3½d. per unit for motors.

Proposed Electric Tramways in Cork.—At the sitting of the Judicial Committee of the Privy Council in Dublin on Wednesday a scheme was passed for the construction of a line of electric tramways in Cork to connect the new station with the Muskerry Railway Station.

A Proposed Floating Electric Lighting Station.—A curious proposal has recently been made with regard to the prospective electric lighting of St. Olave's. It has been suggested that, in the event of no land site being available for the generating plant, this should be placed on a barge moored on the Thames.

Cable Interruptions and Repairs :—

	Date of Interruption.	Date of Repair.
Malta Pozzala......................	Feb. 21, 1894	March 5, 1894
St. Thomé-Loanda................	Feb. 5, „	March 5, „
Cayenne Paramaribo............	Oct. 15, 1893	—
Bissao-Bolama	Nov. 24, „	—
Garachco-Santa Cruz de Palma	Dec. 27, „	—

Institution of Civil Engineers.—At the monthly ballot of the Institution of Civil Engineers, held on Tuesday last, Mr. H. Faraday Proctor and Mr. Charles P. Sparks were elected Associate-Members of the Institution. Thirty-seven other candidates were elected to this grade; and two Members were elected.

Fire in an Accumulator House.—On Saturday morning a fire broke out in the electrical accumulator house at Crewe works. The works fire brigade were quickly on the spot, and checked the progress of the flames. Considerable damage was done to the building, and nearly all the acid tanks were broken by the heat. The origin of the fire is unknown.

The Electrical Trades' Union.—A deputation from the London Trades Council and the Electrical Trades' Union will shortly wait upon the Postmaster-General to lay before him the conditions of labour and rates of pay in the instrument department of the General Post Office. The pay there, it is stated, is much below that ruling in private firms.

Electro-Therapeutics.—According to a German contemporary Dr. Helbing has been successful in twenty cases in healing people of the frozen nose, the treatment being to apply both electrodes to opposite sides of the nose, and to pass a moderately strong current for five or ten minutes, moving the electrodes about; the immediate result is a reddening of the tissues, which may last several days; in some cases ten to fifteen applications are necessary.

The University of London.—Notice has been given that on Wednesday, April 25th next, the Senate of the University of London will elect examiners in various departments, including the department of experimental physics. Two examiners will be elected in this department, at a salary of £210 per annum each; and the present examiners are eligible for re-election. Candidates must send in their names to the Registrar, with any attestation of their qualifications they may think desirable, on or before Tuesday, March 27th.

A Hindu Telephone.—It is reported that an English officer, named Harrington, has discovered in India a working telephone between the two temples at Pauj, about a mile apart. The system is said to have been in operation at Pauj for over 2,000 years. In this connection we may observe that Egyptologists have found unmistakable evidence of wire communications between some of the temples of the earlier Egyptian dynasties; but whether these served a telegraphic, telephonic or other purpose is not certain.

Board of Trade Electric Traction Conference.—The name of Mr. Sydney Morse was accidentally omitted from the list of the representatives at this Conference. Mr. Morse was requested to attend on behalf of the Traction Committee of the Electrical Trade Section of the London Chamber of Commerce, and, as the only legal adviser on the side of electrical traction, his services, as our report of the proceedings showed, were of great value. Mr. J. Swinburne was another representative of this Committee, but owing to pressure of other work was unable to attend.

Telegraph Construction in South Africa.—Intelligence has been received at Durban that, owing to the action of the Portuguese in obstructing the building of the telegraph line between the British sphere and Tete on the Zambesi, which we referred to in our last issue, the commander of the British stern-wheel gunboat "Mosquito" landed a party at Tete and fired upon the Portuguese. The Governor of Quilimane is hurrying to the scene with Portuguese gunboats and troops. The commander of the "Mosquito" is believed to have asked for reinforcements.

A Cold Galvanising Process.—It is said that several shipbuilding firms have adopted the cold process of galvanising sheet iron, and are erecting tanks capable of dealing with plates as large as 25ft. in length. This process was first introduced into practical use at the works of Messrs. Laird Bros., of Birkenhead. It is claimed by the inventor, Mr. Cowper-Coles, that a greater adhesion of the zinc, as well as a greater strength and durability in the covered plate, can be obtained by the cold process than by the hot process formerly and more generally in use. To quicken the process and retain a smooth surface, an electric current is passed through the pickling tank.

An Electric Parcel Van.—Trial was made last Friday afternoon of an electric parcel van, designed by Mr. W. C. Bersey, and built by Messrs. E. J. Clubbe and Co. The interior of the van is left free for goods. Power is derived from thirty-six storage cells, which are carried under the body of the van in a special box, and so arranged that they may be changed in two minutes. With his left hand the driver, by means of a single switch, regulates the speed, which, if necessary, may be as high as fifteen miles an hour. The right hand is free to turn a steering-wheel, which is provided with a pointer, indicating the direction in which the vehicle is going. As the steering-gear has ball-bearings, the conveyance is under perfect control with a minimum of effort.

Lightning.—On the estate of Glencarse, belonging to Mr. T. W. Greig, much damage was done to a large ash tree on

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Tuesday week by a flash of lightning. The tree was struck and broken over 20ft. from the ground, and the branches were broken and blown about in all directions. The trunk of the tree was split from top to bottom. Houses stand within 20 yards of the tree, but fortunately no damage was done to them.——The Norwegian barque "Saga," now at Greenock, from Mobile, while coming up the Channel last Friday night was struck by lightning, and the captain's cabin set on fire. Books and charts were destroyed, but none of the crew were injured. A violent gale was raging at the time.

The Pacific Cable.—At the Australasian Postal Conference, at Wellington, the various schemes which have been formulated for laying a cable to connect Australia with North America were discussed, and the Conference declared itself in favour of a line starting at Bundaberg, in Queensland, and proceeding thence to Samoa, Fanning Island, Honolulu, and Vancouver. This was regarded as the most feasible commercial route for a cable under the Pacific, and as being likely to enlist the support of Great Britain, Canada, the United States, Germany, and France. A Washington telegram, dated March 7th, states that the officials of the Post Office department, referring to the proposals made at the Postal and Telegraph Conference at Wellington, declare that it would be impossible for the United States Government to support a Pacific cable which did not touch United States soil.

The Electrical Purification of Oil.—In a recent number of the *Comptes Rendus* M. A. L. Levat describes some experiments made by him with a view to testing the efficacy of the electrical purification of oil. He placed a column of olive oil of inferior quality, bitter in taste and clouded in colour, in contact with the negative electrode of a voltameter which was in circuit with a small Siemens magneto machine. After electrolysis the oil was clarified and sweet tasting. In all, twenty samples of oil from various sources were hydrogenated, in every case with marked improvement in taste and colour. A series of experiments were also carried out on lubricating oils of bad quality, having at least 5 per cent. of free acid. Their acidity always diminished by at least 20 per cent., and by submitting the oil to a second electrolysis the acidity was diminished by 30 per cent. M. Levat states that he was unable to diminish it further.

Curious Phenomenon attending Silver Electro-Deposition. Those who have had occasion to measure an electric current by the deposition of silver on a platinum bowl as cathode have probably, says *Nature*, occasionally noticed the very regular manner in which the silver is deposited in radial lines. This appearance is particularly noticeable on the sides of the bowl, and when a somewhat strong solution of silver nitrate is employed. Herr U. Behn has conducted an elaborate series of experiments with a view to ascertaining the cause of this regular deposition, and has examined the effect on the deposit produced by the concentration of the solution, the current density, and the potential difference between the anode and cathode. He finds that in the electrolysis of silver nitrate the effect is best obtained with a concentrated solution of the salt, and when the current density at the cathode is small. An increase in the temperature of the voltameter is found to facilitate the formation of the ridges, while, on the other hand, the value of the electromotive force employed seems to exert no influence.

The Recent Sun Spot.—*Nature* states that the recent sun spot, about which so much daily-paper fuss was made, was after all a comparatively small affair. It was first seen in the south-east quadrant on February 19th, and probably passed off the visible disc about March 2nd. It has been somewhat remarkable for its relatively large penumbra and the scattered character of the umbra; a very distinct nucleus was also observed. In the course of an interview, Mr. Maunder stated that the spot was at a maximum on February 20th, when it was about 48,000 by 46,000 miles, and the area 1,870 millions of square miles. It was, therefore, much smaller than the great spot of February, 1892. Though the magnetic disturbances have not been so great as in the case of the 1892 spot, a marked effect on the Greenwich recording magnets was noticed at 3.15 p.m. on February 20, the disturbance lasting about 27 hours. After an interval of about 24 hours, another and more intense storm commenced, and reached a maximum at 3 p.m. on February 23rd. In the case of the spot of February, 1892, the violent magnetic storms occurred *after* the spot had passed the central meridian; but in the present instance, the disturbances seem to have preceded the central transit of the spot.

The Velocity and Shape of Steam Jets—M. H. Parenty has been investigating the forms of steam jets from various orifices, and has published his results in the last number of the *Comptes Rendus*. The diagrams accompanying the Paper, in which regions of different pressures are shaded differently, exhibit some curious fluctuations, which may be described as a series of nodes and ventral segments proceeding outwards from the orifice. These fluctuations are due to the interference between the outgoing waves of steam pressure and those reflected back by the air. In the case of a convergent elliptical orifice of 13deg. there nodes were found with pressures of 115, 165 and 138 c.m. respectively, that at the orifice being 285 c.m. or 3·75 atmospheres. All the nodes occurred within 2 c.m. of the orifice. They were found by means of an air manometer provided with very finely-drawn glass tubes. It appears that the position and value of the nodes or condensations depend upon the difference of pressure between the boiler and the atmosphere and the form of the orifice. At very high pressures the jet assumes an approximately paraboloidal shape, such as would be assumed by a liquid jet falling upon a disc of the size of the orifice. A further conclusion reached by M. Parenty is that the highest attainable velocity of efflux is the limiting velocity of sound in the medium concerned.

The Storage Battery in Telephone Exchange Work.—Amongst the recent improvements in the St. Louis Telephone Exchange service is the substitution of storage batteries and motor-generators for the old primary batteries. The central exchange of the Bell Telephone Company of Missouri, at St. Louis, operates about 4,000 telephones. It is also connected to exchanges in eight neighbouring towns, the most distant one being 24 miles. The Law system is used. The plant at the central office consists of a six kilowatt motor-generator and 90 350-ampere-hour cells of the Julien type. A portion of the current, supplied by 42 cells, accomplishes the work formerly done by 700 cells of gravity battery, which were used for telephone calls only. In addition to their main work, the storage battery plant supplies current to about 60 16-c.p. lamps for lighting the battery room, supply rooms and exchange, and to 100 1-c.p. lamps, using about one-fourth of an ampere and 12 volts each, and the relays of the signal system. The plant at the Lindell-avenue branch office consists of a 2½-kilowatt motor-generator and 50 150-ampere-hour cells of the Ford-Washburn type, which supplies current for all uses. The motor-generators are standard 500-volt motors and 110-volt shunt dynamos of the C. and C. make, directly coupled. The motors at both stations receive their supply from the 500-volt street mains. At St. Louis, also, small 1-c.p. signal glow lamps are lighted up whenever an interchange wire is in use. Another custom is as follows:—Whenever a subscriber calls and the operator finds the connection required busy, the subscriber calling receives a signal of four little musical toots, which is accomplished by a buzzer being momentarily introduced into the subscriber's circuit. This idea is supposed to be a much more agreeable signal to the disappointed one calling than the nervous tap of the bell which has been the usual response. When a customer has finished a conversation and neglects to call off, the bell of his telephone taps at intervals of two seconds until the operator receives the proper signal. The periodic ringing of the bell is accomplished by connecting the subscriber to a special battery circuit which is connected through an interrupter of special design. It consists of a pendulum such as is seen in large clocks, which carries a contact of non-arcing form to make a circuit at each complete swing of the pendulum. These momentary impulses of current pass through an electro-magnet which attracts an armature on the pendulum to keep up the motion. The circuit is then taken to each operator's table and is available at all times for attaching to the forgetful subscriber's who fails to properly disconnect.

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ELECTRIC MOTIVE POWER.*

BY ALBION T. SNELL.

(Continued from page 446.)

Variation of Pressure in Conductors having Self-Induction and Capacity.

The next point to consider is the effect of variations of load on the drop. A bank of incandescent lamps is practically a non-inductive load, and the drop can be estimated without difficulty from the known ohmic resistance and the small increase of resistance in the mains due to the frequency. But if the load be partly or entirely composed of arc lamps or motors, or other devices containing self-induction, then there will be a further drop in the pressure due to a counter electromotive force, which will vary in magnitude with the current. The difficulty is met to some extent in lighting stations by running separate circuits for arc lamps. Also motors have not been used to any appreciable extent in alternate current circuits, and when used are run chiefly by day when the lighting work is comparatively unimportant. And in the few cases where power work is sufficiently large to warrant the expense, separate circuits have been set apart for the motors. The author believes that most of the Continental stations that have tried the dual load have ultimately found it advisable to use separate circuits (at any rate for the larger motors). For although a varying pressure may be unimportant, perhaps, as regards motors, it is a serious matter with arc lamps, and still more so with incandescent lamps. The effect of capacity in a circuit is precisely the opposite to that of self-induction, the condenser electromotive force being phasially 180deg. distant from the electromotive force of self-induction. And since each of these effects are functions of the circuit they may under certain conditions be made to counter-balance each other to some extent. The capacity effect is found in concentric conductors and in single or concentric mains armoured by continuous metallic sheathing, and it is worthy of consideration whether the latter are not of special use for circuits supplying alternate currents to inductive loads. At any rate they should tend to cause a smaller drop of pressure than ordinary copper conductors in an inductive circuit.

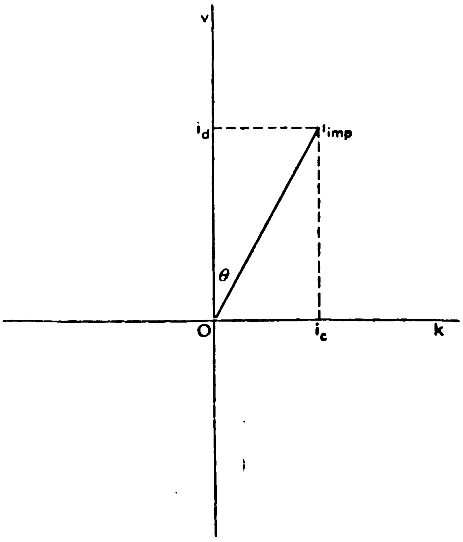

FIG. 84.—Showing the effect of capacity in an alternate-current circuit. O V is the impressed E.M.F.; O i_d, watt current; O i_{imp}, impressed current; and O i_c, condenser current; θ, angle by which resultant current leads impressed pressure.

Some idea of the order of these effects in the mains may be gathered from the following:—

First, consider a concentric conductor carrying an alternate current, and assume that the alternator and the motors have neither self-induction nor capacity. Let the terminal pressure of the alternator be v. Now the capacity

$$C = \frac{K d}{2 \log_e \frac{R_1}{R_2}} \cdot \frac{1}{9 \times 10^5} \text{ microfarads}, \quad . \quad . \quad . \quad (48)$$

d being the thickness of the dielectric between the two conductors, R_1 the radius of the inside of the outer tube, R_2 the radius of the inner conductor, and K the coefficient of specific inductive capacity of the dielectric in C.G.S. units. And the condenser current in practical units is

$$i_c = 2\pi \sim \text{VC } 10^{-6} \quad . \quad . \quad . \quad . \quad (49)$$

i_c and V being effective values.

The condenser current is, as already stated, a quarter period in advance of the pressure. In Fig. 84, let O V represent V. Then Oi_c represents i_c, Oi_d is the dynamic current, and, of course is in phase with Ov. Through i_d parallel to Oi_c, draw $i_d i_{imp}$; At i_c in O K erect the perpendicular $i_c\, i_{imp}$, meeting $i_d\, i_{imp}$ at i_{imp}; and join O i_{imp}. Then O i_{imp} is the current that must be supplied by the alternator, and it is in advance of the impressed terminal pressure by an angle θ.

Fig. 85 is constructed in a similar way, and shows the lag ϕ due to inductance.

The result of capacity, then, is to cause the impressed current to lead the line pressure, while inductance causes it to lag. This phase-difference introduces several important results. If it be positive, the terminal pressure of the generator will be raised, because the armature reactions will then tend to strengthen the field. This is seen to be the case by considering that the maximum pressure obtains when the armature coils are midway between the field poles; and therefore, if the maximum value of the current obtain before this position is reached, the coils will help to magnetise the field magnets; and, on the contrary, if by reason of self-induction the current lags in phase, it will help to decrease the magnetism.

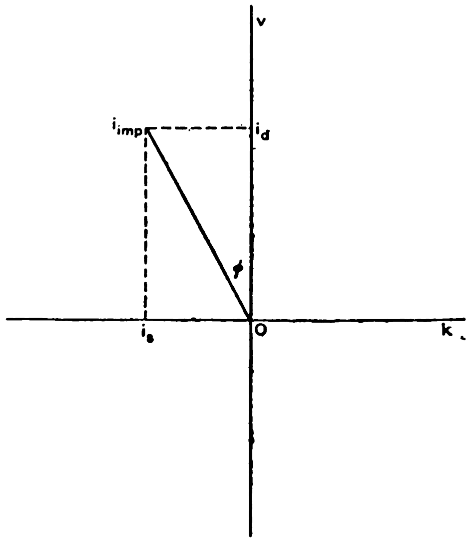

FIG. 85.—Showing the effect of self-induction in an alternate-current circuit. O V is the impressed E.M.F.; O i_d, the dynamic current; O i_{imp}, the impressed current; and O i_s, the current due to the E.M.F. of self-induction. ϕ is angle which impressed current lags behind impressed pressure.

The effects of self-induction and capacity with concentric cables may be shown graphically, when the constants of the circuit are known, by combining the diagrams in the preceding figures. And by suitable approximations the effects for a complete power plant may be estimated in the same manner. The procedure is indicated in Fig. 86.

O C is the maximum value of the difference of pressure between the condenser plates $= \dfrac{i}{C\, 2\pi \sim}$

O L is the maximum value of the counter pressure $= L i 2\pi \sim$. O R is the resultant pressure which sends the current i through the inductive circuit of impedance $\sqrt{R^2 + L^2 4\pi^2 \sim^2}$. The pressure at the terminals of the condenser is H V by the construction (for R H = O L, and R V = O C − O L. Then O V represents in phase and magnitude the impressed pressure required to maintain the current through the condenser.

The condenser effect is a maximum when the angle H O V is a right angle; or H V the condenser pressure has a maximum ratio to O V the impressed pressure when this is the case.

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In practice, with the insulations commonly used and the sizes of conductors most in vogue, the capacity of concentric mains between the inner and outer conductors appears to be about one-third of a microfarad per mile run. But the effect is far more serious between the outer conductor and the earth, being nearly ten times greater. It is, therefore, important with high frequencies and high pressures to take into consideration the capacity effects as well as the self-induction.

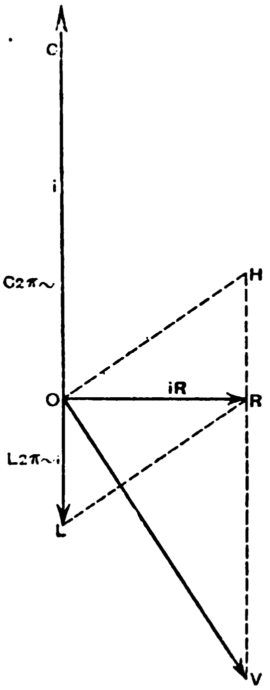

FIG. 86.—Showing the Effect of Capacity and Self-induction in a Circuit.

Concentric cables are used to prevent periodic currents of high frequency influencing telephones and telegraph circuits by induction. They are a remedy for these troubles undoubtedly, but they may cause other difficulties.

As already pointed out, self-induction reduces the useful work of a given plant, but it does not directly waste much power. Capacity, on the other hand, reduces the useful work chiefly by absorbing power.

Compensating for Drop of Pressure in Conductors.

There are several methods in use at present for compensating the variations of pressure in the feeders or in the transmission mains. The most common consists in simply adjusting the

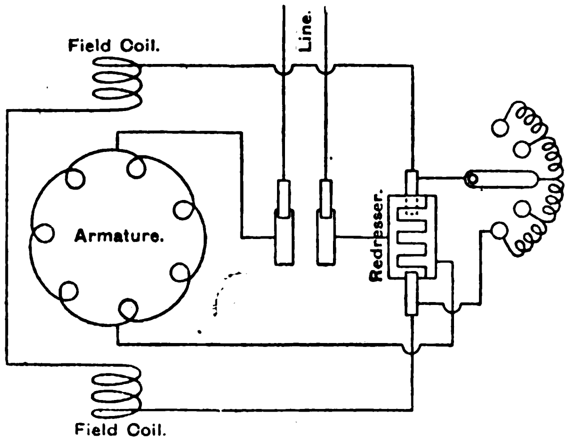

FIG. 87.—Thomson-Houston Method of Compounding Alternators.

excitation by hand or automatically, the generators being separately excited; another is accomplished by compounding the alternators in a manner similar to that adopted with dynamos, the alternators being either self-exciting or else partly self-exciting and partly separately excited.

Hand regulation by a resistance in series with the field-coil circuit is easily understood, and there is no need to make any special reference to automatic devices whose function is simply to vary the resistance of the exciting circuit.

The Brush Corporation, Messrs. Ganz and Co., Messrs. Goolden and Co., and others, make automatic regulators of this description, and the author has spent much time in designing similar devices, but in his opinion they cannot be regarded as complete successes, and certainly are not adapted for use in power plants where there is no skilled supervision. The compound winding, however, is a practical device. By means of it alternators can be made to compensate for any predetermined drop, and therefore meet most of the regulation difficulties in the feeders. The arrangement adopted by the Thomson-Houston Company is to partly excite the field from a dynamo with a steady current and to provide a variable excitation by redressing a portion of the main current and passing it through a pair of coils opposite to each other or else through coils on each of the field poles. It is clear that since the armature current is redressed that the excitation due to it will be proportionate to the load.

The arrangement is shown in Fig. 87. The "redresser" consists of two circular gun metal castings having each half as many projections as there are pole-pieces in the field; both being insulated. One of these is connected to one of the collecting rings and the other is joined to the free end of the armature coils as shown. Two brushes resting on projections belonging to opposite rings of the redresser form the terminals of the exciting circuit. To reduce sparking at the instant of short-circuiting the field coils when the brushes rest on the same rings, a suitable resistance is placed in shunt to the field, and this serves in addition to control the proportion of current in the exciting coils, and therefore to vary the compounding

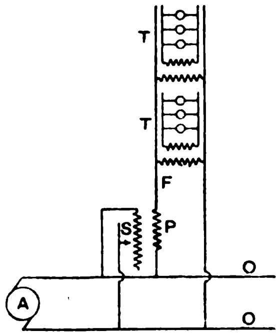

Fig. 88.—Kapp's Method of Regulating the Drop of Pressure at the End of a Feeder.

within the limits of the design. This is a very complete and convenient device. It is characteristic of the methods generally adopted by Ganz and others. Alternators thus compounded will not work parallel.

Another very simple plan is to place the primary of a suitable transformer in series with the feeders, and to excite the compound coils from its secondary current, redressed. Since this current is proportionate to the armature current, it is clear that the compounding can be arranged to any slope of characteristic.

A device patented by Mr. Kapp is interesting. It is shown in Fig. 88.

One coil, P, of a small transformer is placed in series with the feeder, and the other coil, S, is coupled across the station mains. By inserting more or less of the turns of the coil S into circuit by a shifting contact, a few auxiliary volts are put into the feeder by the inductive action of the shunt-coil. This regulator may be designed to add a sufficient number of volts to compensate for any desired drop. It may be applied to each feeder independently, although all the circuits be working off one alternator. This is a distinct advantage, and makes it a most convenient detail for power plants. The Westinghouse Company use a similar device, which they call a "booster."

Determination of Pressure at the End of Feeders.

The pressure at the termination of the alternate-current feeders is read by means of two transformers, without the aid

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of pressure wires run back to the station. The general arrangement is as follows :—The voltmeter is in series with the secondary circuits of two transformers, one of which has its primary in series with the feeder, and the other of which has its primary as a shunt across the feeder. It is illustrated in Fig. 89.

The pressures of the two transformers are opposed to each other. The secondary pressure of the transformer in shunt is proportional to the station omnibus pressure, V ; and that of the transformer in series to the primary current strength i_m, and therefore to i_m R, if the resistance be constant. The voltmeter will consequently read proportionately to V—i_m R, which is the expression for the pressure at the far end of the feeder. This principle with important modifications is

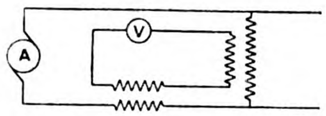

FIG. 89.—Diagram of Station Voltmeter Connections for Reading Pressure at the far end of Feeder.

employed by Messrs. Ganz and Co. Its application is shown in diagram in Fig. 90, the adjustable resistance in the exciter circuit being also shown. The alternator is shown at A, and the feeders at L_1 L_2 ; the shunt transformer at T_1 and the series transformer at T_2. The secondary circuit of T_1 is closed through the solenoid of the regulator S, the resistances T_3, R_1 and R_2. The secondary of T_2 is closed through the resistance R_2. The transformers are joined up so that their electromotive forces are in opposition as regards producing a current in the solenoid S. The terminal pressure of T_1 is evidently proportionate to the station pressure. The difference of pressure between the points *a* and *b*, the terminals of R_2, will be proportionate to the feeder current ; and so the pressure between the points *e* and *f* will be equal to V – i_m R, the pressure at the termination of the feeders. The intensity of the current in the solenoid circuit will determine the excitation, and hence the

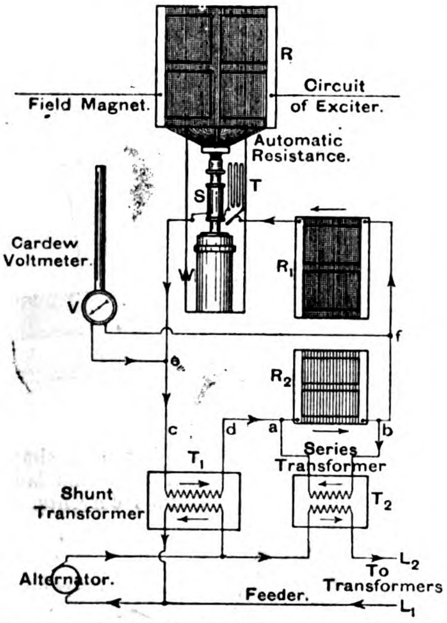

FIG. 90.—Ganz and Co.'s Method of Compensating for Drop in Feeders.

pressure at the sub-station can be kept constant for variation of drop. It will be seen that a Cardew voltmeter is used to read the primary pressure. This is possible by a suitable ratio of conversion in the transformers. It will be evident that these methods of reading the sub-station pressure are only applicable when the virtual resistance of the feeders is practically constant or varies according to some easily determined law, in which case the voltmeter can be specially calibrated to include these effects.

(*To be continued.*)

A NEW ALTERNATOR.

We are enabled to give, in this number, some diagrams and description of a new alternator which has recently been brought out by the Compagnie de l'Industrie Électrique, of Geneva.

In this alternator, the use of stationary windings is combined with the principle of the single inductor, all the poles on one side of the armature having the same polarity. This arrange-

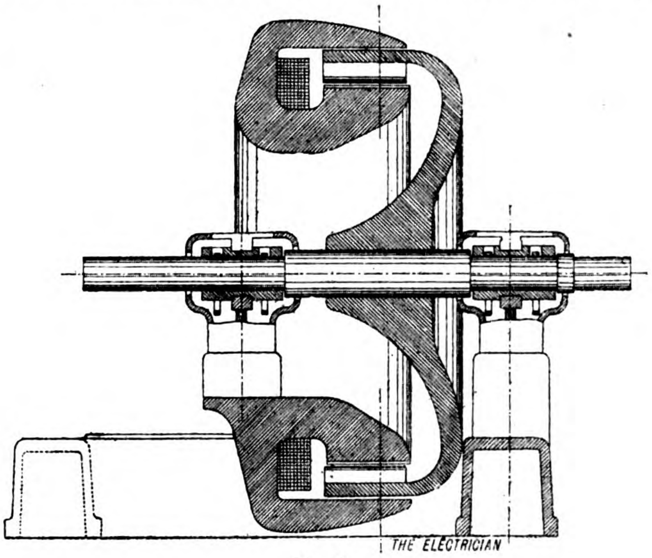

FIG. 1.

ment suppresses completely magnetic leakage, so detrimental when adjoining poles have different polarities. The alternator consists of the following parts, which are represented in the longitudinal section in Fig. 1. Firstly, a circular casting of steel, forming altogether the inductor poles and yoke ; the section of which somewhat resembles a pair of U's placed sideways, one on either side of the shaft and at some little distance from it. To be more exact, this casting is an annulus which is so flanged as to have everywhere a U-shaped section, forming an annular channel. At the bottom of this channel lie the

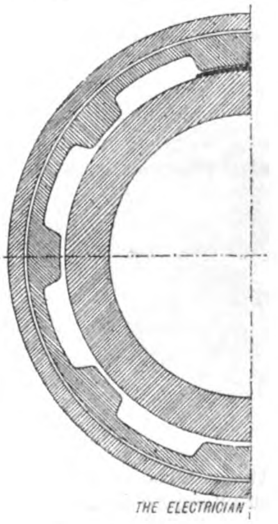

FIG. 2.

magnet windings, which are seen in section a little to the left of the centre in Fig. 1. These windings are built up of several parallel bobbins, placed at some distance apart to ensure ventilation ; and they are wound with bare copper strip. Upon the face of the inner side of the channel, near the lip, and at a place where the casting has been machined to a true surface, the armature windings are fixed, in a series of flat thin coils. These coils are indicated in Fig. 1 by close parallel lines ; and one of them is shown in Fig 2, at the top, as a thickening of the lips. Between the two lips of the annular channel there

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revolves a toothed ring, formed by the flanged end of a second annular casting, which is nested into the gap in the first one. This second casting, which is also of steel, is keyed to the main spindle of the machine. The number of teeth is fixed by the number of alternations per second required, and by the speed of the alternator. The number of armature coils is always twice the number of teeth. The transverse section, showing the inner and outer lips of the U-channel, with the notched ring intermediate between them, is shown in Fig. 2. In this figure one armature coil is also shown, there being in actual fact one such coil under every notch and one under every interspace. The armature conductors are made of stranded copper, to prevent eddy-current induction. It will

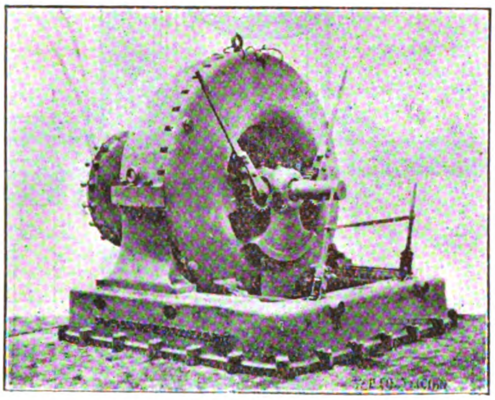

FIG. 3.

be seen that the only moving parts are the shaft and the cast-steel notched ring. On this account it is possible to have a very high peripheral speed, and the mechanical strains on the coils are entirely obviated.

Owing to the small air-gap and also principally to the use of the single inductor system, the power absorbed for the excitation, even with a very small weight of copper, is trifling and varies very little between no load and full load. In practice, with 275 kilowatts alternators, the excitation at full load absorbs three-tenths per cent. of the output of the alternator, and the increase of current between no load and full load is under 20 per cent. For equal weights of copper on the inductors and

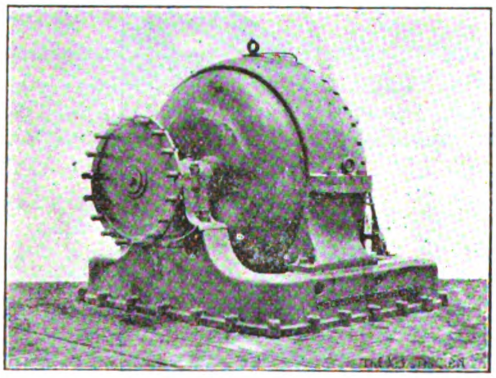

FIG. 4.

for equal powers, this alternator-inductor is said to absorb for its excitation about one-sixth of the energy required for this purpose by alternate poles alternators. The internal resistance is very small owing to the high magnetic densities used. It is possible to use conductors of large sectional area with relatively small-size machines. The C^2R losses are thus small, the armature self-induction weak and the machines easily work in parallel.

Some experiments have been made with a view to ascertaining this matter, on the same lines as the trials made by Mr. Mordey two years ago. The two alternators under trial were driven separately, one by a turbine and the other one, at will, by a turbine or by a steam engine.

During the first trial, at no load, each alternator driven at the same speed was excited to produce equal electromotive forces, and when in step, as shown by the synchroniser, they were connected in parallel without any difficulty. Then the valve of one of the turbines was gradually closed, and a compensating current passed from one of the alternators to the other, maintaining the speed constant by driving as a motor the alternator tending to lag behind the other, its motor being no longer able to maintain the previous speed. On the valve being completely closed, the alternator acting as a synchronous motor was driving the turbine, the machines keeping in step perfectly well. In the second experiment, the steam engine was substituted for one of the turbines, with the same results. For the third trial, still without load, the alternators were differently excited for the purpose of getting different voltages, the parallelling of the machine was easily done, the resulting electromotive force being one-half of the sum of the electromotive forces of each machine. Lastly, the load was put on the machines, the connecting up in parallel being as easy as before; then the current of one was gradually brought to zero, and the two alternators could be connected and disconnected without any effect on the external circuit.

To complete these trials, it would have been well to try the parallel coupling of the alternators without using the synchroniser. It is very probable, from the other results, that the coupling would have taken place as before, a very large current passing from the leading to the lagging machine, owing to the very small armature self-induction. Thus, these alternators allow the parallel working, even under trying conditions, and it is not necessary to use artificial loads. A right and left elevation of the machine are shown in Figs. 3 and 4 respectively.

THE "DOT" ARC LAMP FOR OPTICAL LANTERNS.

The arc lamp shown in the accompanying illustration has been specially designed by Mr. F. J. Borland, of Leeds, to fit into any optical lantern in the place of an ordinary limelight without any

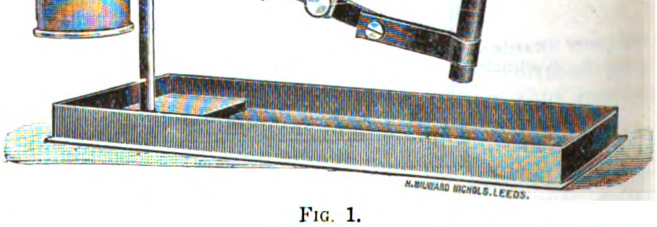

FIG. 1.

alteration. The construction of the lamp is simple, and the working is automatic. It is claimed that this lamp will work equally well on alternate or continuous currents. There is no

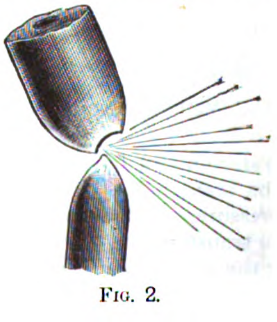

FIG. 2.

brake or mechanism, and the arc is self-focussing. These lamps have been recently used to replace limelights at the Theatre Royal at Preston. The cost is, of course, considerably less than that of limelight.

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DER VERBAND DER ELEKTROTECHNIKER DEUTSCHLANDS.

The following is derived from the last number of the *Elektrotechnische Rundschau.* :—

At the meeting of the Committee of Management of the "Verband der Elektrotechniker Deutschlands" the following agreement with Mr. Gisbert Kapp came under consideration, and was adopted by 19 votes to 8, subject to the approval of the annual general meeting :—

"The following agreement is made between Mr. Gisbert Kapp on the one hand and the Verband der Elektrotechniker Deutschlands on the other hand.

"§ 1. Mr. Kapp undertakes from July 1, 1894, the Directorship of the office of the Union, with the title of General Secretary. . . . . His duty as manager will be to carry into execution the resolutions of the Managing Committee and the annual general meeting, being empowered, on the other hand, to order and rule the business of the office on his own responsibility, according to the general sense of the instructions given him by the Council. He will also undertake the duty of acting as editor of the *Proceedings* (Journal) of the Union according to the terms of the agreement with the publisher.

"§ 2. Mr. Kapp will receive a salary of 20,000 marks (£1,000) per annum, payable monthly ; and, in addition, one quarter of the surplus of income over expenditure in any year (if any). In calculating this surplus, the salary of the General Secretary on the one hand, and the contributions of the guarantors on the other, shall be omitted. . . . . .

"§ 3. With the exceptions described in this paragraph below, Mr. Kapp will devote his whole activity [Thätigkeit] exclusively to the Union, and he is especially not permitted, even gratuitously, to give advice in technical matters, or to write for the papers ; but he is to be allowed, so far as his work for the Union is not interfered with, to take out and deal with Patents in foreign countries, and to make agreements with foreign firms as regards licences for their use. In so far as Mr. Kapp takes out Patents in foreign countries, he is entitled also to take out patents in Germany under the following conditions :—

"The commercial use of the German Patents shall belong entirely to the Union during the existence of this contract." The Union is obliged to grant licences to its members on reasonable terms, the proceeds to go to the Union funds, and *may* give Mr. Kapp a share of such royalties.

"Mr. Kapp is entitled to continue any licences granted to foreign firms existing on July 1, 1894 ; and he is also permitted to publish books and to conclude contracts with regard to their publication ; and to lecture for fees in public schools.

"§ 4. The contract lasts five years, till June 30, 1899 ; and holds each time for a further period of two years at a time, if six months' notice of determination be not given. . . . . .

"§ 5. The Union is to give Mr. Kapp all necessary assistance, and office room, and to pay travelling expenses.

"§ 6. The Funds of the Union not being at present high enough to pay the General Secretary, a certain number of members guarantee his salary.

"§ 7. Mr. Kapp undertakes to take up his residence in Berlin, or in a neighbouring suburb. . . .

"§ 8. The Council is allowed to hand over financial business to the general office, and exercise the right of superintendence."

A further agreement between the Verband der Elektrotechniker Deutschlands and the publishing houses of J. Springer and R. Oldenbourg relates to the arrangements for constituting the *Elektrotechnische Zeitschrift* the official organ of the Union, having two editors, one appointed by the Union and one by the publishers and makes arrangements for sharing the profits of technical publications issued by these houses. This agreement was adopted *nem. con.*

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, March 9th.

PHYSICAL SOCIETY.

5 p.m. The following Paper will be read : "Calculating Machines, and especially a new Harmonic Analyser," by Prof. O. Henrici, F.R.S. Mr. H. Wilde, F.R.S. will exhibit his Magnetarium next meeting.

JUNIOR ENGINEERING SOCIETY.

8 p.m. Ordinary Meeting at the Westminster Palace Hotel, Victoria-street. The following Paper will be read : "The Design, Construction, and Working of Boilers for Locomotive Engines," by Mr. G. Frank Burtt.

ROYAL INSTITUTION.

9 p.m. Evening Discourse : "The Making of a Modern Fleet," by William H. White, C.B., F.R.S.

SATURDAY, March 10th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture on "Light," with special reference to the Optical Discoveries of Newton, by the Rt. Hon. Lord Rayleigh, F.R.S.

MONDAY, March 12th.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

7 p.m. Council Meeting at the Palatine Hotel, Hunt's Bank, Manchester.

8 p.m. Ordinary General Meeting at the Palatine Hotel, Hunt's Bank, Manchester. The following Papers will be read : (1) "Notes on Designing a System of Underground Electric Light Mains," by John H. Rider. (2) "The Various Systems of Underground Mains and Methods of Laying Same," by S. V. Clirehugh.

TUESDAY, March 13th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Papers to be further discussed : (1) "The Liverpool Overhead Railway," by J. H. Greathead and Francis Fox, M.M.Inst.C.E. ; (2) "The Electrical Equipment of the Liverpool Overhead Railway," by Thomas Parker, M.Inst.C.E. The following Paper will also be read (time permitting) : "The Prevention and Detection of Waste of Water," by Ernest Collins, M.Inst.C.E. ; to be followed by a reception by the President and Council.

WEDNESDAY, March 14th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read : "The Fountain Air Brush," by Charles Burdick.

FRIDAY, March 16th.

ROYAL INSTITUTION.

9 p.m. Evening Discourse : "The Scientific Work of Tyndall," by the Rt. Hon. Lord Rayleigh, F.R.S.

SATURDAY, March 17th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture on "Light," with special reference to the Optical Discoveries of Newton, by the Rt. Hon. Lord Rayleigh, F.R.S.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

Steam Piping.—A Paper on "Steam Piping and Efficiency of Steam Plants," by W. A. Pike, was recently read before the American Society of Mechanical Engineers. The author thought sufficient attention had not been paid to this matter by engineers. He considered poorly contrived piping was the cause, in many cases, why the efficiency of an engine was less than it should be. He gave four rules for proper piping, as follows :—(1) The piping and accessories should be so arranged that practically dry steam shall always be delivered to the engine. (2) The steam should reach the engine with very little "drop" in pressure. (3) The piping should be so planned and valves so placed that water cannot, under any circumstances, collect anywhere, except in places especially arranged for that purpose. (4) Wherever practicable, and especially where more than one engine is supplied from one battery of boilers, the piping and valves should be arranged so that, in case of accident to any part, it can be shut off without shutting down the whole plant. The author gave cases illustrating each of the above rules in practice. By attaching a receiver to the pipe close to the engine, he claimed, a large part of the drop in pressure would be avoided, and there would be an improvement in the power developed, and in economy. This last was corroborated by the President, who described how steam was carried over a mountain at one of his collieries, a distance of 4,500ft. by means of a 6in. pipe, and the drop in pressure was but 2lb. or 3lb. He had a large receiver at the end of the pipe, which served as a reservoir for steam and a trap for condensed water. Expansion was provided for by making a right-angle bend in the pipe every 1,000ft., such bend having a large radius.

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MUNICIPAL ELECTRIC LIGHTING LOANS.

The loan of £30,000 for electric lighting purposes originally applied for in December, 1892, by the St. Pancras Vestry was approved about a fortnight ago by the London County Council for a period of 25 years, but the Vestry, dissatisfied with the terms upon which it was granted, decided to seek a loan elsewhere, and have accepted the offer of the Prudential Assurance Office, which agreed to the terms originally asked of the London County Council. Much indignation had, moreover, been previously aroused in St. Pancras Vestry circles by a proposal of the Finance Committee of the County Council that the loan should be split up into three portions, to be repaid within periods ranging from five to fifteen years, according as the money was spent on more or less durable work. In a vigorous pamphlet inveighing against this proposal, it was urged that it was contrary to the avowed policy of the Council that it should impose conditions with regard to loans rendering it "impossible for local authorities to undertake electric lighting without casting unjust and unnecessary burdens upon the present generation of ratepayers." No local authority, it was argued, could possibly give to its ratepayers "the benefit of *cheap electricity*, inasmuch as the present consumers would have to be charged a higher rate per unit for electric current than need be the case, in order to extinguish the capital outlay in a comparatively limited number of years"; a consummation which naturally was not to the taste of those who, like the author of the pamphlet in question, start on the assumption that "the municipalisation of the electric lighting undertaking is desirable in the public interest."

There is, however, compensation in all things, and it must be some compensation for those who have had to raise capital for electric lighting purposes under the onerous conditions

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imposed by the Electric Lighting Acts, to find the biter bit, and to hear the low opinion which municipalities have of short period loans when these are forced upon themselves instead of upon private capitalists. So long as the municipal purchase clause of the Electric Light Amendment Act of 1888 remains on the statute book, so long will it be necessary for any private electric lighting concern, which happens to be prosperous and desires to be provident, to pay a dividend of certainly not less than 5 per cent., to keep its plant in perfect working order, and to set aside annually a sufficient sum towards capital redemption to enable its shareholders to contemplate with equanimity the day of municipalisation. It is true that, according to the Act, a period of 42 years is allowed within which this feat has to be performed, whilst in the case of St. Pancras the maximum period the County Council was originally inclined to permit was only 15 years, and the period finally fixed was only 25 years. But it must not be forgotten that a company is rightly expected to pay a higher interest than 3 or 3½ per cent., and that no monopoly is accorded to it, as is the case with a vestry or other local authority. All things considered, therefore, it would seem as if a private electric lighting concern, with no monopoly, which has to pay 5 or 6 per cent. interest and to redeem the greater part of its capital in 42 years, is in no better position than a vestry with a monopoly which has to pay 3 or 3½ per cent. interest and to redeem its entire capital in five-and-twenty years. Assuming that the St. Pancras Vestry had to repay the whole of the £100,000 it had expended up to December 31st last in 25 years instead of 42, and that the private lighting output remained for five-and-twenty years at its present figure of 400,000 units, the additional sum required to be set aside for the repayment of capital in the shorter period would only mean the addition of about one penny to the total cost of the Board of Trade unit, an addition which increased economy and a larger output would before long obliterate. The suggestion, therefore, that "cheap electricity" is inseparably connected with a minimum of 42 years for repayment of capital will not hold water.

If an inferior runner is given sufficient start he can always win the race. In the same way if municipalities by legislative favours and otherwise are only placed in a sufficiently advantageous position to start with, they will no doubt be able to make a better showing than their hampered rivals, the private capitalists. Is this, then, what we are to understand by municipalisation? Are these its benefits? Because if so, one can have no hesitation in saying they are illusory, and that the community will in the long run repent the error of its ways. If there be any real virtue in municipalising electric light undertakings then it can only arise from the fact that local authorities can really and truly turn out the Board of Trade unit cheaper than can limited liability companies. To first fix the dead weight of the 42 years' purchase clause upon your competitor, trying whenever opportunity offers to make the weight still heavier by cutting down the term of years to 21, and then to deduce the superiority of municipal electric light management from the fact that it can do better than private management so hampered, is to abuse the reasoning faculty. We have no animus against the municipalisation of the electric light, if it can be shown to be "desirable in the public interest." Indeed, it is for this very reason that we hail the decision of the London County Council to insist upon the repayment of all future municipal electric lighting loans in 25 years; this decision, if adhered to, will place private and municipal electric lighting on something like equal footing, and enable non-partisans to judge for themselves whether there be any real superiority in the parochial management of what must ever remain a more or less speculative undertaking, requiring for its successful issue the exercise of just those faculties which have hitherto only been energetically developed by the exigencies of business competition.

But on quite other grounds, there is much to be said in favour of shortening the period for the repayment of municipal electric-lighting loans. The Vice-Chairman of the County Council, in moving that the report of the Finance Committee should be referred back, recommended that the St. Pancras loan should be for the full term sanctioned by the Money Act, 1892, viz., 50 years, or, at any rate, for 42 years, as urged by the Vestry. He admitted that no doubt the present plant, and possibly the present buildings also, would be worn out before then, but plausibly argued that the undertaking of which they formed part would not be worn out, and that there was, therefore, nothing financially unsound in spreading the repayment of the loan over the longer term. The amendment extending the period was, nevertheless, rejected by 61 votes to 36; the argument which closed the discussion being to the effect that if the Council allowed every loan for the longest possible period, they would put themselves in a serious position when they went to Parliament to obtain an extension of the term for housing loans, so that purely selfish, not sound economic considerations had the last word. In the case of long-lived municipal works of public utility and necessity, such as town-buildings, sewers and water-supply, which are not in the least degree likely to become obsolete, and from which the whole community for many generations after will continue to reap benefit, it is both just and proper not to throw the entire burden of repayment upon the generation which is enterprising and public-spirited enough to undertake them; long period loans, are appropriate only in such instances; in all others they encourage municipal extravagance.

The Finance Committee of the County Council, with a truly *doctrinaire* longing for absolute mathematical accuracy, wished to have each individual pound of the St. Pancras loan automatically repaid the very instant the particular object on which it was expended was relegated to the scrap heap. In the same logical spirit it might well be argued that the repayment of loans raised for purposes of public utility and necessity such as those mentioned above should be extended over an indefinitely long period, the sums annually repaid asymptotically approaching zero as the benefit derived from the original expenditure made a similar approach. Practically, however, a limit is set to the indefinite extension of the period for repayment of such municipal loans by the consideration that the life and prosperity of a town is not in the nature of things everlasting, and that a time will, in all probability, come when the repayment of loans contracted in the hey-day of youth will be impossible. But loans for sewers and water-works are one thing, and loans for an electricity supply on the three-wire system another. Traces of sewers and water-works are met with in the excavated remains of every ancient city, but up to the present nothing corresponding to a Kapp dynamo or Brockie-Pell lamp has been unearthed. The difference is no more accidental than is the absence of human remains from eocene deposits. The three-wire system is all very well in its way, but civilised people have managed to live without it before, and may do so again. Candles have superseded torches, and gas candles, whilst at the present time it looks as if electricity were destined to secure whatever lighting is left it by oil; and the march of events is not likely to be arrested by the fact that it will cause considerable inconvenience to a London vestry which has venturesomely em-

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barked a large sum of the ratepayers' money on an undertaking which must by the very nature of it be more or less of a business speculation, and which would have been on that account far better left in the usual hands, at any rate, for the period allowed by the Act of 1888.

REVIEWS.

Thermodynamics of Reversible Cycles in Gases and Saturated Vapours. By M. I. Pupin, Ph.D. Arranged and edited by Max Osterberg. (New York: John Wiley and Sons. London: Kegan Paul, Tench, Trübner and Co. 1894.)

This little work professes to be a synopsis of a ten weeks' course of lectures delivered by Dr. Pupin, and consists of the revised lecture notes of one of the students. It possesses no table of contents, and is destitute of an index; while the need for these is made the greater on account of the somewhat rambling arrangement of the subject matter. As the Chicago Congress did not venture to crystallise the science of thermodynamics, it may be protested that an author is at liberty to adopt what units and symbols he pleases. But he will select unpopular ones only at the expense of the popularity of his book. A system of thermodynamics based on the metre, the kilogram, and the kgr. calorie is by no means one which can be conveniently compared with the more recognised systems. It is a pity, too, to use the symbol γ for the specific heat of unit volume, since it has been universally adopted by all the authorities as the symbol of the ratio of specific heats at constant pressure and constant volume. Sufficient prominence does not appear to have been given in these lectures to the entropy function, which is granted only a few words of meagre explanation at the end of the sections on perfect gases, and which is only slightly used in the later sections on steam. The prominence into which entropy-temperature cycles have been raised of late, especially in relation to the theory of the steam engine and other heat engines, makes it especially important that the student of thermodynamics should early make himself familiar with this important thermodynamic function and its properties. Absolute temperature is frequently mentioned throughout the lectures; but its true significance, either in relation to the volume of a gas—or more important still—in relation to thermodynamics, is nowhere pointed out. The work is not an elementary one, for it skips many of the essential elements of the science; neither can it be regarded as an advanced one, for it avoids most of the important theorems of advanced thermodynamics. Still, some portions of it are fairly readable; such, for example, as the sections in which the cycles of steam engines are discussed. This work may represent thermodynamics from an American aspect; but English students will do well to select their text-books of the science where they will be sure of getting a clearer and more accurate statement of it, expressed in symbols which everyone recognises and can understand.

The Engineer's Year-Book of Engineering Formulæ, &c. By H. R. Kempe. (London: Crosby Lockwood and Son. 1894.)

This is a mass of useful information very well arranged and printed, and is a development on the lines of Molesworth, Trautwine, and D. K. Clark. The reason for calling it a year-book is not very apparent, but it is stated in the preface that "obviously a work of this nature, to fulfil its purpose of being kept up to date, will require periodical revision, and it is accordingly intended to reissue it from year to year." As in almost all books of this class there is too much condensed text-book matter. The mathematical tables seem to be particularly well done; the linear, superficial and cubical dimensions of segments and zones are given. Square roots and reciprocals running to nine figures, and cube roots to eight figures, for numbers up to 100 are noteworthy. The electrical section contains the everlastingly-repeated diagrams of various windings of field-magnets, together with such rules as "Practically, the armature resistance may be made one-twentieth of the external resistance, and the shunt resistance twenty times as great." "For insulating wires for electric-light purposes india-rubber is preferable to gutta-purcha, as the latter gets soft when heated." This information might have been useful ten years ago, but surely is out of place in a work which aims at being up to date. In a specification for wiring we find a misprint, the only one which we have noticed, platinoid wire of 7·2 millimetres diameter being recommended for fuses of single lamps; 7 mils is probably intended. A few lines farther, on page 470, it is recommended that the centre fillet of wood casing for main cables should be 2in., for branch cables 1in., and for single conductors not less than 2in. The general contents of the book are of a much higher order than is suggested by these extracts, and if such superfluous pages as those devoted to descriptions of square-hole drilling machine, steam hammer, lighthouse construction, and dock gates were omitted, its usefulness would be greatly increased. The book is excellently printed and bound, but is greatly disfigured by a large number of advertisement pages scattered throughout the whole.

Rules for Electricity Works Management. By Albert Gay. (Published by *Lightning*, Limited.)

A set of nine sheets of rules, for engine-drivers, stokers, cleaners, electricians in charge, electricians on mains, wiring inspectors, jointers, meter inspectors, and meter-room attendants have been drawn up by Mr. Gay. These were, no doubt, excellently adapted for the conditions of the House-to-House Company's station at Brompton, where the author was chief engineer, and will doubtless serve for the Islington station which is in his charge. Rules of this sort may be useful as guides or models for other stations, but are not generally applicable, if for no other reason than that an engineer of a station ought to be able to draw up rules for himself, and in nine cases out of ten would very much prefer to do so. We can imagine what a nuisance a fussy vestryman might make, if, armed with these rules, he visited a parochial or municipal station, and inquired into the observance of a few of the regulations taken at random.

THE BRIGHTNESS OF LIGHT: ITS NATURE AND MEASUREMENT.*

BY JAMES MARK BARR AND CHAS. E. S. PHILLIPS.

Of all things in nature for which we feel an appreciation that is definite, light, with its many gradations, would appear to stand first. And at the start it would seem to be a perfectly specific and definite operation to compare one light with a second, and express its brightness in terms of the luminous intensity of the other. But what do these terms define?

The meaning of *brightness* of light, as far as the eye is concerned, does not depend upon one theory or another regarding the nature of light *per se*. But if the emission hypothesis were correct we could have a mental appreciation of brightness which would be quantitative in the material sense, and actual photometry would be analogous to capacity measurement, so that a unit of brightness might be determined apart from the eye, and yet be near in expression to what the eye really gives to the brain as brightness.

Since the emission theory is not correct, we are still further away from the absolute measurement of luminous intensity, and we find it more difficult at the start to grasp the exact meaning of such intensity.

When we define the brightness of light as the luminous intensity per unit area, we are merely stating that the unit of brightness is the brightness of the unit. In such cases as this some arbitrary standard is resorted to for definition. We set up a candle, for instance, and say that there is the unit of brightness, without actually defining the effect at all. Such a standard may meet the requirements for arriving at specific appreciation if we can be certain that it gives constant effects. But it has been said in this journal not long since that "The Parliamentary candle is not a more scientific or accurate standard than was the old barleycorn, of which three went to the inch."

To express luminous intensity we can have no other terms but those for ultimate physiological or, indeed, psychological effect, and we ask: What are these terms? We see at once that it is impossible to measure them directly.

Prof. Langley defines the brightness of light as the intensity of "retinal absorption," and he calls it a provisional definition. But there may be a large gap between the amount of retinal absorption

* Read at the Institution of Electrical Engineers (Students' Meeting), December 15, 1893.

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and the degree of luminous intensity as felt by the conscious brain.

And aside from this there is a gap between the energy of a light and the amount of retinal absorption which follows. Prof. Langley shows that there is much confusion regarding the connection of "candle-power" with the energy *per se*. *Per se* because, in spite of the law that when there is any physical effect in nature there is always a definite amount of energy at the back of it—in spite of this—the energy here connected directly with the *psychological* effect is quite distinct from the energy related to the production of the light vibrations.

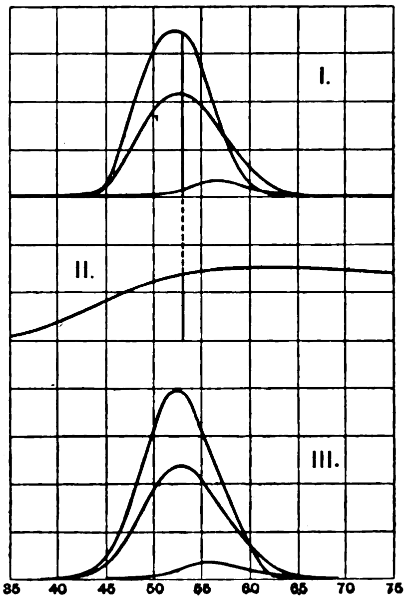

Fig. 1.

The physiological or physical effect at the retina may be proportional to the energy of the spectrum band considered, but because the retina receives, say, a large impingement by radiation, it does not follow that the brain centre will give a message for *brightness* in proportion. The link between primary energy and ultimate psychological effect is quite elastic, though for a monochromatic light the brightness will vary within practical limits directly as the energy or amount of retinal impingement.

If we imagine that there is no such thing as the retina, then light—as light—ceases to exist, and if we were to say generally, that the brightness varies with the energy, then we would say that in the spectrum range of visibility there is more energy than elsewhere. But this, as we have seen, is not true. Professor Langley, in a paper on *Energy and Vision*,* gives the curves which we show in Fig. 1. The curves at I. give the luminous intensity of the

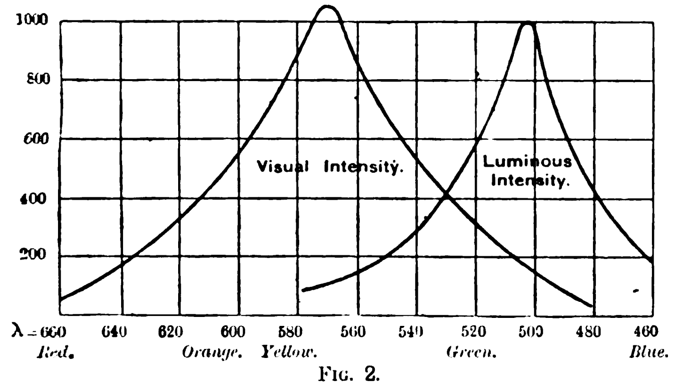

Fig. 2.

normal solar spectrum; curve at II. the thermal energy for above; and curves at III. give the luminous intensity as referred to a constant amount of energy.

The determinations of brightness for the above were made by taking the percentage of correct readings of a table of logarithms illuminated in succession by rays from various parts of the spectrum. This method is regarded by Professor Langley to be the most reliable for photometric work. It is to be noted that there are three curves, one for each of the observers. We see that for different eyes there are different positions in the spectrum for the maximum brightness, and the differences in ordinates show the general variation in strength of eyesight. We call attention to the curves in Fig 2, which are from a Paper by M. Blondel.† This writer takes views diametrically opposite to those of Capt. Abney with regard to colour photometry, and it is not surprising that we here find a use of terms differing from that of Professor Langley. M. Blondel speaks of visual intensity as being distinct from luminous intensity. The curve having its maximum at the yellow-green is labelled "Visual Intensity," and the other "Luminous Intensity." If we reversed the titles then the curves might be accepted as meaning that the eye can *detect* a very feeble green-blue light best, although it would *read* say a table of fine print better with yellow-green rays. This seems rather paradoxical, and we believe that there is something to be said regarding a difference between the words of M. Blondel and Professor Langley.

* Phil. Mag., Vol. 27, p. 91, 1889. † *The Electrician*, December 1, 1893.

But hair-splitting over definitions will not bring us to what is really wanted in the measurement of brightness. We value one light more than another chiefly when we can *find our way* better with one than the other. The practical world requires that the photometer shall tell the candle-power of a lamp in terms of *distinguishing power*. As to the nature of the brightness of light, we can only say that it is first a physical, then a physiological, and lastly a psychological effect. Therefore, its measurement must be relative.

The difference in the position of maximum brightness (*see* Fig. 1) constitutes a great source of error where several are taking the photometer readings. And as there is a great variation in the amount of *power* required to produce minimum visibility with different colours for any one person, it follows that the sources for error when many are reading with "white" light are multiplied. Langley's calculations of the average horse-power required for minimum visibility for three observers show the variation for different colours of the normal solar spectrum to be :—

Violet............................	$\mu 0{\cdot}40 = 18 \times 10^{-15}$ H.P.
Green............................	$0{\cdot}55 = 75 \times 10^{-19}$ H.P.
Scarlet	$0{\cdot}65 = 34 \times 10^{-12}$ H.P.

To sum up, we have the following values of the sensitiveness of the eye for different periods, taking sensitiveness to yellow (sodium flame) as unity :—

Violet	= 0·104
Green	= 5·790
Scarlet	= 0·036
Crimson*	= 0·00007

* At A line.

And compared to green-yellow the rays of maximum brightness, Prof. Langley gives :—

Violet to Green	= 1 to 56
Scarlet to Green	= 1 to 160
Crimson to Green	= 1 to 83,000

Lastly, we must call to mind the variation of the percentages of three colours required to make white light for different people. We see from the above that in dealing with *whitish* lights we are beset with a source of error which cannot be eliminated with satisfaction by practicable means. It is obvious that the use of colour screens will not serve when several are reading, unless the observers use individual glasses which would bring the various points of maximum brightness of spectrum to a common position. But this would not compensate for the above-mentioned error due to differences in power for minimum visibility.

There are a number of methods for determining error due to colour difference, but all of these fail to be of practical use where time is a consideration. We find that the only instrument which would measure the brightness of light regardless of colour is uncalibrated. It is the eye itself. That we do have graduated slide scales in photometry means very little, for what we really want is a quantitative measure of the intensity of brain effect. And how can we do this with the brain itself? We are beset with physiological, or, rather psychological, effects, and as yet there is no psychological unit which we can represent by anything concrete to give to the Board of Trade.

If there were any outside reliable effects in nature which were functions of the actual brightness of light, as we feel it, we would have a photometric principle.

About the only light effect having its maximum in the yellow-green rays is that of the resistance variation of selenium, but of all things to exhibit the total depravity of the inanimate this stands first. The variation of its resistance is truly a function of the brightness, but on a curve which changes totally from day to day.

Fig. 3 shows the inconstancy of two selenium grids made at Pittsburgh, U.S.A., in 1889.

It is usually stated that the maximum reduction of resistance is as 1 is to ½ for dark and light, but it has been found possible to obtain double this variation. The topmost curve in Fig. 3 shows a ratio of 4 to 1 at the beginning, when the selenium had just been annealed.

The grid deteriorates greatly by spasmodic alterations, and it is surprising that we sometimes get indications of a considerable *rise*

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in the ratio after it has got very low. The effect at any moment is always proportional to brightness in the neighbourhood of the yellow-green rays so that for short intervals it gives a good photometer principal. But it is a question whether or not the variation could be discernible for small differences of candle-power. It is to be noted that there is practically no change for minute alterations in temperature, and that it is not the heat of the spectrum which gives the effects. Light *reduces* the resistance of selenium, and in this selenium acts contrary to the other metals as affected by heat rays. Mr. Mordey suggested to the writers that this might indicate that the effect was due to a change in the *association* of the particles of the granular substance. Mr. Shelford Bidwell, in a Paper before the Physical Society in 1890, has given a most exhaustive account of the nature of selenium changes. He suggests that the whole action is due to the presence of small quantities of a selenide, and that the deliquescence of selenium oxides, always present, give rise to the spasmodic alterations of the ratio. He also points out that the amount of selenide in a grid increases by long use, so that there is a gradual and permanent reduction of the ratio after an excess of selenide is formed. Siemens was one of the earliest to propose a selenium photometer, and a number of arrangements, comprising light sensitive resistance grids and selenium couples in circuit with a galvanometer have been suggested from time to time. But the erratic variation of the ratio gives an insurmountable difficulty, and as yet nothing practicable has been brought out.

We will now refer to other relative measurements. It has been suggested that for a given illuminant we might determine the *heat* produced as an independent variable, of which the brightness of the corresponding light might be regarded as a function, and thus reduce practical, or rather commercial, photometry to thermometric measurement. For instance, if we were making a given kind of glow-lamp

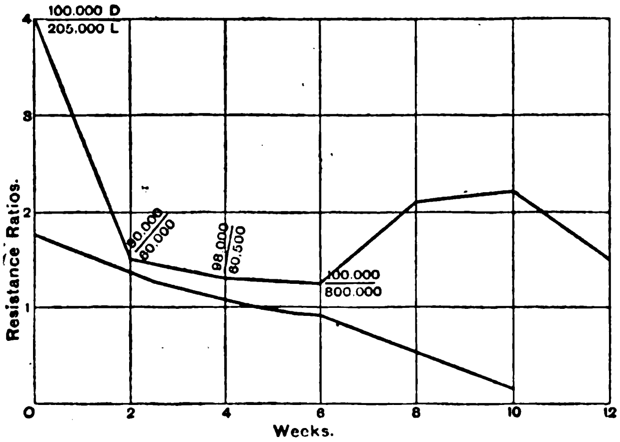

FIG. 3.

filament which had the known curves (Fig. 1) for brightness and thermal intensity, why not measure by a Melloni pile or Bolometer the ordinate Y′ of Curve II., and at once know the ordinate Y of the corresponding Curve I.? It would be just as definite to propose measuring the watts in a given kind of filament as a quantity to which the luminosity is proportional. Speaking generally, the brightness cannot be a perfectly definite function of either the amount of heat or temperature of a number of filaments of one kind, although we can state that in each it varies as some power of the amperes.

If, by attending to an absolutely definite routine of treatment of the carbon, we could make the expression

$$a\left(\frac{A'}{A}\right)^{-a}$$

constant, where A and A′ are two values of current for the candle-powers c and c' in the equation

$$\frac{c'}{c}=\left(\frac{A'}{A}\right)^{a},$$

then glow-lamp photometry would exist on ammeter scales. But the variation in a is beyond every endeavour in the manufacture. Experiments were tried in 1888-9 by M. Lodyguine to control the value of a in the process of making the filaments, but he found that irregularity was inevitable.

On the other hand, it has been proposed to measure the *actinic* effect from a given luminant in order to arrive at the value of the *brightness* of the light. This is slightly more promising from a theoretical standpoint. There are many chemical effects of light, but most of them are too unreliable for practical use. The most familiar actinic actions are those of ordinary photography, and among many others a very ingenious photometric method has been based on the reduction of metallic salts by light.

The next actinic action is that of the formation of hydrochloric acid by light from a mixture of its constituents. A good many years ago Bunsen and Roscoe, and later, Roscoe with Schörlimer, utilised this action of light to measure the solar luminosity during the course of the day and year. They exposed a tank of hydrogen and chlorine to the sun's disc during the whole day, and at intervals removed definite quantities of the gas. A screen was used to prevent too rapid an action.

By noting the amount of HCl formed they obtained values which they took as ordinates proportional to the brightness of the sun at different elevations. From these they plotted curves, which have been made use of in photography. But such a curve really fails to give the *brightness* of the light as we feel it. Gradations of shade in orthrochromatic negatives, exposed with regard to the curve, might give it, however. Other effects of light are as follows:

Sulphur acts like selenium. Chlorine decomposes water upon exposure to light, liberating oxygen. Mercurous oxide decomposes, forming mercuric oxide and free mercury. Nitric acid decomposes slowly. Oxalic acid decomposes slowly. The vegetable green, chlorophyll, liberates oxygen in presence of sunlight. Iodide of nitrogen in ammonia decomposes, liberating nitrogen, the quantity of which is proportional to the intensity of the light. It has not been stated for this action just where the position of maximum effect lies in the spectrum, but for ordinary whitish light it may be taken as practically proportional. We refer later to a photometer which has been based upon this principle. Another chemical effect of light is the production of carbonyl chloride from a mechanical mixture of carbon monoxide and chlorine upon exposure to luminous rays. The combination does not take place with heat, and on account of the light effect this gas has been named Phosgene.

The next effect of light is the most interesting of all, and perhaps is the most promising for use as a measure of luminosity. It is the mechanical expansion of chlorine gas upon exposure to light. The effect is entirely independent of heating, and moreover the gas recovers its original volume upon darkening. This perhaps is the only known direct mechanical effect of those rays which we appreciate as light. The same chlorine can be used over and over again, and for this reason, and also as the action is truly due to luminous rays, Dr. Richardson, of University College, Bristol, thought of utilising it for the practical measurement of the brightness of light. In 1891, before the Physical Society, he pointed out that for rays just a little beyond the yellow-green the method was most accurate.

Few of the above effects could be used for the actual measurement of the brightness of light, but we believe them to be interesting as showing how well surrounded we are with suggestive photometer principles, while we are unable to utilise them.

Since brightness, fundamentally, means some quantity which is referred to a psychological unit, it might seem hopeless to expect by any mechanical means to measure it. However, as is well known, very many methods have been devised to do this, and, although no absolute photometer has yet made its appearance, some of the instruments constructed to measure brightness are of great practical value.

During the latter part of the last century Count Rumford suggested his now well-known method of measuring brightness relatively, by comparing the intensities of two shadows of the same object produced by two separate sources of light. Thus originated the first instrument for measuring brightness, and it is interesting to note that, although many years have elapsed since its introduction, the principle of the modern photometer is essentially that of Rumford. Since Rumford's date much time and labour has been spent in perfecting photometric apparatus, but nothing perfectly absolute has been obtained.

The readings of a galvanometer may be definite, so also the time at any instant can be read from the dial of a clock with accuracy; but with photometers it is different, as sometimes considerable variations occur in the readings taken by different people, all other conditions remaining the same.

This state of things is deplorable, though not astonishing after a little consideration as to the real meaning of the term "Brightness." It is only through the eye* that we realise the sensation of brightness, and since this organ varies in so many ways with different individuals one cannot hope to get a scale of measurement that will be applicable to everyone. Therefore all methods of measuring brightness in which the eye is involved are vague, and so we must look further afield for a principle upon which to base the ideal photometer of the future. If some property of light depending upon its intensity could be utilised—such, for example, as its power to promote certain chemical combinations—then, if in the meantime a definite standard of brightness had been established, photometric measurements would be comparable as regards exactness with those of length and weight. We venture to think that the introduction of such a photometer is not far distant.

* By "eye" here we mean the whole system of nerves which communicate the retinal impressions to the brain, and, indeed, the brain itself.

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[The authors then proceed to describe a number of photometers, including the Bunsen, Joly, and Lummer-Brodhun.]

The diagrams shown in Fig. 4 were obtained from a large number of photometric experiments carried out at the Central Technical College, and we are greatly indebted to Prof. Ayrton for permitting us to see the original reports upon this work. The diagram is interesting, in so far as it shows the relative efficiency of the most generally used photometers.

It will be at once seen from this diagram that the small star spot photometer is the most efficient of all the instruments tested. The principle upon which this photometer depends is similar to that of the grease spot. Two sheets of stiff white paper with star-shaped apertures (of equal size) cut out from their centres are pasted one on either side of a thin sheet of some semi-transparent paper. The two star-like holes being placed opposite to one another, so that, if

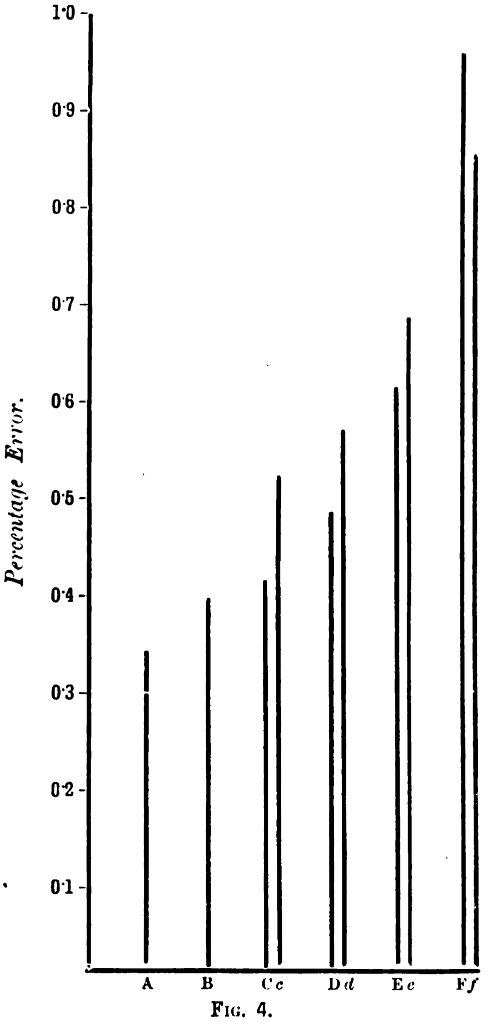

FIG. 4.

A Small star spot.
B Paraffin block (Joly) photometer.
C Large star spot, 400 cms.
c do. do. 192·5 cms.
D Glass block, 400 cms.
d do. 192·5 cms.
E Another glass block, 400 cms.
e do. do. 192·5 cms.
F Grease spot, 400 cms.
f do. 192·5 cms.

the arrangement be held up to the light, the star will be clearly seen. The method of using this photometer is exactly similar to that for the grease spot already described. In using paper screens, as in this case, it is particularly necessary to keep them scrupulously clean. At the Westinghouse photometric department considerable use is made of this photometer.

[The authors then quote descriptions of chemical and other photometers from the *English Mechanic*, April 22, 1881; *Nature*, December 8, 1881; *ibid*, Vol. XLII. p. 511. They allude to the MM. Legul and Verscheffel's modification of the radiometer, to the work of Mr. A. Wurts, Mr. A. P. Trotter, Mr. W. H. Preece, Prof. Pickering, and Prof. Thorpe, the two last relating to stellar and solar photometry.]

We have already referred to chemical photometers, and mentioned some of the more theoretical methods. The following two ways of measuring brightness we venture to suggest ourselves.

It has been shown by several investigators that some of the chemical-light effects may be used in photometry with practical approximation to accuracy. However, aside from Roscoe's work upon the solar intensity (using mixture of 2 H and Cl, as described), Dr. Richardson's experiments with chlorine, and the investigations of Bidwell and others upon selenium variation, little has been done to bring out a practical photometer based upon these effects.

It is generally supposed that it is only the *actinic intensity* of the light which is involved, and that therefore it is a vain effort to attempt to measure *illumination intensity* by the chemical-light effects.

But there are several gases which show a maximum of action in the yellow-green rays, and this, considered with the fact that in the largest practical use the kind of illuminant would not vary within wide limits, should give us some hope for a new photometer.

No investigations have conclusively shown that the action of carbonyl chloride may not be utilised for the practical measurement of candle-power. The writers venture to suggest a simple photometric arrangement involving the use of the above gas, and it is probable that with an approximately constant kind of illuminant, the instrument could be used practically. Carbonyl chloride is formed from a mixture of carbon monoxide and chlorine upon exposure to white light, and the mixture changes in volume from one to half when all combination is completed. For the measurement of high candle-powers it is proposed to employ a cylinder of the above mixtures exposed to the lamp and connected to a simple manometer tube, arranged to indicate in a magnified way a change in pressure in the cylinder. Arrangements would be made for compensating for the heat effects and for the regulation of the gas pressure.

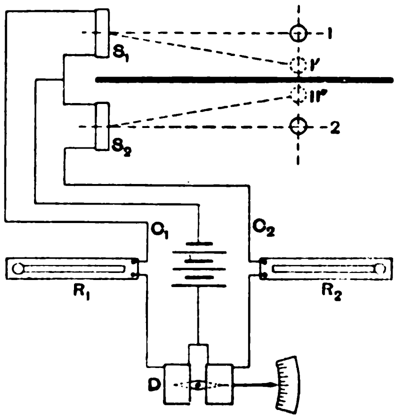

FIG. 5.

The second method we suggest consists in an attempt to use selenium grids in such a way as to give accurate results independently of any of the variations to which they are so liable. All that is required of the selenium grids in this case is that a change in the resistance takes place, which is greater the brighter is the light, without constancy or proportionality. Two selenium grids are arranged in differential circuit with a galvanometer, and both are exposed to the standard in succession. By means of adjustable resistances the deflections to right and left are made equal, so that now, if both grids are exposed simultaneously to the same light, there will be no deflection, see Fig. 5. After c_1 and c_2 are adjusted as described, the standard is placed at the position 1, and the lamp to be measured placed at position 2. Now, any deflection of the galvanometer will have no quantitative value, but will indicate simply that a *difference* exists between the two lights, and it shows by its sign which way the unknown must be moved on its scale to bring the illumination at s_2 and s_1 to equality. This only requires that the grids remain constant in action for a moment at a time. For electric standards it would be convenient to have two standards at 1′ and 1″, so that during measurement they could be flashed on and off at intervals as a check on the action of grids.

We had hoped at the outset to have given a more complete account of light-measuring apparatus, and to have described in some detail the ingenious photometric methods of Capt. Abney and Mr. Trotter.

Time will, unfortunately, not permit this, and we must also for the same reason abandon the consideration of light standards, a subject of so much importance and so closely related to photometry.

We feel, however, that we cannot conclude our remarks without thanking those who have so kindly helped us by supplying suggestions for this Paper. More especially are we indebted to Prof. Ayrton for his valuable advice upon some of the more intricate parts of our subject, and for permitting us to read the original reports on some of the extensive photometric investigations that have been carried out at the Central Technical College.

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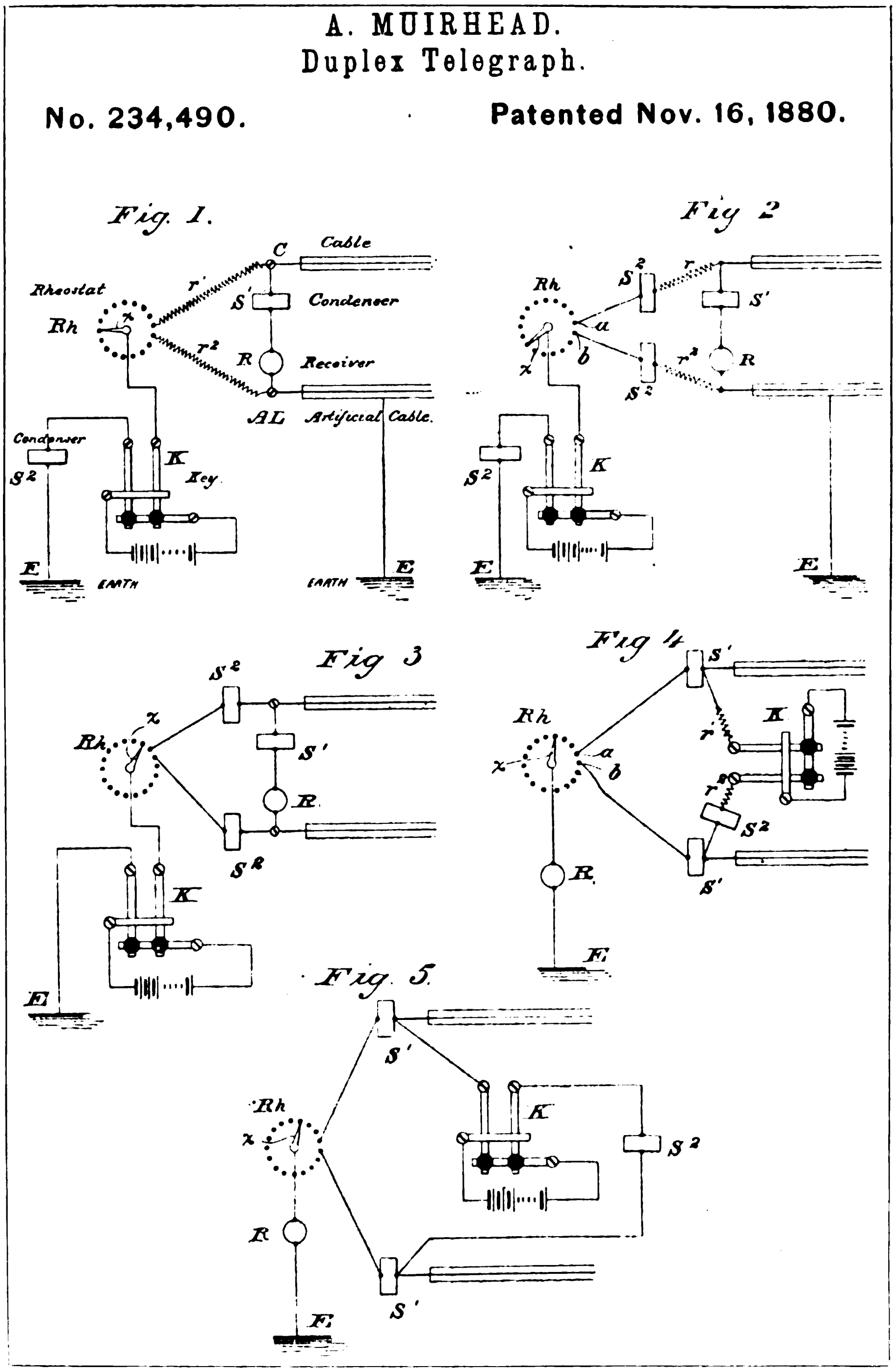
LEGAL INTELLIGENCE.

Muirhead v. The Commercial Cable Company.

This case came on for hearing before Mr. Justice Kennedy in Queen's Bench Court III., on Wednesday last week. Mr. Finlay, Q.C., Mr. Bousfield, Q.C., M.P., and Mr. E. H. Pollard appeared for the plaintiffs, instructed by Messrs. Trinder and Capron. Sir Richard Webster, Q.C., M.P., Mr. J. F. Moulton, Q.C., and Mr. A. J. Walter appeared for the defendants, instructed by Messrs. Budd, Johnsons and Jecks.

Mr. FINLAY said that the action was brought to recover royalties under an agreement giving the defendants a right to use certain patents belonging to the plaintiffs. The sums claimed in the action were £1,879. 18s. 9d. for royalties due from July to September, 1891, and £1,685. 2s. 8d. for royalties from September to December, 1891, making together £3,566, but the decision of the action would involve the decision practically as to whether the plaintiffs were or were not entitled to recover royalties from July, 1891, up till November, 1897, that being a sum of about £45.000. The question in dispute was whether one of the patents (United States 234,490 of 1880) comprised in the plaintiff's licence to the defendants was or was not still in force. The defendants sought to attack the patent on the grounds of American law, though precluded from averring that a patent under which they took a licence was invalid—they sought to show that it was invalid *pro tanto*, and ceased to exist at the same date at which a so-called identical British patent No. 2,564, of 1876 came to an end. A licensee, like a lessee, though he could not dispute his landlord's title, might show that it had expired, but if the mode in which the defendants sought to show that the plaintiffs' patent had expired involved an attack on the patent itself, it would not be open to the defendants. The plaintiff was the patentee of a very ingenious system of duplex telegraphy. On January 2, 1884, he granted a licence to the Commercial Cable Company. Counsel then proceeded to recite in some detail the terms of the licence, Article 9 of which provided that the contract should be construed as an English one, and to describe the principles underlying duplex telegraphy as applied to submarine telegraphy. The importance of the United States patent No. 234,490, of 1880, was, Counsel stated, due to the fact that, by the combination of a rheostat with the three condensers, one on each arm of the bridge and one on the line on which the receiver was situated, it enabled them to get together two things which previously had been incompatible. These were the greatest possible speeds of transmission with a perfect balance. For the purpose of facilitating the obtaining of a balance before this invention, telegraphists were constrained to employ very high resistances, going up as far as 2,000 ohms on each arm of the bridge.



Reproduction of the Drawings from the American Specification of 1880.

THURSDAY, MARCH 1ST.

On the hearing of this case being resumed, Prof. SILVANUS P. THOMPSON, examined by Mr. Bousfield, stated that he had had his attention particularly called to three patents, the United States patent, No.

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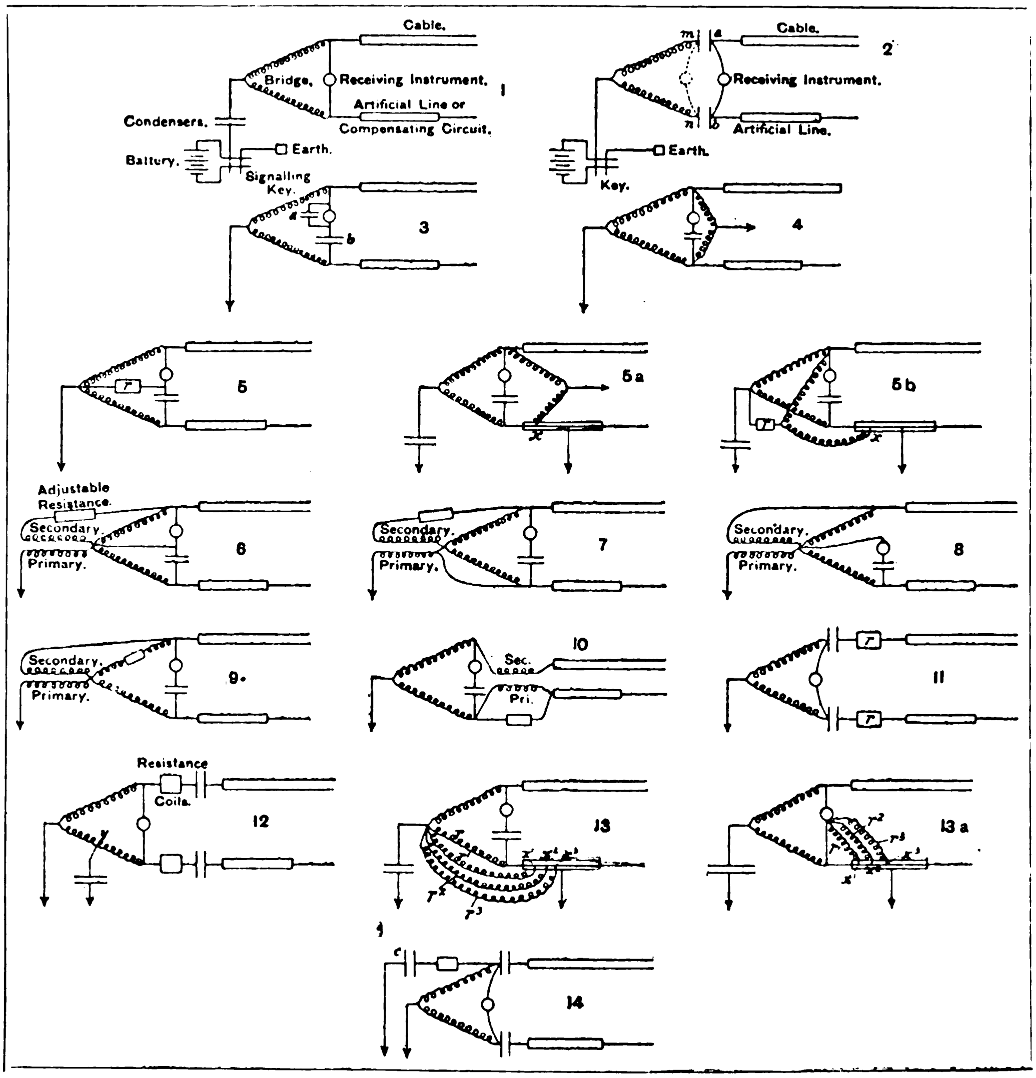
234,490, of 1880, and two English patents, 2,564, of 1876, and 2,538, of 1877. Witness then explained to the Court the general principles of duplex telegraphy. Examined on the American patent 234,490, of 1880, witness explained that the changes which were introduced in the arrangements shown in that specification in Figs. 2 and 3 was that in Fig. 2 the resistances r^1 and r^2 of the bridge arm had been reduced, because there had been interposed in each of the two arms a condenser. That was the only difference between Fig. 2 and Fig. 1. In Fig. 3 the resistances r^1 and r^2 of the bridge arms had been entirely removed, and instead there are simply the condensers S^2—one in each arm. That was the point of novelty—that hitherto large resistances had been employed in the bridge arms—resistances of a magnitude comparable to the cable itself. In Fig. 3 the rheostat discharged precisely the same function as it did in Fig. 2, namely, that of enabling a small adjustment to be made. The first claim of the American patent was for the combination in a telegraphic circuit of "the battery, the key, the adjustable rheostat, the sending condensers each in a bridge wire, the cable or true line connected with one section of the condenser and the artificial line with the other, and the receiving instrument and its condenser." In the former patents referred to of 1876 and 1877 he did not find this combination. There was no rheostat used with

Mr. BOUSFIELD: I submit that to take one point after another and attempt, as it were, to break down the 1880 patent on the ground that this, that and the other was known, is not within the scope of these gentlemen, who are licensees, and therefore cannot attack the validity of this patent in any shape or form. They can only succeed, as my learned friend Mr. Finlay submitted, and I take it there cannot be any controversy about that, by showing that the invention which is covered by the 1880 patent is to be found patented in either 1876 or 1877.

Sir RICHARD WEBSTER: I desire your lordship to understand that the sole point and object I am cross-examining to is to show that to any electrician the two things are identical, and so far from disputing the validity of the 1880 patent or the 1876 patent, I am simply directing myself solely to the issue. which is the only issue in this case, whether or not there is any substantial difference between the patents of 1880 and 1876.

Sir RICHARD WEBSTER (continuing cross-examination): In so far as the receiving instrument is on the cable side of the condensers, does it (Fig. 2, English patent) not exactly correspond with the change that is made in the American specification between Fig. 1 and Fig. 2 of the American specification?—In so far it does correspond.



Drawings from the English Duplex Telegraph Patent, No. 2,564, of 1876.

a bridge arm resistance in the 1876 patent. As regards Figs. 4 and 5, they referred to another point of novelty. "The combination in a telegraphic circuit of the receiving instrument the adjustable rheostat the separate condensers in the bridge wire one connecting with the true and the other with the artificial line with the key battery and condenser in the bridge or circuit between the two cables."

Cross-examined by Sir Richard Webster WITNESS said a rheostat was nothing more than a *readily* adjustable resistance. Wheatstone's receiver was a particular form of it; they merely had to turn a handle until they obtained the resistance required. He did not think a resistance box could be called a rheostat. The condenser, S^2, near the key in Fig. 1 (U.S. Patent), had nothing to do with the balance bridge there. Condensers were used in that way long before the duplex was introduced. It was quite immaterial whether the resistance was put one side or the other of the condenser. It was essential in duplexing that as nearly as possible a perfect balance should be maintained in the two arms of the bridge.

Sir RICHARD WEBSTER: Now, in Muirhead's English specification, Professor Thompson, the two bridges which are there shown as r^1 and r^2 are shown there as a sort of little twisted wires?—Yes.

Must there not have been in order to keep the proper relation between the cable and the artificial cable a means of adjusting the resistance in those two bridges?—No, not if you had the one on the artificial cable.

Look at Fig. 2 and Fig. 3 of the American specification. Will you compare that for a moment with Fig. 1. Is not the change from this point of view—leaving out adjustable resistances at present—is not the change from Fig. 1 to Fig. 2, or to Fig. 3, that the condenser is taken into two pieces—is split—one part is put on the part of the bridge going to the main cable, the other is put on the part of the bridge going to the artificial cable?—Yes, in so far.

And the position of the receiving instrument with respect to those condensers is identical with the position of the receiving instrument shown in thick lines on the right hand side of Fig. 2 of the English cable?—It is in Fig. 3, not in Fig. 2.

Look at Fig. 2?—In Fig. 2 the condenser is nearer the rheostat, and the resistances are beyond.

I am speaking of the position of the receiving instrument. If you will look at the position of the receiving instrument in Fig. 2 of the English patent on the right hand side—the thick line—it is on the cable side of the condenser?—It is.

That is its position in both Fig. 2 and Fig. 3 of the American patent?—Yes, so far.

Re-examined by Mr. Bousfield: WITNESS said that as regards the combination of rheostat and bridge wires shown in the 1880 patent, he knew of no better combination that could be used. The particular arrangement

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of the rheostat at the apex of the bridge gave the best result he knew of, for the reason that it afforded such a very ready and reliable way of making the small change that was required. In the 1876 patent the only indications relating to adjustments are those that relate to adjustments effected not on the bridge arms or at their point of junction, but on the artificial cable. The arrangement of getting a balance indicated (Fig. 4 of the 1876 patent) was not, in his opinion, as good as the one in the 1880 patent of the United States, because the use of that method diminished the sensitiveness of the receiving instrument; it shunted some of the current off. The arrangements in figures 5*a* and 5*b* (English patent) were entirely different to the arrangement in the 1880 United States patent. The electro-magnetic devices referred to in the English patent were less desirable than the arrangements referred to in the United States patent. No one of the arrangements for obtaining a perfect balance at the two arms of the bridge was the same as the arrangement described in the United States specification of 1880, though the nearest was Fig. 4 (English patent) because it had all the elements of the rheostat.

Mr. FINLAY: My lord, I am now in a position to make a statement about the Canadian patent, so that your lordship and my friend may not be taken by surprise. I do not propose to dispute that the Canadian patents are identical in fact with the patents of 1876 and 1877.

Lord KELVIN was then examined by Mr. Bousfield, and stated that there was no general knowledge of instruments used for duplexing submarine cables in 1876. He believed duplexing was done entirely by Messrs. Muirhead and Mr. Taylor. In his view the use of the rheostat and its use in the particular point indicated in the United States patent was a matter of great importance. It was of great importance to keep r plus r^1 constant. In Fig. 3, for example, of the American patent the only resistance in the bridge was the resistance in the rheostat. Even assuming that r and r in Fig. 11 of the 1876 patent were rheostats, he did not find any indication in the 1876 patent which would lead a person to place a rheostat at the junction of the arms of the bridge, so as to get the results which come from the 1880 patent. Supposing the simple 1880 method of balancing had been known in 1876, he could not conceive of anybody going out of his way to construct a method of balance such as that shown, say in Fig. 13 (patent of 1876).

Cross-examined by Mr. Moulton, WITNESS said that neither in the 1876 or 1877 patent was there any indication of any means accessible to the operator for performing adjustments. It was of importance to keep the sum of the two resistances constant.

Re-examined by Mr. Bousfield, WITNESS said that the shunting effect would be increased when r plus r^1 was diminished, and would be diminished when r plus r^1 was increased; when r plus r^1 was increased the signals would be stronger, when r plus r^1 was diminished the signals would be weaker.

Mr. JUSTICE KENNEDY: Would you mind turning to Fig. 1 of the 1876 specification? Does that show to you as a scientific electrician any method of adjustment?—It shows no method of adjustment.

The other figures, more or less, do show, do they, methods of adjustment, or not?—The diagrams do not actually show, but the letterpress describes.

Sir RICHARD WEBSTER: Taking the figures as they stand with any explanation of those figures that appears in the specification, a rheostat, such as appears in the 1880 patent, would not be workable?—It would not be workable, certainly.

Mr. JUSTICE KENNEDY: Do Fig. 1 and Fig. 2, with any explanation of those two figures that you find in the text, lead you to a conclusion one way or other as to whether a rheostat would be workable with those at the point of the apex?—No; decidedly not. There is no direction given to place one there. If we are to hold, as I have heard in Court it is held, that each of these resistances is to be adjustable, they must be separately adjustable; I mean to say it is not stated that they are adjustable at all in the specification. Of course, we all know that the electrician would have to adjust, but he would adjust each one, and he would not apply an instrument which would automatically throw in resistance to the one and throw out to the other.

It is plain that what you call the working of a rheostat so as to preserve the sum does not, in your opinion, fit in with Fig. 1 or Fig. 2?—No; certainly not.

Sir FREDERICK BRAMWELL, examined by Mr. Finlay, stated that he quite agreed that in 1876 the rheostat was a well-known instrument, but he did not agree that it was an obvious thing to employ it for the purpose for which it was employed in the 1880 patent; basing that answer upon the fact that in 1876 Mr. Muirhead apparently did not know how to do it.

Cross-examined by Sir Richard Webster, WITNESS stated that according to his reading of the 1876 patent all the descriptions were self-contained; that was, 4 to 14, and that everyone of them would produce the balance without the addition of any adjusting instruments. He had not sufficient information of detail to know whether the position he suggested was the right or the wrong one.

Sir RICHARD WEBSTER: Am I not correct that from beginning to end of the 1876 specification you find no indication of the kind of adjusting instrument that is to be used anywhere. If an adjusting instrument is necessary in view of what is shown in the specification, you find no kind of indication what adjusting instrument is to be used?—No. If there be anything beyond what the patentee has pointed out in detail. I find no direction as to its nature or as to how it is to be used.

I am also correct, am I not, that if you look in the 1880 specification beyond the word rheostat and the picture there is nothing to indicate the particular class of resistance adjusting instrument to be used?—Not beyond those words.

I should like to ask you this, will you undertake to say that a rheostat would not be a most useful instrument in several of those figures there shown, 4 to 14, assuming that further arrangements are required?—I think it would be.

Friday, March 2nd.

On the hearing of the case being resumed Mr. GEORGE MOCKRIDGE was sworn, and examined by Mr. E. H. Pollard. Witness stated that he had been superintendent of the Western Union Telegraph Company at Penzance since 1881. He had previously been a cable operator in the Direct United States Company. The Direct United States cable was duplexed in 1878. It was duplexed on the ordinary bridge system, with resistance coils as the arms of the bridge The Penzance cable was duplexed in 1883. When this was duplexed they also used the rheostat at the apex of the bridge. The double-block or condenser system was used first on that cable in March, 1887. The resistance coils were removed altogether, and only the rheostat and the condensers in the two arms were used. The result was a 30 per cent. increase in speed.

Mr. HERBERT TAYLOR, examined by Mr. Bousfield, stated that in 1875 Messrs. Muirhead and he began to plan the scheme which they now had in use. In 1876 they actually applied it in successful working. The state of common knowledge in the years 1875, 1876, 1877, 1878, up to then, as regards duplexing of submarine cables was nil, except speculative knowledge, theoretical knowledge. In practice there was none till they did it. The successful duplexing of a long submarine cable was first done in March, 1876, on the cable between Marseilles and Malta, 800 miles. The crux of duplex working at that time was to make the artificial line of sufficient electrical resemblance to the cable, so that the receiving signals did not send the receiving instrument wild—and so that the sending signals did not upset the receiving instrument. The first submarine cable duplexing upon the double block system without any resistance in the arms of the bridge was done in 1884.

Cross-examined by Sir Richard Webster, WITNESS stated that the effect of the arrangement depicted in the specification of 1876, Fig. 2, was that the arms of the bridge could be greatly reduced in resistance with a consequent reduction in the retardation of the signals.

Sir RICHARD WEBSTER: Was not that in consequence of putting the condensers into the bridge arms?—Yes.

And was not that exactly the same operation as is described in the American patent, namely, of reducing the resistance of the bridges. Answer that question please?—I cannot say yes or no.

Answer that question, and then add any explanation you like!—It meant greatly reduced—not abolished.

I did not say anything about either greatly reduced or abolished. Was not the putting of the condensers into the bridge arms the invention whereby you were able to reduce the resistance. I care not whether it is reduced or abolished?—Yes, that is the claim.

Was not that the invention in 1876?—Yes, it is claimed.

Now no means of adjustment are shown in Fig. 2?—No.

I put it to you, with your knowledge, having been working at this as you have from 1875, would it not have been impossible to work Fig. 2 without some means of adjustment?—Adjustment where?

Of resistance in the bridges?—Yes. I would not say impossible, but nobody would have dreamed of doing it.

Will you look at the description of the invention from line 17 to line 37, and see if there is the slightest reference there to any method of adjusting the resistance. I think you can take it from me that there is not, but by all means look?—I think not.

Mr. Justice KENNEDY: What was there in 1880 that you did not know in 1876?—We were unable in 1876 to overcome the difficulties in obtaining a balance—we could not without large resistance in the bridge—which greatly facilitates the maintaining of the balance, we could not get a balance.

Prof. JAMES THOMSON BOTTOMLEY, examined by Mr. Finlay, stated that he had carefully examined the patent of 1880 and the English patents of 1876 and 1877. Two main advantages were secured by the 1880 patent. One was the obtaining a balance and preventing the sending instrument at the given end from interfering with the receiving instrument at the same end. The other advantage was the obtaining of distinct legible signals. He had never heard of that combination having been made before 1880. In his judgment, turning to the patent of 1876, he did not find any anticipation in that patent of the combination in the 1880 patent. A resistance box would not keep the sum of the resistance in the two arms constant. It would change the one arm without changing the other also. It was essential where quick sending was concerned to keep the sum of the resistance the same while altering the ratio, because if the small resistance employed in the 1880 patent were adopted, any little alteration on the total amount of the bridge would upset the signals of the receiving instrument. In 1876 and 1877 the first thing that had to be done in duplexing a cable was to guard the receiving instrument so that it should not be driven completely wild by the sending signals at its own end. For this purpose they had to introduce the most elaborate guards, which cut down the speed of the signalling instrument to say 60 per cent. They succeeded in doing that, and it was a great feat to do it. The combination of balance with speed could not be secured except by the combination shown in the 1880 patent.

Cross-examined by Sir Richard Webster, WITNESS stated that in a duplex system without condensers the use of a rheostat would not enable one to adopt low resistance instead of high. The sole function of a rheostat was to adjust the balance in a duplex system. Essentially a rheostat was something that would not break the current. There were resistance boxes made which could be used so as not to break the current. Fig. 2 of 1876 could not possibly be worked without an arrangement for adjusting the resistance in the bridges. In Fig. 2, 1876, he did not find any direction in the specification as to how that adjustment of the bridge arms should be done. He had stated that it was most important that r plus r^1 must be constant, and was ready to pledge his reputation from practical knowledge that r plus r^1 must be kept practically constan tin order to make the thing work properly, though it might be increased (diminished a little.

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Dr. ALEXANDER MUIRHEAD (examined by Mr. Finlay) said that he was the grantee of the American patent of 1880, and had never used that combination before.

Cross-examined by Mr. Moulton, WITNESS stated that the difference between Fig. 1 and Fig. 2 of 1880 was putting the condensers into the bridge arms. Putting the condensers into the bridge arms enabled them to use much lower resistances in the bridge arms.

Mr. JOHN MUIRHEAD, examined by Mr. Finlay, said the patent of 1876 was granted to him, and the patent of 1877 was granted to him jointly with Dr. Alexander Muirhead.

Dr. JOHN HOPKINSON, examined by Mr. Bousfield, gave a *résumé* of the differences between land-line duplexing and the duplexing of a submarine cable. As far as he knew, in the year 1880 it was a new thing to use a rheostat in combination with condensers and without any other resistances. There was nothing in the 1876 patent which would lead one to the combination shown in the 1880 patent.

Sir RICHARD WEBSTER then proceeded to summarise the American law on the subject of the duration of patents granted in the United States for inventions previously patented abroad, and argued that the 1876 patent was included in the 1880; although 1880 might include further improvements, it did not affect the question. If the plaintiff's statement was true—if the invention of 1880 was a new and different invention from that of 1876, it was not protected by letters patent in this country at all. The case that he had to suggest was that in 1880 it had been found out that the particular combination shown by Figs. 2 and 3, 1876, was practically speaking the best, if not the only useful combination of those described. The pith and marrow of the 1876 invention was the insertion of the two condensers at a particular place in the bridges.

SATURDAY, MARCH 3RD.

On the hearing of the case being resumed, Sir RICHARD WEBSTER continued his argument. The answers of all the witnesses, he said, clearly showed that the invention, which everybody had recognised as being the invention until the necessities of the case suggested another view, was putting the condensers in the bridge instead of putting them in the combined sending wire. In Fig. 1, of 1880, the inventor described what he did not want to patent. He described in Fig. 2 what he did want to patent, and the only change was the putting in the condensers. He submitted that it was quite clear that in 1880 the patentee picking out what was best in his invention of 1876, telling it to America, desiring to have the best patent he could, there picked out the best part of the 1876 patent, and he picked out the condensers in the bridge. There was not a witness who had suggested that the use of the rheostat *per se* made any difference at all in the great advantages which were claimed by both patents, and in obtaining the objects which were specified on the face of each patent. What was the position with regard to Fig. 2 of the 1876 patent? Common knowledge that the best way of adjusting the resistance of the bridges was by putting a rheostat at the apex; no direction in the specification of the patentee as to what kind of adjustment resistance to use; admission by witness after witness called that in order to work the invention, the great invention specifically described—in order to obtain the objects specifically described—one must have some method of adjusting the resistance in the two bridge arms: statement of the patentee. "This patent is to be read excluding the most common way of doing it." He (Sir Richard Webster) was going to call witnesses—who had done as much work in duplexing of cables, and had as much experience as any other persons whose names could be mentioned. They would state that the introduction of the rheostat was the most common means—as Sir Frederick Bramwell admitted—of adjusting the resistance, in the manner employed in the patent of 1876. Something of the kind must have been implied, otherwise the invention could not be worked at all. It was treated as common knowledge by Mr. Muirhead in that year, and he was not entitled, in order to make out that there was a different invention in the 1876 to that in the 1880 patent, to come now and say that so far from being common knowledge it was to be treated as the pith and marrow of the invention of 1880; there not being one single word in that specification of 1880 to give the faintest indication that the rheostat was of any importance, having regard to the position in which it was placed.

Prof. ANDREW JAMIESON, examined by Mr. Moulton, stated that he was assistant to Sir William Thomson and Prof. Fleeming Jenkin in connection with the making of the Western Brazilian and the Platino-Brazilian cables. At the end of 1873 he was sent out to Brazil. In the autumn of 1876 Sir John Pender and Sir James Anderson secured his services, and authorised him to make himself fully acquainted with duplex telegraphy in every sense, and proceed as soon as possible to Marseilles and to Malta in order to readjust the duplex system as put up there by Dr. Alexander Muirhead, Mr. Munro, Mr. Laughton, and others. In duplexing it made no difference whether they used an apparatus like a resistance box or a rheostat. It was of no practical effect whether they made the adjustment by the rheostat at the apex or the rheostat in one arm, or the rheostat in the other arm. In 1876 a competent electrician looking at Fig. 1 would understand by the lines to the left that they were formed of adjustable variable resistances. With regard to Fig. 2, he would suppose that the lines were exactly the same, namely, adjustable variable resistances, which would be absolutely necessary in order to make the thing work. A competent electrician at that date would not require any specific statement that they were to be adjustable variable resistances. In his opinion, as a competent electrician, there was nothing more told in Fig. 1 of 1880 than was told in Fig. 1 of 1876. All that was told by Fig. 1 of 1880 over and above Fig. 1 in 1876 was the receiving condenser and the rheostat as depicted at the end of the line. As a matter of substance, that latter was no information to a competent electrician beyond what the 1876 patent told. Looking at the 1880 specification, and comparing Fig. 2 and Fig. 1, in his opinion, the invention shown in Fig. 2 was the introduction of condensers in each arm of the bridge, which he found also in the 1876 specification.

And to a competent electrician, do you find that the specification of 1880 tells of any other invention excepting that?—It does not. It was of no importance to keep the sum of the resistances in the two bridge arms constant, and, as a matter of fact, it was never done.

Cross-examined by Mr. Finlay, WITNESS stated that at Malta, on the Malta-Alexandria No. 2 cable, along with Mr. Benjamin Smith, he adopted, about 1876, the duplex arrangement with all resistance entirely eliminated from the arms of the bridge. He had a condenser in each arm of the bridge, a condenser on the receiving circuit, but no rheostat at the junction. The arrangement adopted there for adjusting the balance was adjusting the condensers on one side or the other. The process adopted at Malta was described in Mr. Benjamin Smith's patent of January 5, 1876, No. 47. It was a fact that in that description and drawing there was no condenser on the receiving circuit; that was a mere appendage of the receiver like the battery. The use of resistance boxes in the cable, as described in the Smith patent, for the purpose of obtaining a balance, had the undesirable effect of reducing speed. He was of opinion that with that apparatus the results could be obtained which were stated by the Messrs. Muirhead to have been obtained—95 per cent. of improvement over the simplex method—on a long cable.

Mr. FINLAY: How on earth did this valuable invention disappear after a day or two?—After we got the thing into perfect working order, when I reported to Sir James Anderson on the thing, he said, "Jamieson, I believe thoroughly in Muirhead's duplex; be good enough to remain with that."

He thought Muirhead's was better?—He did.

He thought it was better?—Yes, in every sense.

And so yours disappeared?—It disappeared for the time being.

The Court then adjourned until Monday.

A summary of the proceedings of Monday, Tuesday and Wednesday, on which day the Court sat until 10 p.m., will appear in our next issue. At the conclusion of the hearing of the case, judgment was reserved.

Edison-Bell Phonograph Corporation (Limited) v. Smith and Young.

This motion came before Mr. Justice Wright on Tuesday last to commit the defendant Young to Holloway prison for contempt of Court, in parting with the possession of certain phonographs made in infringement of plaintiffs' letters patent by shipping such phonographs to one Van Obett in Amsterdam, on February 5th, in breach of an undertaking given by defendants' counsel to the Court on February 3rd. It was also complained that Young continued to offer phonographs for sale in breach of an injunction granted on February 3rd, as reported in *The Electrician* on February 16th.

After hearing counsel, His LORDSHIP said that from the materials before him he should not be justified in committing the defendant. The defendant denied that he had parted with any instruments, and as to the offering for sale, he was not satisfied that defendant was a principal. As to the costs, however, he could not give the defendant costs, there being so much suspicion in the matter.

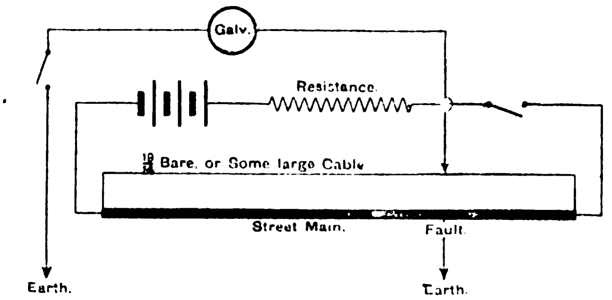
Motion dismissed, without costs.

CORRESPONDENCE.

LOCALISING FAULTS IN STREET MAINS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The following method has occurred to me as suitable for locating earth faults in short lengths of large section street mains for electric supply.



But not having yet tried the same I write in the hope that any reader, who has so applied the Wheatstone bridge, will be good enough to communicate his experience through your columns.

The bare $\frac{19}{14}$ cable is to be attached as above to defective cable, and laid above surface of ground along line of cable below. This bare cable is to be well insulated from earth.

Of course, on obtaining balance, the sliding contact should be over the fault.—Yours, &c., W. H. COLLIS,

Inspector of Mains to the Liverpool Electric Supply Company (Limited).

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VARLEY TESTIMONIAL FUND.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: We beg to inform your readers that the accounts of the Varley Testimonial Fund must be closed on the 15th of the current month. We therefore make a last appeal to all those who have in one form or another benefited by the invention of the dynamo, compound winding, and other matters with which Mr. Varley's name has been so largely associated, to send in a subscription to the undersigned before the above-mentioned date.—Yours, &c.,

A. Stroh, Honorary Treasurer.
R. E. Crompton, Honorary Secretary.

March 2, 1894.

DOUBLE-ACTING GAS ENGINES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In the letter you kindly inserted in your issue of February 16th last, I referred to the six-stroke cycle Griffin engine as obsolete. It was well-known that the sole licensees of this engine had abandoned it, but I now learn that Messrs. Griffin and Co., of Bath, have arranged to take up its manufacture. This being so, it is not right to say that the engine is "obsolete," and in justice to Messrs. Griffin and Co., I shall be glad if you will allow this correction to appear.—Yours, &c.,

March 3, 1894. J. Emerson Dowson.

THE EWING MAGNETIC MODEL.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am surprised to see in Mr. Evershed's article on p. 481 of the current number of *The Electrician* that I am credited with having devised a model for illustrating Prof. Ewing's theory of magnetisation. In justice to Prof. Ewing I wish to state that I had no hand whatever in the matter. The model was described by Prof. Ewing in the same Paper as the theory (*Proc.* Roy. Soc., 1890) and was exhibited by him at the British Association meeting in the same year. Twelve months later I determined the magnetisation curve for a group of magnets, which Prof. Ewing has reproduced in his book on magnetism, but even for this I can claim no credit, as it was merely given to me as a problem in Practical Physics by the examiner for the Cambridge Science Tripos —Yours, &c.,

J. W. Capstick.

Trinity College, Cambridge, March 6, 1894.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Through your courtesy I am enabled at once to notice Mr. Capstick's letter. I need hardly say that in writing as I did I had no intention of ascribing the credit of discovering the model to anyone but Prof. Ewing himself. Your readers cannot be so ungrateful as to have forgotten that the first model was described and exhibited by Prof. Ewing at the B. A. meeting in Leeds in 1890, since which time it has always been known as the "Ewing model."

In writing of a "Ewing-Capstick" model I was under the impression, derived from the footnote on page 329 of Prof. Ewing's "Magnetic Induction," that Mr. Capstick, in answer to an examination question, designed and made a model with the special intention of obtaining a cyclic curve. In this I was clearly mistaken, but I am bound to say that some credit for experimental skill is due to Mr. Capstick for the very perfect cyclic curve he was able to secure with a model containing only twenty-four magnets.—Yours, &c., Sydney Evershed.

Woodfield Works, March 8, 1894.

Steel Castings for Dynamos.—Writing in the *Journal* of the Franklin Institute, Mr. H. F. Parshall states that steel castings are largely used for dynamo-building in the States. The permeability of this material is about 20 per cent. greater than that of cast iron, but from 20 to 25 per cent. less than that of wrought iron. The 1,500-kilowatt generator, built for the Brooklyn-street Railway Company by the General Electric Company, has wrought-iron cores, and a steel casting weighing 38,000lb. as the yoke-piece.

TRADE NOTES AND NOTICES.

Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]

Our readers are reminded that the 1894 Edition of "The Electrician" Electrical Trades' Directory and Handbook is now ready. This valuable book contains 1,000 closely-printed pages, and several new and useful features have been added. The price of the Directory and Handbook is 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

"Electrical Engineering Formulæ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.) A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). prospectus on application to the Publisher.

"Electromagnetic Theory," by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application to the Publisher.

"Drum Armatures and Commutators."—This book, written by Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.) Prospectus on application.

Tenders Invited.—The Stafford Corporation invite tenders for the erection of buildings for their new central electric supply station. Specifications, &c., can be obtained of Mr. J. F. Bell, engineer, the Gas Works, Stafford; and tenders must be in to Mr. M. F. Blakiston, town clerk, before noon of the 19th inst.

——— The Manchester, Sheffield and Lincolnshire Railway Company announce that they are prepared to receive tenders for the supply, for the year ending April 30th, of various stores, including telegraph materials and wire. Tenders must be in by March 20th.

Tenders Accepted.—The Lancaster Town Council have accepted the tender of the Brush Company for extending their mains along St. Leonard-gate for the sum of £147.

Appointments.—Ninety-eight applications were received by the Electric Lighting Committee of the Edinburgh Corporation for the post of city electrical engineer, and from this number three candidates were selected by the Committee for submission to the Town Council for their final choice. These three were Messrs. E. W. Monkhouse, of the Westminster Electric Supply Corporation, London, and Messrs. R. A. Chattock and G. B. Dunn, of the Metropolitan Electric Supply Company, London. The Town Council have decided in favour of the first-named gentleman; who is appointed at a salary of £180.

——— For the post of electrician-in-charge of the central station at Londonderry the Electric Lighting Committee received seventy-one applications, and at the request of the Corporation Messrs. Siemens Brothers and Co. selected three of the number for the Council to choose from. There were Messrs. John Christie, of the Glasgow Corporation Electric Lighting Stations, H. C. Kromschreider, of Woolwich; and Albert Barnes, of South Kensington, London. Mr. Christie was on Tuesday appointed to the position by the Corporation.

——— Mr. H. M. Sayers, now superintending engineer of the Companhia de Luz Elettrica, Oporto, has been appointed Superintending Engineer of the Bournemouth and District Electric Supply Company.

Liquidations.—Notice is given that the following persons have been appointed a committee of inspection to act with the Official Receiver and Provisional liquidator:—Messrs. John Hampton (holding a general power of attorney for I. and S. Roberts, Limited), Henry Percy Dodson (holding a general power of attorney from Reuter's Telegram Company, Limited), Charles Henry Cox, Thomas Bell Elliner, Edward Bond, William Stevens Squire, William Duncan, Thomas Pilling, and Sir James Clarke Lawrence.

——— Mr. Justice Vaughan Williams, on Wednesday, ordered the voluntary winding-up of Latimer Clark, Muirhead and Co. (Limited) to be continued, under the supervision of the Court.

——— Creditors of the Platinum Plating Company (Limited) (in voluntary liquidation) must send in their claims to the liquidator, Captain R. W. Shackel, Elmhurst, Mitcham Common, by the 31st inst.

——— The first meetings of creditors and of contributories of Newington, Priddle and Co. (Limited) will be held at 33, Carey-street, W.C., on the 15th inst., at 11 and 12 respectively. Under the winding-up order made last January against this Company. accounts were issued on Wednesday showing debts £1,210. 19s. 10d., ranking against assets £744. 1s. 4d., and a total deficiency of £6,446. 18s. 6d. to contributories. The sole right to

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manufacture and sell the "Phonautograph" was acquired by the Company in May, 1893, and a sum of £500 was advanced to the inventor to be repaid out of the profits on the sales, but no such sales have been effected. To the lock up of that £500 and to insufficient working capital the failure of the Company is attributed.

Electric Lighting Plant for Disposal.—The London and India Docks Joint Committee are prepared to receive tenders for the purchase (including removal) of a large quantity of second-hand electric lighting plant. Tenders must be in not later than March 31st, addressed to the Chairman of the Works and Stores Committee. Further particulars are given in our advertisement columns, and all other information can be obtained at the Dock House, 109, Leadenhall-street, London, E.C.

Messrs. Crompton and Co. (Limited).—We have received a copy of a handsome complete catalogue just issued by Messrs. Crompton and Co., containing nearly 200 pages of closely-printed matter concerning their special manufactures of electric plant, machinery, and apparatus. In issuing this catalogue, Messrs. Crompton and Co. point to the fact that their large works at Chelmsford originated in the visit of Mr. Crompton to the Exhibition at Paris in 1878, where he made the acquaintance of M. Gramme, and brought back with him to England a pair of Gramme dynamo machines. This was the commencement of the works at Chelmsford, where and on their various contracts nearly 1,000 hands are now employed. The firm are manufacturing and exporting to all parts of the world every requisite necessary for electric lighting, power transmission, electro-metallurgy, and electro-chemistry, for which they have gained the highest awards at all the great exhibitions held since 1878. It is pointed out that since the issue of their first catalogue in 1889 great reductions have been made in the prices of their manufactures, which have now reached an abnormally low level. The catalogue is divided into eight sections, all of which are very fully illustrated. For convenience many of the figures in the tables are printed in two colours. In addition to well-executed drawings of the well-known Crompton dynamos, motors, and combination sets, some excellent illustrations appear of electric travelling cranes, drills, and motors, electrically-driven fans and blowers, hoists, cranes capstans, and pumps. In the electric traction section the Southend Electric Tramway, for which Messrs. Crompton and Co. are the engineers and contractors, is shown, and the electric haulage plant at the Abercanaid Colliery is also pictured in a subsequent section. Arc lamps and lanterns are fully dealt with, and the section devoted to measuring instruments is a very full one. A large number of flattering testimonials, covering a long period, from users of Messrs. Crompton and Co.'s plant, accompany the catalogue, and the list of contracts carried out and customers supplied occupies many pages, including no less than 22 complete central stations, both at home and abroad, in addition to 10 others for which plant and apparatus have been supplied or are on order. The letterpress particulars accompanying the various sections make the catalogue most complete and useful.

Messrs. Mather and Platt.—The London office of this firm have recently completed an electrical installation at Emmanuel College, Cambridge, the plant of which consists of a 20-b.h.p. portable engine driving an Edison-Hopkinson dynamo. About 300 incandescents are used.

Messrs. Perry and Co.—The Empress Frederick paid a visit to the show rooms of this firm in Grafton-street, Bond-street, London, W., last week, to inspect the various methods devised by the firm for effectively lighting picture galleries and works of art by the electric light. Her Imperial Majesty gave several orders, and expressed her appreciation of the successful efforts made by the firm in their various designs for lighting art galleries to the best advantage.

Messrs. Rashleigh Phipps and Co.—Amongst the contracts in hand by this firm may be mentioned an additional 1,000 lights for Messrs. Marshall and Snellgrove, for their extensive premises in Oxford-street and their new premises in Vere street, London, W., the plant including four sets of accumulators. Three hundred lights have just been completed at the mansion of the Hon. H. Sturt, M.P., in Portman-square.

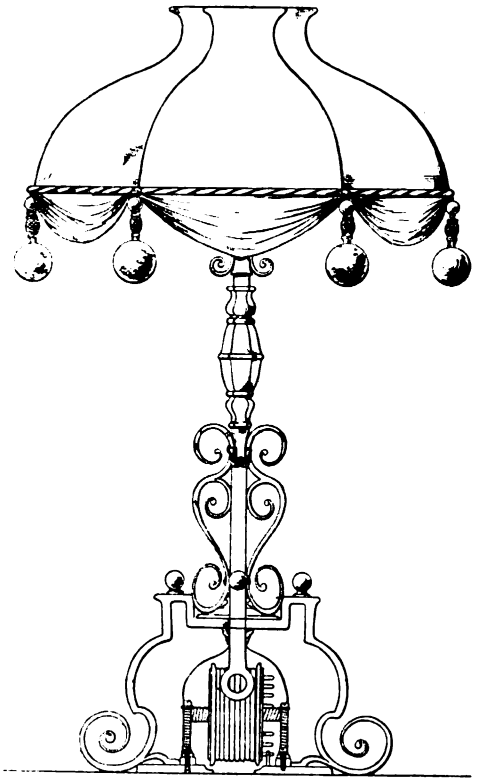
Telephonic Communication.—It is announced that the first step has been taken towards the establishment of telephonic communication between Copenhagen and Berlin, the Finance Committee of the Copenhagen Parliament having reported in favour of the proposal received from the German Telegraph Department that the cable between Copenhagen and Odense shall be so laid as to form part of the eventual telephone line to be carried through Odense, Kolding, and Hamburg to Berlin.

"Science Progress."—This is the title of a new monthly review of current scientific investigation, which is published by the Scientific Press (Limited), of London. Price 2s. 6d.

Antwerp Exhibition.—Mr. G. R. de Courcy-Perry, Her Majesty's Consul-General at Antwerp, and British Commissioner-General for the Exhibition, notifies that France, Germany, and other European States are making strenuous efforts to be well represented at Antwerp. Every facility is being given to British manufacturers to enable them to exhibit, but time is very short. It has, therefore, been arranged that Prof. W. Layton shall attend daily at the offices of the London Chamber of Commerce, Botolph House, Eastcheap, E.C., between eleven and four o'clock, on and after the 12th inst., to give all necessary information, and to treat with intending exhibitors for the allotment of space.

Launch.—The Thames Electric and Steam Launch Company have recently completed and launched the steam yacht "Britannia," of 65 tons register and 40 tons displacement, which is the largest vessel of the kind ever built and launched above the new lock at Richmond, now nearly completed. The "Britannia" is to carry an electric pinnace, the accumulators for which are charged from a specially designed charging plant on board, and is also provided with an electric lighting installation to be supplied from the same accumulators or plant. The Company also announce that they will shortly launch a new vessel, designed for passenger traffic on the Thames, having a 70ft. promenade deck, and lighted by arc and incandescent lamps.

Automatic Winding Gear.—The illustration below shows Hedge's patent automatic winding gear for portable lamps, by which the action of the helical spring, which is contained in the porcelain reel, is controlled by a small stud projecting from the base of the lamp, so that when placed on the table the spring is inert, but comes into action directly the lamp is raised. It is claimed for this invention that it can be applied to either large or small lamp pedestals. The illustration shows a design made by



Starkie Gardiner, where the winding gear is contained between the legs, and is, therefore, not unsightly. It is especially useful where it is desirable to keep electric lamps out of a room until they are actually required to be used, such as in hotels and restaurants. The drums are arranged to mark either horizontally or vertically. The device is manufactured by the Carboid Oil-less Gearing Company under licence.

"Inverted" Arc Lighting.—Messrs. Dobson and Barton (Limited), of Bolton, have placed a contract with Messrs. Lowcock, Hill and Co., of Manchester, for the lighting up of a portion of their Bolton machine shop with 120 inverted arc lamps, and also with a large extension of their incandescent installation.

Aberdeen.—While general satisfaction is expressed at the public lighting by electricity, a proposal is to be made askin the Town Council to provide additional lamps, as those already erected are, in the opinion of many, too far apart.

Belfast.—The Electric Lighting Committee of the Corporation have reported that it will be necessary for them to appoint a resident engineer for the electric lighting station, to superintend

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the erection of the plant and the laying of the mains, under the direction of their consulting engineer, at a salary of £250 per annum. This proposal has been approved. The committee further report that they hope to have the electric lighting works completed, and to be able to supply consumers within the compulsory area, by September 1st next.

Brighton.—The Town Council have had before them the electric lighting accounts for the past year, in which it is stated that £4,011 is the net revenue received, enabling the Council, after paying off large amounts of capital and interest, to carry forward a credit balance of £300. The number of houses connected with the electric current has increased from 215 in 1892 to 423 in December, 1893, and 1894 shows even more satisfactory progress. The question of lighting the Council Chamber by electricity is to come before the next meeting of the General Purposes Committee.

Bury.—At a Town Council meeting last week the Borough Engineer presented his report upon the system to be adopted for the electric lighting scheme. The Electric Lighting Committee had visited the stations at Liverpool, Bradford, and Leeds, and had selected the continuous-current system with accumulators. It is proposed to put down plant equal to a supply of 4,000 8-c.p. lamps, but the central station is to be built for an ultimate capacity of 7,000 lamps. 150 Epstein cells are to be included in the plant. The Committee are considering the question of the utilisation of waste heat from the destructor.

Burnley.—The Board of Guardians are undecided whether their intention to spend money upon the installation of the electric light in the Union offices is unusual and extraordinary, and therefore cannot be legally sanctioned, or whether it is quite legal, and in accordance with precedent. The Clerk maintains that the latter is the correct view.

Cheltenham.—At their last meeting the Town Council discussed the report of the Electric Lighting Committee, which recommended that the tender of Messrs. Siemens Bros. and Co., of Westminster and Woolwich, be finally accepted for the sum of £4,610 (including Willans engines). The subject has been before the Council many times during the past seven years, but notwithstanding this, a motion that the matter be again deferred "for the purpose of affording the Council an opportunity of obtaining further information," was adopted, on the understanding that in the event of the sanction of the Local Government Board being forthcoming the Mayor will call a special meeting of the Council for the acceptance of tenders.

Derby.—At the last Town Council meeting it was proposed that an electrical exhibition should be held at Derby, and that the Electric Lighting Committee should be authorised to expend a sum not exceeding £200 on the project. In support of the proposal, Mr. Marsden stated that the Committee had spent £30,000 on electric lighting, and that instruction had been given in public on gas-cooking, and it was only fair that electricity should have a similar opportunity. The resolution was carried.

Derry.—A Local Government Board inquiry has been held in reference to the application by the Corporation for sanction for a supplemental loan of £5,000 to complete the electric lighting works, making in all a total of £78,000 expended on these works. In explaining the necessity for this further loan, Mr. M'Cay, the city solicitor, stated that as time went on it was found that additions were necessary to the plant, and other departures had to be made from the original specifications, but in every case the Corporation were justified in the extra expenditure incurred, notwithstanding the unreasonable opposition which the Corporation had met with in carrying out their scheme. The money had all been expended for the public good, and when the work was completed the result would be a good and sufficient answer to the opponents of the scheme. Councillor Magee, the Chairman of the Lighting Committee, said the Committee had been throughout influenced in some items of expenditure by a desire to make a thoroughly good job of the electric lighting; all the apparatus used was of the best description, which was advisable where a permanent installation was intended. Mr. Blake, the Corporation's electrical engineer, also gave evidence bearing out the statement of the City Solicitor and Chairman of the Lighting Committee. The opponents to the Corporation's scheme (who were represented by Mr. O'Doherty) contended that the original estimates were glaringly inaccurate, a contention which was strongly opposed by those responsible. It was fitting that the local gas company should oppose the application and Mr. B. H. Lane, who represented their interests, stated that in the estimates prepared by the Lighting Committee no notice had been taken of a very large claim which the Gas Light Company intended to lodge, but which the Corporation intend to vigorously dispute.

Edinburgh.—The Electric Lighting Committee of the Town Council have decided that the charge per unit for electric current shall be 6d. for lighting, and 3½d. for motive power.

Fleetwood.—The Lighting Committee of the Improvement Commissioners will shortly visit the Coatbridge electric lighting station in order to inspect the working of the gas engines in parallel, which is a similar system to that proposed to be adopted at Fleetwood.

Hampstead.—The Vestry are applying to the London County Council for a further advance of £5,000 for electric lighting purposes.

Lancaster.—The Town Council propose to borrow a further £5,000 for the purposes of the electric lighting scheme.

Littlehampton.—The Local Board have received a communication from Mr. W. E. Hayne, of Brighton, in reference to the dissatisfaction expressed at the gas supplied at Littlehampton, and suggesting a scheme for the electric lighting of the district. Mr. Hayne points out that, although Littlehampton is a comparatively small town, it is daily increasing in size, and is, moreover, a port and health resort on the South Coast. He adds that there is a suitable ground near the waterworks for central station, and intimates that certain manufacturing electrical firms are prepared to supply the requisite machinery and cables, for which, if a local company is formed, they would be willing to take part payment in shares to the extent of at least £1,000, *i.e.*, presuming the Local Board were unwilling themselves to undertake the control of the electric lighting supply. The letter has been referred to a special lighting committee for consideration.

Liverpool.—Mr. Councillor Houlding has for some time past advocated the adoption by the Liverpool Corporation of a steam refuse destructor, and the City Engineer (Mr. H. P. Bulnois) has, in conjunction with the Health Committee, erected on Corporation land in Chisenhall-street destructors for this purpose. Connected with the destructor apparatus is a 60-h.p. engine, from which it is proposed to derive motive power for an electric motor to light the whole of the yards in connection with the Chisenhall Department of the Corporation. The engineer's report has been presented, and states that to replace the gas jets at present in use, the engineer proposes that six 2,000-c.p. arcs and 20 sets of incandescent lamp fittings shall be used, and that the only additional plant necessary would require an expenditure of about £260. The proposals in the engineer's report have been approved by the Committee.

———— A letter has been addressed to the Lord Mayor of Liverpool by the secretary of the Liverpool and Vicinity United Trades and Labour Council, enclosing a copy of the following resolution recently passed by that body:—"This meeting urges upon the City Council, in view of the present exorbitant price of gas, to consider the possibility of utilising the tidal force for the generation of electricity, thus improving the lighting of the city at a reduced cost to the ratepayers."

London County Council.—The Highways Committee have again recommended that the Victoria Embankment should be lighted electrically from standards erected in the centre of the thoroughfare.

Maidstone.—The Local Board are still in doubt as to the advisability of proceeding with the electric lighting business. They have postponed giving their final decision in the matter till Wednesday next.

Mill Lighting.—The extensive mills of the Ulverston Paper Works, near Barrow, are now lighted throughout by electricity, the contract having been carried out by Messrs. W. R. Thornton and Son, of Barrow. About 500 8-c.p. lamps are provided for.

Monmouth.—The Town Council have received a report from Messrs. Bramwell and Harris on the combined scheme for electric light and drainage in the borough, and in particular on the practicability of utilising the water of the River Wye as motive power. This report fully approves of the scheme as set out in the plans prepared by Mr. Lailey, but does not approve of the site selected for the turbines. The site recommended is on a now disused watercourse at the Old Forge, on the River Monnow, where a continuous supply of water, with a fall of 9ft., can be relied upon all the year round. This arrangement would allow of the sewage pumping machinery being fixed on a convenient place and worked by electric motors. The report was ordered to be printed and considered.

Morley.—The Town Council have received a report from the Electric Lighting Committee stating that various schemes have been considered for the lighting of the district, and visits have been paid to Bradford, Huddersfield, and Leeds. The premium offered by the Council for the best scheme of electric lighting has been awarded to Mr. Robert Hammond. It is estimated that the initial scheme will cost £15,000, and is to be similar in principle to that established at Leeds by the House-to-House Company. The Committee are preparing a detailed report, and will shortly ask the Local Government Board's sanction for a loan.

Rothesay.—The new Glenburn Hydropathic Establishment, which has been erected on the site of the old building destroyed

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by fire in 1891, has been partly fitted for the electric light by Messrs. Claud Hamilton (Limited), of Glasgow, the dining-room being fitted with twelve 3-light electroliers, and the drawing, billiard, reading and writing, and recreation rooms with brackets and electroliers. The recreation room has a handsome 10-light electrolier designed by Mr. Crawford, the architect of the building, and the stage, which forms a part of the recreation room, is completely lighted by electricity. Messrs. Ransomes, Sims, and Jefferies have supplied the motive power, which consists of two high-speed vertical double-acting engines of 60 i.h.p. The cables, wiers, &c., are of Silvertown make.

RUGBY.—The Chairman of the Local Board announced at the last meeting that the public gas lighting contracts are now falling in and their renewal would be shortly necessary. In reply to a question as to a chance of having the electric light, the Chairman said that there was no possibility of any such improvement.

SCARBOROUGH.—At the Mayor of Scarborough's "At Home," held at the Grand Hotel, last week, the Scarborough Electric Supply Company (Limited) gave an exhibition of electrical appliances, which included lighting, heating, and cooking by electricity. A fine exhibit was made by the Edison & Swan Company who contributed samples of the various products of their extensive works at Ponders End and South Benwell, as applied to domestic and public lighting advertising and general utility, consisting of Electroliers, Brackets, Pendants, Electric Motors, Measuring Instruments, Clocks, and other accessories. Several hundred varieties and types of Incandescence Lamps of various shades and colours were shewn including their new Sunlight High Candle Power 2 watt lamps. One of the great attractions of the evening was an illuminated device containing about 150 series lamps composing the words "Success to Scarburg," the old Saxon name of the town. A large party were entertained, and took great interest in the exhibition, which was of a very comprehensive character, and included everything from an 8-c.p. incandescent lamp to the penny-in-the-slot machine now in use on the Metropolitan District Railway. Mr. A. A. Campbell Swinton, the Managing Director of the Scarborough Company, gave a series of experiments with the electric current, and effectively explained, with the aid of Mr. Peck, the apparatus on view. The large banqueting hall in which the exhibition was held was crowded, and much interest was taken by those present in the variety of uses to which electric current can now be applied. On Wednesday Mr. J. Hutton explained to the members of the Constitution Club the uses of the electrical apparatus on view at the club, which formed part of the exhibit at the Grand Hotel and which had been lent for the occasion.

SHIRLEY AND FREEMANTLE.—The Local Board are discussing a proposal to light the district by electricity. The matter is under the consideration of the General Purposes Committee.

ST. OLAVE'S (SOUTHWARK).—Mr. G. W. Thompson, surveyor to the Board of Works, has presented a report to that body on the electric lighting question. He recommends that the larger thoroughfares be lighted by arc lamps, and the minor streets by incandescents ; 32 of the former would be required, and 386 of the latter. In the event of any difficulty being experienced in obtaining a satisfactory site for the central station, Mr. Thompson suggests that permission be obtained to moor a barge on the Thames to contain the necessary plant. Mr. Thompson estimates the cost of lighting the district, exclusive of building site and cost of Provisional Order, at £21,269, and the annual charges at £2,429. These estimates are based upon a supply of 1,000 lights for private lighting in addition to the public lighting. The report is decidedly favourable to the early introduction of the electric light.

ST. PANCRAS (LONDON).—In consequence of the demand for current in the principal thoroughfares off the Tottenham Court-road district, the Vestry have decided that mains be laid in Goodge-street at an estimated cost of £560. The offer of the Prudential Assurance Company to loan the Vestry £15,400 at 3½ per cent. for 42 years, for electric lighting purposes, on the security of the rates, was agreed to. It will be remembered that the London County Council refused to grant the loan for a longer period than 25 years.

WALTHAMSTOW.—The Local Board have appointed a sub-committee to inquire and report as to the practicability of adopting the electric light.

WIRE STEALING.—The two men, Borette and Denny, accused of stealing 210 yards of copper wire, the property of the Postmaster-General, were brought up at the London Central Criminal Court, on Tuesday. Denny, upon whom the property was found, was discharged, and Borette was sentenced to fifteen months' hard labour. It appears that the wires had been cut between Liverpool-street and Stratford on many occasions, with the result that the Fire Brigade had been turned out to false alarms.

WOOLWICH.—The Local Board have decided to defer the consideration of the proposal to light the Town Hall and municipal offices by electricity for three months.

WOTTON-UNDER-EDGE.—The inspectors of this district, appointed under the Lighting Act, will shortly advertise for tenders for lighting the district by oil, electricity, or gas.

STAFF DINNER.—The annual staff dinner of the National Telephone Company was held on Friday evening last at the Holborn Restaurant, Holborn, W.C., under the presidency of Mr. E. L. Gaine, the general manager. About 200 sat down to dinner, including Sir A. K. Rollit, M.P., Mr. Albert Anns, secretary, Mr. Dane Sinclair, engineer-in-chief, Mr. Calder, Mr. Phillips, Mr. Fletcher and other prominent officials of the Company. The toast of the evening was "The National Telephone Company and the Board of Directors," in proposing which the Chairman expressed his regret at the absence of the President and Vice-President. He said the enterprise in which the National Telephone Company was engaged had been beset with many difficulties of a most worrying nature. Those present might rest assured that the steady progress which the telephone had made in a city like London was not secured without a tremendous amount of detail work, and this also applied to all large centres. Perhaps, however, the unkindest cut of all had been the declaration of legal opinion that the telephone was a telegraph. The National Company owned upwards of 100,000 miles of wires, and at the present time these wires carried 250 million messages per annum, and they had upwards of 540 exchanges throughout the country. With regard to the question of the telephone being a monopoly, he contended that in the very nature of things the telephone was a monopoly, and must remain a monopoly, whether owned by the State or in the hands of a private company. Mr. Dane Sinclair replied to the toast of "The Science and Progress of Telephony." Amongst other toasts that of "The Post Office" was proposed by Sir Albert Rollit and responded to by Mr. Ardron, of the Post Office ; and that of "the Chairman" was proposed by Mr. Joseph Chambers, superintendent of the Company's Northern Province. The musical programme was a strong one, the Blue Hungarian Band adding much to the evening's enjoyment, and professional friends of the staff providing excellent vocal music. The dinner was altogether a great success.

SMOKING CONCERT.—The London staff of Messrs. Drake and Gorham held a smoking concert on Friday last, at which a large party of *employés* and friends were present.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

January 27, 1894.

1,776. W. A. WALTON. Improvements in electric arc lamps.

1,788. J. P. BAYLY. London. Improvements in electric glow lamps. (W. Wiklund, Sweden.)

1,794. W. ADKINS. Birmingham. Improvements in electrical traction or electrical railways and tramways.

1,798. J. W. FLETCHER. Stockport. Improvements in electrical signalling apparatus, and in apparatus connected therewith.

1,810. H. E. S. HOLT. Teddington. Improvements in electrical measuring instruments.

January 29, 1894.

1,886. H. MARRIAN. London. Improvements in switches and automatic movements for use in connection with telephones.

1,903. M. WUILLOT. London. Improvements in or relating to electrodes.

1,919. C. LANGDON-DAVIES. London. Improvements in telegraph relays.

January 30, 1894.

2,007. THE EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED) and C. F. PROCTOR. London. An electric switch.*

2,048. R. VOIGTLÄNDER. London. Improvements in dynamometers.

January 31, 1894.

2,093. H. H. BROWN. London. Improvements in the manufacture of insulated wire.

2,104. G. J. GUHL. Croydon. Improvements in electric switches to be used in conjunction with contacts for continuous ringing.

2,105. F. BROWN and C. H. OFFORD. Walsall. Improvements in arc lamps.

2,112. T. H. CALEY. Manchester. Improvements in electric lampholder switches, and the like.

2,118. V. FABRIS. London. Electric light improvements.

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February 1, 1894.

2,203. G. DURLACHER, A. LACOSTE, and W. LOWRY. London. An improvement in electric candle lamps.*

2,211. Sir C. S. FORBES, Bart., and the DOMESTIC TELEPHONE COMPANY (LIMITED). London. Improvements in microphones.

2,217. H. CHITTY. London. Improvements in dynamo-electric machines.

2,250. O. HUND. London. Improvements in galvanic batteries. (G. Wehr, Germany.)

2,251. O. HUND. London. Improvements in galvanic dry batteries. (G. Wehr, Germany).

February 2, 1894.

2,262. A. ASHBY. London. Improvements relating to electroliers, and ceiling roses for same.

2,271. C. R. G. SMYTHE and A. H. DUNNACHIE. Glasgow. An improved method of constructing manholes, inspection boxes, junction boxes, and the like.

2,274. P. J. PRINGLE. Sidcup. Improvements in the means for electrically propelling tramcars and other vehicles, and the apparatus therefor.

2,321. W. E. YATES and A. CLEGG. London. Improvements in or connected with dynamos.

February 3, 1894.

2,366. J. E. PALMER. Birmingham. System of underground electric traction.

2,424. D. DE MITO. London. An electric locking device for door locks.

2,437. A. A. CARDOSO E BASTOS. London. Improvements in and relating to electric time alarm and synchronising apparatus.*

February 5, 1894.

2,451. C. R. G. SMYTHE, Glasgow. Improvements in, and connected with, electrical concentric conductors.

2,452. F. W. CROSSLEY and J. ATKINSON. Manchester. Improvements in thermo-dynamic motors.

2,487. C. J. HALL. London. Improvements in, or relating to, secondary batteries.

2,493. R. F. RANDELL. London. Improvements in holders for electric incandescence lamps.

2,514. J. H. WEST. London. Improvements in, or relating to, electric bells.*

2,524. BLACKMAN VENTILATING COMPANY (LIMITED). London. An electromotor for fans. (F. Stahl, Germany.)

February 6, 1894.

2,548. H. V. KEESON. London. Improvement in firing keys or electrical contact makers

2,562. F. M. ASHLEY. Manchester. Improvements in electrical tramways and railways.

2,607. R. FLEBBE. London. An improved magnetic electric conduit system for electric tramways, railways, and the like.

2,623. W. M. MORDEY. London. Improvements in regulating and controlling dynamos.

February 7, 1894.

2,677. C. A. BECK and L. KAMM. London. An improved printing telegraph and transmitter.

2,693. E. O. KUMBERG and B. E. CLARKE. London. Improvements in or connected with phonographs.

2,721. T. SEWELL and H. BODTKER. London. Improvements in and connected with insulators for supporting electric telegraph, telephone, and similar conducting wires.

February 8, 1894.

2,542. T. FIELD and C. SURETIES. Improvements in and relating to the manufacture of plates for engraving and electrotyping purposes.

2,730. T. B. GRANT. London. A new and improved protector for electric cables laid underground.

2,733. W. C. MOUNTAIN and G. T. O'B. CAREW. Newcastle-on-Tyne. Improvements in or relating to the regulating mechanism of electric arc lamps.

2,734. J. H. KERR. Dublin. An improved electrical contact screw.

2,749. D. DENISON. Bradford. A new or improved register and holder therefor for recording telephonic messages.

2,790. F. KLEGE. London. An improved electric-registering apparatus for recording the speed and occupation of vehicles.

2,800. E. F. A. SOLEAU. London. Improvements in incandescent lamp fittings.

2,805. C. KELLNER. London. Improvements in electrolytical decomposing apparatus.

2,812. N. TESLA. London. Improvements in methods of and apparatus for the generation of electric currents of defined period. (Date applied for under Patents, &c., Act. 1883. Sec. 103, August 19, 1893, being date of application in United States.)*

February 10, 1894.

2,851. W. P. THEERMANN. Manchester. Improved electric signal apparatus.

2,866. W. L. WISE. London. Improvements in and having relation to dynamo-electric machines. (J. N. Lewis, United States.)

2,897. C. P. SHREWSBURY, F. L. MARSHALL, J. COOPER and J. L. DOBELL. London. Improvements in the manufacture of coke or carbon for electrical or other purposes.

2,930. J. RUDHOLZNER, London. Improvements relating to the electro-deposition of metals.

2,936. A. B. BROWN, Glasgow. Improvements applicable in connection with telemotor apparatus for actuating mechanism at a distance for telegraphing, indicating steering, and analogous purposes.

2,965. J. H. GEISENHEIMER and E. A. LESSING, London. Improvements in holders for incandescent electric lamps.

2,968. O. IMRAY, London. An improvement in electrolysing liquids and apparatus therefor. (The Farbwerke vormals Meister, Lucius, und Brüning, Germany).

2,976. H. V. LANCHESTER. London. Improvements in casings and fittings for electric wires and fittings.

February 12, 1894.

2,990. T. PARKER. Wolverhampton. Improvements in electric tramways.

3,013. S. A. MAHOOD. Hanley. Improvements in apparatus for drawing through electrical or other cables or conductors in underground pipes or conduits.

3,020. F. TUDSBURY. Sheffield. Improvements in induction electrical machines.*

3,035. S. MACDONALD. London. New or improved electrically-operated instrument for tattooing the skin.

3,045. L. BÄÄRNHIELM and A. JERNANDER. London. An improved insulating compound.*

February 13, 1894.

3,052. J. W. EWART. London. Improved method of advertising by means of an electric lamp.

3,056. A. MARR. Manchester. Improvements in, and relating to, electrical safety fuses.

3,072. J. E. WOOLVERTON. Glasgow. Improvement in arc lamps.*

3,079. H SANDERS. Birmingham. An electric bell indicator.

3,080. W. P. THEERMANN, W. CROOKELL, and G. C. ELLIOTT. Manchester. Improved method of fixing electric call bells.

3,101. W. B. SAYERS, H. A. MAVOR, W. A. COULSON, and S. MAVOR. London. Improvements in armatures for dynamo-electric machines.

3,108. P. W. LEFFLER and E. CORRIGAN. London. Electric railways.*

3,109. J. IMRAY. London. An electric locomotive for combined adhesion and rack traction. (F. Rinecker, Germany).

3,111. R. HADDAN. London. Improvements in electric signalling devices. (A. S. Williams, United States.)*

3,118. I. A. TIMMIS and A. J. SMITH. London. Improvements in the regulation of electric motors.

3,125. O. DUFAULT. London. Improvements in armature connections for dynamos.

3,130. L. B. MILLER and M. W. WOODS. London. Automatic cut-out or regulator.

February 14, 1894.

3,155. W. WILLIAMS and T. B. JOHNSTON. Bristol. Combined casings and insulators for electric wires.

3,166. J. B. HOWARD. Halifax. Improvements in underground conductors of electrical tramways. (W. Simon, W. Beissbarth and J. Beissbarth, Germany).

3,217. H. F. JOEL. London. Improvements in electric arc lamps.

3,223. W. DONALDSON. London. Improvements in heating of gases by electricity.*

3,234. W. C. BERSEY, E. J. CLUBBE, and A. W. SOUTHEY. London. Improvements in the locking mechanism of common road vehicles propelled by electromotive or other power.

February 15, 1894.

3,245. D. COOK. Richmond. Improvements in lead-covered electric cables.

3,273. A. CHESTER and J. J. RATHBONE. London. Improvements connected with arc lamps.*

3,277. G. H. NISBETT. London. Improvements in the construction and methods of manufacture of electrical cables.

3,291. A. W. MONEY and H. NASH. London. Improvements in electric arc lamps.

3,294. M. PETERSON. London. Improvements in electric lighting apparatus for gas burners.

3,312. H. H. COOPER and THE ELECTRICAL INSTALLATION COMPANY (LIMITED). London. Improvements in electric arc lamps.

February 16, 1894.

3,363. S. S. ALLIN and W. H. WOOD. London. Improvements in arc lamps.

3,376. J. B. HOLROYDE. Manchester. Improvements in appliances or means for securing the covers to the casings of electric-light wires, applicable also to other purposes. (C. J. Holroyde, Australia.)

3,384. J. W. TURNBULL. London. Improvements in incandescent electric lamps.*

3,399. W. LANGDON-DAVIES. London. Improvements in apparatus for obtaining a rotary magnetic field.

February 17, 1894.

3,422. W. ROCKLIFFE. Newcastle-on-Tyne. Improved method of, and means for, generating steam by electricity.

3,425. D. HUNTER and W. A. JACK. Glasgow. Improvements in electric lamps, and in the holders or sockets therefor.

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3,450. W. R. Wynne. London. An improved flexible and electrically-insulating shaft coupling.*
3,460. G. Plumpton. Manchester. Improvements in draw-tongs for telegraphic and other purposes.
3,468. E. Pollak. London. Hygienic safety device or guard for telephones.
3,469. P. Pöschmann and R. Hanisch. London. Improvements in dynamo-electric and electro-dynamic machines.
3,476. H. B. Little. London. Improvements in and connected with electric bells.

February 19, 1894.

3,519. J. Wilkinson. Blackpool. Improvements in chairs and rails for electric railways underground channel.
3,545. G. G. Sarney. London. An electrically-controlled race game.
3,548. W. Rowbotham. Manchester. Improvements in and relating to electric arc lamps and mechanism for operating and controlling the same.

February 20, 1894.

3,575. W. Rockliffe. Whitley. An improved scrat brush used in the electroplating process.
3,589. R. A. Goodman and A. B. Barlow. Manchester. Improvements in electric arc lamps.
3,609. W. H. Elliott. Tipperary. Improvements in mechanical and electrical interlocking in connection with railway signalling.
3,652. I. A. Timmis. Westminster. Improvements in the arrangements for working railway signals electrically.
3,658. C. J. Hall. London. Improvements in dynamo-electric machines.*
3,667. The Phonopore Company (Limited) and E. W. Smith. London. Improvements in telegraphic and telephonic apparatus.
3,674. W. H. Longsdorf. London. Improvements in primary galvanic batteries and in the liquids used therein. (G. Hewett, United States.)
3,688. A. H. Johnston. London. The electric-light cane.

February 21, 1894.

3,725. T. Blackhurst. Darwen. Dry or semi-dry galvanic elements.
3,729. E. A. Claremont. Manchester. Improvements in dynamo-electric machines.*
3,730. E. A. Claremont. Manchester. Improvements in electric arc lamps.*
3,749. A. J. Boult. London. Improvements in galvanic batteries. (C. Cudell, J. Cudell, and M. Cudell, Germany.)*

February 22, 1894.

3,841. C. E. Grove. London. Improvements in electric motors for vehicles.
3,859. W. P. Thompson. Liverpool. Improvements in or relating to electric gas-lighting apparatus. (M. Ulmer, Germany.)
3,860. A. Linard. London. Improvements in dynamo-electric machines.
3,863. A. E. Jones. London. An improved electric arc lamp.

February 23, 1894.

3,897. W. J. Hancock. Westminster. An improved bracket for telegraph and other insulators.
3,902. A. Chamberlain and G. Hookham. London. A new method of applying electro-motors to lathe work.*
3,922. M. Roskell. Liverpool. Improvements in, or relating to, the electro-decomposition of metals.
3,926. W. M. Mordey. London. Improvements in, or applicable to, dynamo-electric and other machines or apparatus for the purpose of preventing or retarding the passage of magnetic lines of force from or to such machines or apparatus.
3,931. F. S. F. Schneider. London. Improvements in apparatus for transforming continuous electric currents into alternating currents.

February 24, 1894.

3,951. F. Richmond. Burnley. Improvements in dynamo-electric machines.
3,962. C. M. Dorman and R. A. Smith. Manchester. Improvements in electrical switches.*
3,976. J. Boyes. London. A method of utilising the movements of the recorder coil or siphon connected connected thereto, or the movements of other apparatus used for receiving telegraphic messages through submarine cables or land-lines to automatically transmit telegraphic messages from one submarine cable or land-line to another submarine cable or land-line.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d. each.

1892.

19,194. Langdon-Davies. Telephones.
19,714. Chitty. Dynamo-electric machines.
21,480. Anders and Kottgen. Measuring electricity.
23,023. Puskas. Telephonic news transmitters.

1893.

36. Villiers-Stead. Electrical station indicators for vehicles.
2,267. Vautin. Electrolytical separation of bases of salts, &c., from saline solutions.
2,922. Scott and Burnet. Electric clocks.
3,413. Muirhead and Edgar. Telegraph recording instruments.
3,690. Morris. Ammeter and voltmeter.
4,938. Ram. Incandescent electric lamps.
4,952. Smith and Granville. Electrical relays and measuring instruments.
5,337. Ewing. Conductors for electric railways.
5,505. Watkin. Moulding bodies of electric switches, &c.
5,684. Tuckerman and Mackenzie. Electric primary batteries.
5,844. Thompson (Hartung). Storage batteries.
6,032. Mills (Hutchinson). Switches for electric light fixtures.
6,050. Bláthy and Déri. Alternate-current motors.
6,439. Marsh. Electric switches.
6,613. Parsons and Willis. Boxes for electric transformers.
6,642. Mather and Kemp-Welch. Socket shank of electric lamp.
6,813. Bryan. Electric arc lamps.
6,965. Urbanitzky and Fellner. Electric furnaces.
9,478. Lake (Hartmann and Braun). Insulators for electric wires.
10,147. Dowling. Applying electricity to human body.
14,087. Lake (General Electric Co.). Incandescence lamps.
16,008. Piedfort. Multiple telegraphy.
19,410. Firth and Ashwell. Rendering electrical fittings luminous in the dark.
19,967. Petschel. Secondary batteries.
20,799. Schroeder, C. A. J. H. and H. E. R. Electro-positive electrodes.
21,430. Robertson. Electric lamps.
21,734. Wilson. Dynamo-electric machines.
21,850. Naber. Voltmeters.
22,131. Lowrie. Electric switches.
22,255. Fitzpatrick (Broughton Telephotos Co.). Signalling by electric lamps.
22,594. Davy. Electric lamps.
22,858. Orling. Electric lighting and extinguishing apparatus for gas burners.
23,017. Low and Brown. Arc lamps.
23,424. Green. Incandescent electric lamps.
23,897. Reed. Electric signalling.
23,913. Haddan (Blackmore). Dissociating soluble salts by electrolysis.
24,607. Claremont. Electric switches, &c.
24,608. Claremont. Fixing fly-wheels to pulleys of dynamo-electric motors, &c.
24,865. Lake (Rand). Electric wire insulators.
24,867. Love and Gallatin. Electric railways.
24,946. Randall and others. Coverings for electric wires.
24,948. De Segundo and Derham. Time electric switch.

COMPANIES' MEETINGS AND REPORTS.

City of Bath Electric Lighting and Engineering Company (Limited).

The annual meeting of this Company was held on Wednesday, at the offices, Dorchester-street, Bath. Mr. T. O. Callender, Chairman of the Company, presided.

In moving the adoption of the report, which appeared in our last issue, the CHAIRMAN said the Directors were sorry they could not recommend the declaration of a dividend, but they felt this satisfaction, that the business of the future would proceed in a much more satisfactory way than in the early part of last year. All the Company needed was an extension of the number of customers. Their regular standing charges and those incurred by the running of the machinery were heavy, whether they supplied many or few lamps, and they had got to this point now that additional extensions would mean a source of considerable profit. He felt it would be a satisfaction to the shareholders to know that the Company's plant was capable of supplying a very much larger number of lamps, that their mains ran past the doors of most houses in the City, and that all they now wanted was a larger number of citizens to adopt the illuminant. The Directors had found that the old contract system did not work out satisfactorily, and the meter system which had been substituted was considered on all hands to be the fairest and best. It was certainly no injustice to the consumer, for now each customer got what he paid for, and the immense waste formerly existing had been stopped. Alluding to the accounts, he pointed out that while the revenue of the Company had considerably increased, their expenses remained the same. Many alterations had been carried out at the works: Mr. Metzger had been appointed engineer and manager, and the Directors were glad to say that, with his assistance, considerable economies and improvements had been effected. The machinery and plant had also been thoroughly improved, and the station was now in a much better condition than it had eyer been. There had been several changes in the Board of Directors, several having retired, while Mr. B. H. Van Tromp and Mr. J. B. Wood had been elected. The Board was now

much smaller than previously, but the business was proceeding satisfactorily.

Mr. VAN TROMP seconded the motion, which was carried unanimously.

Mr. E. B. TITLEY moved the re-election of the retiring Directors, which was seconded by Mr. SIMPSON, and carried; and Mr. Butcher having been re-elected auditor, the meeting terminated.

Yorkshire House-to-House Electricity Company (Limited).

The first annual meeting of this Company was held on Tuesday at the Central Electric Lighting Station, Whitehall-road, Leeds. Mr. Grosvenor Talbot (Chairman) presided.

The CHAIRMAN, in moving the adoption of the report (which appeared in *The Electrician* of the 23rd ult.) said that since their meeting of May 12th last year the Directors had had not only a busy and laborious time, but a time of considerable anxiety. They had to establish the Company, and they had suffered anxiety on account of the constant increase in their plant that was necessary. On the work of the last eight months they had been able to show a profit of £1,155, which was, he believed, different to what most electric lighting companies had been able to show for so short a period of working. That was most satisfactory to them considering that the months of May, June, July, and August, were the months of the longest days, when lighting was little required. They had only four months of really good lighting, and they certainly had not done badly in making the profit they had done. He trusted that the way in which they had disposed of the profits would meet the approval of the shareholders. The Directors had thought it better that they should reduce the amount of the preliminary expenses account, and they had applied £1,000 for this purpose. He did not think that in another year they would be called upon to apply a similar amount. They had had to contend with two difficulties. There had, in the first place, been one of the brightest winters and autumns on record, which meant a great many hours less lighting; and then there was the coal strike. But they felt that, after all, they had not made a bad record during the last eight months. The lamps had been put in in small numbers until they got to the maximum amount in the dead of winter, and they had found that unless they took the proper steps they should not be able to supply their customers. In Leeds the number of lamps burning was, compared with the number of lamps in store, larger than in any other district. In other stations they reckoned to have twice as many lamps as they had burning, but in Leeds they had three-fourths of their lamps going at the same time. Referring to the increase in the horse-power mentioned in the report, the Chairman said it became necessary for the Directors to consider what would be their position in the following winter, for they knew that there were several large buildings in course of erection in the city which were depending upon electric lighting directly they were opened. It had been growing upon the Directors month after month that the value of the site of the station was almost incalculable; it was in such a wonderfully good position, close to the centre of the town, and they felt the necessity of making the best use of that excellent site. They had made the Corporation an offer to supply the Town Hall and the municipal buildings with electric light at a considerably less cost than appeared in the published accounts of the County Council. Some of their customers had suggested that the price of electricity was high, but they intended next April to reduce the price by 12½ per cent. They felt sure that their customers would realise the benefits of electric lighting, that they would find that they were not only getting a better light, but that their decorating and painting bills were considerably less than when gas was used. He confidently believed that the price of electricity, paradoxical as it may seem, lay more in the hands of the inhabitants of Leeds than with the Directors, because with a progressive demand they should be able to give successive decreases until they got it down to a reasonably small figure. The initial expenses of starting the electric lighting station had been heavy, but afterwards the decrease was most remarkable. They had made a very fair start, and he had confidence that they should be able to have in Leeds a large, paying, and thrifty electric lighting establishment.

Mr. G. H. CROWTHER seconded the motion for the adoption of the report, and it was carried.

Mr. Samuel Ingham and Mr. Arthur Greenhow Lupton were re-elected Directors of the Company, and Mr. John Gordon, jun., was reappointed auditor; and the meeting closed with a vote of thanks to the Chairman.

Scarborough Electric Supply Company (Limited).

The second ordinary general meeting of this Company was held at the offices, Westborough, Scarborough, Lieut.-Col. Steble in the chair.

The CHAIRMAN, in moving the adoption of the report (which appeared in our issue of the 23rd ult.), said that last year at this time the Company had not a brick laid. Now their supply station was in full working order, and two engines were generating electricity equal to 5,000 c.p. They had accommodation for five more engines and one boiler when they needed them, and therefore they were fully prepared to make the additional supplies of electric light which they might fairly anticipate in the near future. He congratulated the Company on the success it had so far attained, and said that the favour in which the illuminant the Company supplied was held was still spreading. He emphasised the growth of the supply since September 1st, as set forth in the annual report, and said that the business they were doing was extremely satisfactory for a small Company like theirs. The current supplied represented a revenue of £370, less discount, and that was a satisfactory return towards the expenditure upon the generating plant. The Company's capital expenditure had been about £20,000. That, he thought was very small, considering that it included the cost of mains and cables. They had now 5½ miles of mains, and nearly 18 miles of cables laid. He hoped that before very long they would require more machinery, and if that were so they would require more capital. It would be for the Directors to consider how this should be raised, and it might be that they would issue debentures to cover the cost. He was looking forward with some confidence to the day when electricity would not only benefit Scarborough and the Company materially, but also benefit the health of the borough. In saying that he was thinking of the experiments which were now being made in utilising town refuse for the generation of electricity instead of coal, and anticipated a favourable result. If the experiments should succeed, and they were able to generate electricity in that way, the Company would, of course, supply the light at a much cheaper price than they were now doing. They were now charging from 5¾d. to 6½d. per unit, less 5 per cent. discount on accounts settled within a reasonable time, and he was not without hope that before very long they would be able to make a little further reduction in prices to consumers and also make a return to the shareholders. It was not to be anticipated that in the first year the Company would be able to pay anything in the shape of interest to the shareholders, and he thought they would be thankful to know that the income balanced the working expenses.

Mr. A. A. CAMPBELL SWINTON seconded the motion, and said that the question of dividend was the one that probably interested the shareholders most. The receipts amounted now to £125 per month and just about balanced the expenditure. With the addition of 2,000 or 3,000 more lamps, therefore, the Company would be in a fair way of paying a dividend. It was difficult, however, until they had been working one year to make accurate calculations. There was no doubt that it was to the interest of the Company to make the electric light as cheap as possible, and for that reason it was important, too, that consumers should remember that the lamp patents had expired, and that very much more efficient lamps could now be obtained than was previously the case. Of course the less efficient the lamps were the more electricity would be consumed, and therefore the least efficient lamps would in one sense be an advantage to the Company. On the other hand, the better the light the more likely would its use extend, and therefore the Company recommended consumers to use the most efficient lamps, which could now be obtained to give the same amount of light for two-thirds the amount of current that was used before the expiration of the patents. He recommended the high-efficiency lamps, and said that though they did not last quite so long as the old lamps, the cost of renewal was very small as compared with the cost of the current. The machinery at the Company's generating station had been working satisfactorily. The amount expended on capital almost exactly corresponded with the original estimates, the only difference being that they had laid rather longer mains than originally planned.

The motion was adopted.

On the motion of Mr. WILKINSON, Mr. G. L. Beeforth, the Hon. C. A. Parsons, and Mr. G. Alderson Smith were re-elected as Directors; and the auditor having been re-appointed, a vote of thanks to the Chairman concluded the meeting.

Morecambe Electric Light and Power Company (Limited).

The third annual meeting of this Company was held at Morecambe last week, Mr. C. Mabbott presiding. The report, an abstract of which appeared in our last issue, was adopted, and a dividend of 2 per cent. declared. It was stated that but for the temporary suspension of service by fire this would have been increased to 5 per cent. Mr. W. B. Hodgson was re-appointed a Director, and Mr. James Duff (Halifax) re-elected auditor.

The engineers in their report stated that the Company had been the pioneer of a new system of electric lighting generated by means of Dowson gas made on the premises, and that the economical system adopted at their works had resulted in not less than six public authorities adopting the same system, by which electric light could be generated and supplied at a price consumers could afford to pay.

Isle of Man Tramways Company (Limited).

A meeting of the shareholders in this Company was held on Friday, at Villier's Hotel, Douglas, for the purpose of approving the sale of the undertaking and assets of the Company to the Douglas and Laxey Electric Tramway Company for £38,000. Mr. Pittar, chairman, presided. It was explained that the dividend declared in December last had to be deducted from the sum offered; £1,400 was set aside for the expenses of winding-up the Company and compensation to such officials as the Board decided were to receive it, leaving £35,000 as assets divisible amongst the shareholders. The Ordinary shareholders were entitled to all the profits after payment of the Preferential dividend of 6 per cent. The Preference shareholders were entitled to repayment of their capital of £10,000 at par, and the balance of £25,000 would be divisible exclusively amongst the Ordinary shareholders, of which there were 16,000 odd, which would be equal to £1. 10s. 4d. per share.

The CHAIRMAN explained that the Directors, who held about one-fifth of the shares, strongly recommended that the offer be accepted.

Mr. A. BROWN moved that the offer be accepted, and pointed out that the purchasing Company agreed to take over the liabilities, amounting to £3,100, so that they were practically paying £41,000 for the concern.

Although considerable dissatisfaction was evinced at the proposed sale by the Preference shareholders, the motion was carried by a large majority.

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Oriental Telephone and Electric Company (Limited).

The following has been issued to the shareholders of this Company, under date February 23rd :—

"At the extraordinary general meeting of the Company, held on the 21st inst., the resolutions referred to in the accompanying notice were considered, and the result of a poll taken upon them showed that the votes in favour of the scheme amounted to 49,756, and in opposition thereto 1,116. The Directors did not vote in the poll, nor did they use the proxies which they had received, which carried further votes amounting to 90,597. Had the Directors voted and used the proxies held by them, the total votes in favour of the scheme would have amounted to 198,544."

An extraordinary general meeting of the members of the Company will be held on Monday next, March 12th, at 1, at the Cannon-street Hotel, E.C., when the resolutions which were passed at the extraordinary general meeting, held on the 21st ult. (and set out in *The Electrician* of the 16th ult., p. 437), will be submitted for confirmation as special resolutions.

Hove Electric Lighting Company (Limited).

The following report of the Directors is to be presented at the annual general meeting of the shareholders at the Town Hall, Hove, near Brighton, on Wednesday next, the 14th inst., at three o'clock :—

This statement covers the whole period since the formation of the Company in August, 1892, and is intended to supersede the interim statement submitted to the members on December 12th last. The Directors have pleasure in again congratulating the shareholders on the progress of the Company. The number of lamps attached to the Company's main is now equal to 6,915 8-c.p. lamps, and the number of houses has increased to 105. The working of the Company has resulted in a small profit at December 31st last, and from the increasing number of new customers and additional lamps connected each week, the Directors look forward with confidence to a very satisfactory profit at the end of the current year. The opposition Company—the Brighton and Hove Electric Lighting Company—who are supplying a certain number of consumers in Hove with electric current from overhead wires, have been directed by the Board of Trade to make certain alterations in their system of conductors, but they have, it is believed, decided to discontinue their operations in Hove altogether, and consequently your Directors expect a large accession of lights to their system shortly. Indeed, at the present moment, they have applications from consumers with nearly 3,000 additional lights.

Since the date of the interim report the Directors have allotted 756 additional shares, bringing up the total allotted to 4,046 shares, representing a subscription of £20,230, while the capital expenditure amounts to £29,235, and consequently there are large balances due to the contractors and others, in addition to which the Company's further commitments on capital account amount to nearly £13,000. It is, therefore, necessary that further subscriptions for capital be obtained, and the Directors urge upon the members to subscribe for the balance of the Company's shares.

Colonel A. J. Filgate and Colonel H. Wood, C.B., retire from the Board by rotation, and being eligible, offer themselves for re-election, as does Mr. Robert Payne, F.C.A., the auditor.

NEW COMPANIES, STATUTORY RETURNS, &c.

In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1894, *pages* 274-300, *&c., &c.*]

ELECTRIC WELDING COMPANY (LIMITED).—The annual return of this Company, made up to December 31, last, was recently filed. The nominal capital is £460,000, divided into 45,000 Ordinary and 1,000 Founders' shares of £10 each. 25,000 Ordinary and 948 Founders' shares have been taken up, of which 8,333 were issued as fully paid. Upon the remaining 16,667 Ordinary shares a call of £6 per share has been made, and upon the 948 Founders' shares the full amount has been called. The calls paid have amounted to £116,339, leaving £29,143 in arrears.

EASTERN TELEGRAPH COMPANY.—The annual return of this Company, made up to February 8, has been filed. The nominal capital is £4,700,000, divided into 400,000 Ordinary and 70,000 Preference shares, of £10 each. 469,988 shares have been taken up, the full amount called, and all calls paid in full.

CITY NOTES, &c.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—Notice is given that the transfer books of this Company will be closed from the 15th to the 21st March inclusive, preparatory to paying an interim dividend of 3s. per share, being at the rate of 6 per cent. per annum for the half-year ended December 31st, free of income-tax, payable on the 22nd inst.

CHELSEA ELECTRICITY SUPPLY COMPANY (LIMITED).—Subscriptions are invited for 6,000 Six per Cent. Preference shares of £5 each in this Company, issued at a premium of 10s. per share, payable 10s. on application, £1. 10s. on allotment (including the premium of 10s.), £1. 10s. on April 16th, £1 on August 15th, and £1 on December 15th. The additional capital is required (the prospectus states) for the extension of mains into a fresh district in Chelsea, and to defray the cost of the buildings, works, and machinery necessary to enable the Company to deal with the increasing demand for current, &c. The accounts for 1893 show a net balance of £3,105. 2s. 7d., and a dividend of 5 per cent. has been declared on the Ordinary shares for the past year. The prospectus shows that a steady improvement is apparent in the position of the Company. During the past year 10,665 additional lamps have been joined up, making the total number of 8-c.p. lamps connected to December 31st last 40,665. Applications for shares must be made on the form accompanying the prospectus, which can be obtained at the offices of the Company, Draycott-place, Chelsea, London, S.W. ; of the London and South-Western Bank, Sloane-square, S.W., and 170, Fenchurch-street, E.C. ; or at the offices of the Electric and General Investment Company (Limited), 1 and 2, Great Winchester-street, E.C. The list opened on Tuesday last, and closes on Tuesday next at 4 p.m., for both town and country.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—It is announced that, in response to the application for £100,000 Five per Cent. Debenture Stock, made last week, applications amounted to no less than £1,288,835. Letters of allotment and regret were posted on Wednesday evening.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended March 4th were £934, as against £929 in the corresponding period of last year, being an increase of £5. The total receipts for the half-year amount to £8,544, as against £8,672 for the corresponding period of last year, a decrease of £128.

COMMERCIAL CABLE COMPANY.—A quarterly dividend at the rate of 7 per cent. per annum has been declared by the Directors, payable on April 2nd.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of February are £3,600, as compared with £3,765 in the corresponding month of last year.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of February amounted to £1,698, as against £1,808 for the corresponding period of 1893.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the month of February amounted to £54,904, as against £55,281 in the corresponding period of last year.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the month of February amounted to £35,187, as against £39,533 for the corresponding period of 1893.

EDINBURGH AND DISTRICT TRAMWAYS COMPANY (LIMITED).—The question of the transfer of the agreements between the Corporation of Edinburgh and Messrs. Dick, Kerr and Co. (Limited) appears to have been settled, as the prospectus is now issued of the above Company, which is formed to acquire the lease which the Corporation came to with Messrs. Dick, Kerr and Co. for a period of 21 years from the 9th December last. The lines comprise about twelve miles of tramways. The capital of the new Company is £117,500 in 20,000 Five-and-a-Half per Cent. Cumulative Preferred shares of £5 each, and 17,500, Deferred of £1 each. Messrs. Dick, Kerr and Co. continue to work the tramway during the continuance of the lease, paying to the new company all receipts in return for their providing all necessary funds and plant for the purposes of the undertaking.

ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL COMPANY (LIMITED).—In our issue of February 23rd publicity was given to a circular issued to the shareholders, in which the Directors announced that, unless £5,000 was subscribed by the shareholders, the Directors would be compelled to create £30,000 in Preference shares. In accordance with this notification a circular is now issued, in which the Directors regret that the £5,000 had not been subscribed, and that, therefore, they have no alternative but to proceed with the issue of the £30,000 Preference shares. At the same time they announce that a contract has been entered into with the German Imperial Marine for a three years' supply of all the copper tubes between 7in. and 12in. diameter that may be required at the Government Docks at Wilhelmshaven, Kiel, and Dantzic. "It is, therefore, imperative that the Company should be strengthened financially, in order to be able to carry this contract into effect."

ELMORE'S WIRE MANUFACTURING COMPANY (LIMITED).—It is stated in the financial papers that the recent issue of £30,000 Preference Stock of this Company has all been placed, and that Mr. Edward Reynolds (of Vickers, Sons and Co., Limited) has joined the Board of Directors.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company for February, 1894, amounted to £20,000, and from January 1st to February 28, 1894, to £41,000. In the corresponding months of 1892 and 1893 the amounts were £40,800 and £41,200 respectively.

HOBART ELECTRIC TRAMWAYS COMPANY (LIMITED).—For the month of February the receipts were £1,431.

STOCK EXCHANGE NOTICES.—Applications have been made to the Stock Exchange Committee to allow the following securities to be quoted in the Official List :—General Hydraulic Power Company (Limited), further issue of 10,000 shares (1892), Nos. 80,001 to 90,000 ; National Telephone Company (Limited), further issue of £74,983 Four and a-Half per cent. Debenture Stock.

UNITED ASBESTOS COMPANY (LIMITED).—The Directors of this Company recommend the payment of the following dividends for the past year :—10 per cent. on the £10 Preference shares, 6 per cent. on the £5 Preference shares, and 2½ per cent. on the Ordinary shares, carrying forward a balance equal to 5¾ per cent. on the Ordinary shares.

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WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the week ended March 2nd (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £3,001.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the two weeks ended February 28th were £2,331, as compared with £2,442 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Feb. 28.		Price Wednesday, Mar. 7.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending Mar. 7. Highest	Lowest.
			TELEGRAPHS.								
£1,134,640	Stock	13 6	Anglo-American	42	44	42	44	5 13 8	Jan., Apr., July, Oct.	42	..
£2,932,680	Stock	27/0	Do. Preferred	79	80	78	80	6 5 0	" "	79¾	79
£2,932,680	Stock	5/0	Do. Deferred	7	7½	7	7½	..	..	7	
£184,500	100	4%	African Direct Telegraph 4% Deb. (Reg. & Bearer)	100	103	100	103	3 17 8	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	11½	12	11¾	12¼	5 4 0	Mar., June, Oct., Dec.	12⅛	11¾
£18,700	£100	5%	Do. 5 per Cent. Bonds	99	102	99	102	4 18 0	January and July ..	..	–
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	..	–
10,000,000	$100	7%	Commercial Cable Capital Stock	135	145	135	145	4 16 7	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine xd	12	13	12	13	6 3 1	February and August	12¾	..
6,000	10	10%	Do. Preference 10 per Cent. xd	18	19	18	19	5 5 3	" "	..	–
12,931	5	1/7½	Direct Spanish (£4 paid)	2	3	2	3	5 6 8	April and October	2⅞	..
6,000	5	10%	Do. Preference 10 per Cent.	8	9	8	9	5 11 1	" "	..	..
60,710	20	3 0	Direct United States Cable, 1877	10⅜	10⅝	10¾	11	6 2 6	Jan., Apr., July, Oct.	10⅞	10 13/16
400,000	10	2/6	Eastern	14⅞	15⅛	15	15½	4 5 3	" "	15¼	15
70,000	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16¼	3 13 10	" "	16 3/16	16
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	115¼	114¾
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	106	109	106	109	4 11 9	February & August	..	..
250,000	10	2/6	Eastern Extension	15⅜	15⅝	15½	15¾	4 8 11	Jan., Apr., July, Oct.	15⅝	15 7/16
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	114	117	114	117	3 8 5	February & August	114½	..
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	102	105	103	106	4 14 4	January and July ..	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	102	105	103	106	4 14 4	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103	106	103	106	3 15 6	February & August	104	..
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	107%	110%	107%	110%	3 12 9	May and November	..	..
180,227	10	1/3	Globe Telegraph and Trust	8½	8¾	8¾	9	5 0 0	Jan., Apr., July, Oct.	8 15/16	8 11/16
180,042	10	6%	Do. 6 per Cent. Preference	15⅛	15⅝	15¼	15½	3 17 5	" "	15⅝	15 3/16
150,000	10	5/0	Great Northern	20½	21½	21	22	3 18 0	Jan., April, and July	..	..
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue .. xd	105	108	104	107	4 13 6	March & September	..	..
17,000	25	12/6	Indo-European	42	45	43	45	5 11 1	May and November	44	..
37,548	10	4/0	London Platino-Brazilian	4	5	4	6	..	" "	..	–
£100,000	100	6%	Do. 6 per Cent. Debentures xd	107	110	104	107	5 12 2	March & September	..	–
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red 1942	102	105	102	105	3 16 2	..	..	–
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	–	..
3,381	£100 Cert.	25 0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	" "	–	..
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July ..	..	..
£249,900	100	5%	Do. 5 per Cent. Debentures xd	100	103	98	101	4 19 0	March & September	99½	99¼
30,000	10	2/0	West Coast of America	2	2½	2	2½	..	January and July ..	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	97	101	97	101	7 18 5	June and December		..
88,321	10	1/0	West India and Panama	1⅛	1⅜	1⅛	1⅜	..	..	1 1/16	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	9¾	10¼	10	10½	5 14 3	May and November	10¼	10
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	" "	8¾	–
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	105	108	106	109	4 11 9	June and December	..	..
64,242	15	4/6	Western and Brazilian	7	7½	7¼	7¾	..	May and November	7¾	7½
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5½	6	5½	6	..	..	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¾	2¼	1¾	2¼	..	..	2 1/16	1⅞
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	104	107	104	107	5 12 2	February & August	–	–
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	104	107	104	107	5 12 2	" "	–	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds xd	103	106	100	104	5 15 5	March & September	..	–
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	2	3	..	–	–	–
224,800	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
220,000	£1	4·76d.	Oriental Telephone and Electric (11s. paid)	¼	⅜	¼	⅜	5 6 5	Yearly	..	–
484,597	5	2/6	National	4½	4¾	4½	4¾	5 5 3	June and December	4 13/16	4 9/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½	15½	14½	15½	3 17 5	" "	15 3/16	15 1/16
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	14	15	14	15	4 0 0	" "	14⅝	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¼	5½	5¼	5½	4 10 11	..	5 7/16	5 3/16
925,017	£100	4½%	Do. Deb. Stk. 4½%	113	115	113	115	3 18 3	January and July	..	..
58,000	5	1/0	United River Plate	1½	2	1½	2	–	" "	–	–
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	–	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	10½	11½	11	12	–	..	11½	11
20,000	10	6,0	Do. 6 per Cent. Cumulative Pref. (fully paid) xd	12¾	13¼	13	13½	..	–	13¼	12¾
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	–	–
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	–	–	–
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	–	–
8,322	£5	..	House to House Electric	..		..		–	–	–	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		–	–	–	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	–	–
30,000	£5	1/9	Liverpool Electric Supply (£4 10s. paid)	5 7/16	5 9/16	5 7/16	5 9/16	..	–	–	–
15,000	£5	2/6	Do. (fully paid)	6⅛	6⅝	6⅝	6⅞	..	–	..	–
111,000	5	..	London Electric Supply	¼	¾	¼	¾	..	..	..	–
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	8	8½	8¼	8¾	2 5 9	..	..	–
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	106	109	106	109	4 11 9	June and December	107½	–
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	–	–	5⅜	–
19,980	£5	4,6	St. James' and Pall Mall	6¼	6¾	6	6½	..	–	..	..
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½		8½	4 2 4	–	8 3/16	8
59,900	5	2/6	Westminster Electric Supply (fully paid) xd	5½	6	5½	6	2 18 4	–	5 13/16	–
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering xd	2⅝	2⅞	2⅝	2⅞	6 5 4	–	2⅞	2⅝
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative xd	2⅛	2⅜	2⅛	2⅜	5 1 1	–	2 3/16	2⅛
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures xd	104	107	106	109	4 2 7	March & September	–	..
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	3	4	3½	4	..	January and July	..	..
12,139	5	..	Edison and Swan United	–		–		–	–	–	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		–	–	–	–
120,000	2	..	Electric Construction	¼	¾	¼	¾	..	–	..	..
12,845	2	..	Do. 7% Cumulative Pref.	1½	2	1½	2	..	..	..	..
91,195	2	10/0	Elmore's Patent Copper Depositing	9/16	11/16	⅝	⅞	–	–	..	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	–	..	–
50,000	10	15/0	India Rubber, Gutta Percha &c., Works xd	23	24	23	24	5 4 2	February & August	23¾	23½
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	103	105	103	105	4 5 9	March & September	..	..
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	–	..	–	–
16,000	£10	..	Do. 8 per Cent. Preference	–		..		–	December and June	–	–
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	⅛	¼	—	⅛	–	–	–	..
78,949	5	3/6	Swan United (£3. 10s. paid)	2	2½	2	2½	..	May and November	..	..
37,350	12	36/0	Telegraph Construction and Maintenance xd	39	41	39	41	4 7 10	March and July	40½	39½
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	–		..		..	January and July	..	..
37,514	£5	–	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		–	–	–	–
41,098	£5	–	Do. Preference (fully paid)	–		–		–	–	–	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	5%	City and South London Railway	27	32	27	32	4 5 11	May and November	..	..
37,500	£10	..	Liverpool Overhead Railway	5¼	5½	5½	5¾	–	–	–	–

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NOTES.

In the brief but highly practical discussion which followed the reading of Major-Gen. Webber's paper at the Institution of Electrical Engineers, Mr. Alex. Siemens, it will be remembered, took up the cudgels on behalf of armoured cables for distributors, at any rate so far as the City of London was concerned, pointing out that they "could be threaded in under or over the gas and water pipes" without any difficulty, and that they were exempt from what the daily press is pleased to call "electric lighting explosions." In the Paper read on Monday last before the Northern Society of Electrical Engineers, Mr. J. H. Rider corroborates this opinion, supplementing it by another in favour of the use of a "draw-in" system for feeders. Mr. Rider points out that electric light mains can now be calculated so as to meet future as well as present requirements; hence the hitherto insuperable objection to armoured cables, namely, that the streets must be frequently opened up, is no longer valid. Should the demand, however, increase so unexpectedly in any given district or street as to render the fall in volts along the distributors too great to be permitted, the simplest way out of the difficulty, Mr. Rider argues, would be to run another feeder, which, of course, involves a network of feeders on the "draw-in" system. The objection, however, raised by Mr. Clirehugh, in the Paper read at the same meeting of the Northern Society, that it is more difficult to localise and repair faults where armoured cables are concerned, than in the case, say, of cables run in iron pipes, is one which must not be lost sight of. Nevertheless, Mr. Rider's preference for armoured cable distributors, and "draw-in" feeders, the converse of the usual arrangement, appears to be well supported by practical reasoning.

At a recent meeting of the Bristol Electrical Committee, some revisions in the system of charging for electric energy were made, with a view to encouraging increased consumption. The decision that between midnight and one hour before sunset energy should be charged for at a lowered rate, is based on sound principles; but the same cannot be said for the arrangement which was made to grant heavy discounts on a sliding scale to large consumers. Customers from £50 to £100 are to have 5 per cent. rebate; from £100 to £250 they will receive 10 per cent. rebate; while reductions to the amount of 20 per cent. are promised. We have several times shown the fallacy of making rebates on any such system as this. The large consumer may be a boon or a nuisance to the supply corporation; but in ninety-nine cases out of a hundred he is the latter. Large consumption, *per se*, is, of course, a boon, but one cannot have large consumption where there are not many lamps or large motors; and there is nothing to show that the large consumer consumes at a greater rate, in proportion to the lamps he has wired, than the small consumer does. The sort of customer that Bristol and other electrically supplied towns will find it advantageous to encourage is not necessarily the large consumer with his big bill, but the consumer whose bill is large in proportion to the lamps he uses, however small that bill may be in actual £. s. d.

In the current number of *Wiedemann's Annalen*, Herr du Bois describes a ring magnet, by the aid of which he has attained a field of 38,000 C.G.S. units in air over a space of several millimetres; and has attained in iron an induction density of 60,000 C.G.S. units, which we believe to be the highest value yet observed. In such a field the resistance of a bismuth wire would be tripled. The most interesting experiment in these cases would be to take the B—H curve of the iron wire, in order to determine whether it had become parallel to the line denoting H in the air. When this parallelism is attained, all the Ewing molecular magnets would have been turned parallel to the axis of the wire. It is, however, probable that the number of magnets is extremely large, and consequently the magnetising force to produce this result would have to be almost infinite. Herr du Bois does not appear to have experimented in this direction.

One of the most interesting features of the Scarborough electric supply, which is described elsewhere, is the use of large buried transformers, a compromise between the wasteful house transformer system and the complicated and expensive sub-station system. The encouragement given by the former to mulct consumers for transformer "rental," and by the latter to suggest an intricate automatic switching gear, are absent. The system, which is receiving attention in several other towns, seems to be very sensible, and ought not to be difficult to carry out, even in crowded streets.

We turn with interest, every week, to the "Electric Lighting Memoranda," as well as to the other columns of our contemporary, the *Journal of Gas Lighting*, a publication to which

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we have often referred, and one in which our readers will often find useful information as well as candid criticism. The two articles on Tests of Gas-burners and the supplementary one on Comparative Cost of Lighting by Gas and by Electric Light, which appeared in our columns at the end of last year, have been recently reprinted in our contemporary. These, as was natural, were criticised in a succeeding number. The criticism exhibited a remarkable departure from the usual fairness of our gas contemporary, and contained several misrepresentations, which we did not think worth noticing at the time. Finding, however, a repetition of these perversions in the last issue of the *Journal of Gas Lighting*, we are compelled to put our contemporary right on one or two points. "Exception may be taken," it was remarked in "Electric Lighting Memoranda" of February 27th, "that there are in nightly use in all parts of the world, thousands of economical high-power gas-burners of patterns not included in the selection dealt with in this report." Thousands of burners, not thousands of varieties are, of course, meant. This we readily admit, and confess that we were surprised to find that Prof. Ayrton's students had not included, for example, any "Peebles," "Cromartie," "Christiania," or Heron's burners, but in the first set of tests, no less than twenty-six burners were examined, besides 30 and 80-c.p. Bray's, and Wenham, Albo-Carbon, Argand, and Welsbach. In the summary of results, twenty-seven burners were included, and in the table of the cost of a candle-hour, twenty-eight sets were given. Of these we selected the first twenty-two, "omitting the last six burners, which are of large candle-power and high efficiency." These were Bray 30 c.p. and 80 c.p., London Argand, Wenham, Albo-Carbon, and Welsbach. On the *average* of these twenty-two the whole of our comparison was founded.

We intended to compare ordinary gas burners with ordinary electric light. Had we included arc lamps, of course, gas would have been nowhere, light for light. In our issue of December 8th, p. 143, a table was given showing graphically the comparative cost of lighting by means of lines of different lengths. We gave three lines for gas burners, these were the worst, the average of twenty-two, and the Argand. After these three we gave nine lines for glow lamps under different conditions. The first of these was an 8-c.p. lamp at 4 watts per candle, and at 6d. per unit. Now everybody knows that several of the London supply companies charge 8d. per unit, and at Eastbourne and Hastings and elsewhere this is exceeded; further, the general custom, before the expiry of the lamp patent, was to run lamps at nearer 5 watts per candle than 4, and that competition in price, light for light, with gas at 2s. 6d. is then out of the question. We began with the case to which we have alluded, and this gave practically the same cost as the worst gas burner. The general comparison was, of course, with the average of twenty-two burners, and we showed that, contrary to the enthusiastic estimates of many electricians, real competition in price does not begin until we run 16-c.p. lamps at 3 watts per candle, with supply at 4d. per unit, or at 2½ watts per candle at 5d. per unit. The last line on our diagram referred to a 16-c.p. lamp at 2½ watts per candle with supply at 4d. per unit. The cost under these conditions is more than 16 per cent. less than gas at 2s. 6d. consumed at the average rate of these twenty-two burners.

Our contemporary accuses us of starting "with an utterly unfair and unpractical datum, consisting of the calculated cost of gas-lighting by a No. 1 flat-flame burner." We did nothing of the sort. Throughout the article, we referred solely to the average of 22 as our datum. "This old trick," says our contemporary, "of rating gas light at the worst effect which can be forced upon it by carefully selecting the most unsuitable burner that offers itself for the purpose, and comparing the result with such an ideal of electric lighting as that imagined in the purely supposititious combination of a 2½-watt lamp with current at 4d. per unit, has surely been played often enough. . . . It might be asked why, if the articles in question were so vitiated by having a false conclusion forced upon them, we reproduced them in these columns. The answer is that if we were to ignore these exercises of the electrician we should lie under suspicion of being afraid of what they say. It is policy to give them all the publicity they crave; and then, if their utterances prove worthless, their discredit is all the greater." This and more abuse is offered, but the above is enough. How did we deal with the 2½-watt lamp? We wrote that "we are now hoping to find a 2½-watt lamp." This is a different thing from saying that we had found one, and still more different from taking it as a basis of comparison. But lest this should be thought ambiguous, we distinctly wrote, "we must for the present discard the 2·5 watts per candle. It is true that we have promises, and, indeed, offers of such lamps, and a guarantee of one at 2s., but we have no experience as to their life." This is sufficient to turn the tables completely against our critics, and we cast their own words at them, for "if their utterances prove worthless, their discredit is all the greater."

We made the comparison with the full knowledge that it is only under exceptional circumstances that glow lamps can compete with ordinary gas burners, and knowing the uncertainty of the life of lamps, and that we were considering examples of three watts per candle, we put the lamp renewals as high as 6s. per 1,460 hours. This is equivalent to 486 hours for a 2s. lamp, 365 hours for a 1s. 6d. lamp, or 243 hours for a 1s. lamp. We took no account of the incidental economies of electric lighting, and stated the case as impartially as possible. Of the nine examples of glow lamps used under different circumstance, only two came out at a lower cost than that of the average of 22 gas burners, and one of these is to be discarded for the present, as we clearly stated, because it is run at 2½ watts per candle. The *Journal of Gas Lighting* is generally fair, but on this occasion either gross carelessness or something worse—something, however, perhaps, not quite so bad as that of which we are accused—has led it into a flagrant example of "cooking by gas."

We are glad to record that our present issue has been edited under the genial beams of the electric light. We have waited long and patiently for it.

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Technical Education.—Lord Norton has given notice that on an early day he will move for a return of the various modes in which the Technical Education grant is being administered by County Councils receiving a share of it.

Cable Interruptions:

	Date of Interruption.
Cayenne-Paramaribo	Oct. 15th, 1893.
Bissao-Bolama	Nov. 24th „
Garachico-Santa Cruz de Palma	Dec. 27th „

Leeds Association of Engineers.—At the last monthly meeting of the Leeds Association of Engineers a Paper was read by Mr. C. J. Hall on "The Generation and Distribution of Electricity." Mr. Hall reviewed the various systems of electric distribution of power which have come into use.

Prize Competition for Electric Light Schemes.—The 100-guinea premium offered by the Corporation of the small Yorkshire town of Morley for the best scheme of Municipal Electric Lighting Works for the borough has been awarded to Mr. Robert Hammond, who competed under the pseudonym of "Lux et Felicitas."

The Telegraph in British North Borneo.—The Eastern Extension Telegraph Company have just agreed to connect Borneo with Labuan by a branch cable, and the Directors of the British North Borneo Company have decided to connect Sandakan, the capital of their territory, by telegraph and road across country, a distance of over 200 miles. The work will be completed within a few months.

Telephony between Berlin and Trieste.—Some experiments have been made on a line formed by coupling to one another the Trieste-Vienna-Prague-Reichenberg-Zittau-Berlin lines, a total distance of some 600 miles, when it was found that although a melody was easily transmitted, speech was not very distinct. The experiments are considered to be so promising as to raise afresh the question of the desirability of telephonic communication over this route.

The Electric Lighting of the Embankment.—The Highways Committee of the London County Council at the meeting on Wednesday, again brought up a recommendation for the lighting of the Embankment by lamps in the centre of the carriage way.—Mr. Roberts moved, and Mr. J. W. Benn, M.P., seconded, that, in the opinion of the Council, it was undesirable to place lamps in the centre of the carriage way. —After some discussion a vote was taken and the amendment carried.

Electric Lighting at Windermere.—At Troutbeck Bridge, between Windermere and Ambleside, a small electric light works has been established. A turbine, 6ft. 6in. in diameter, has been erected, supplanting an old and cumbrous 35ft. water-wheel. This furnishes the motive power for the dynamos, and there is provision for the water power being supplemented, or on occasion superseded for the time being, by steam power in the event of a temporary failure in the water supply. Last week a connection was completed between the works and the Low Wood Hotel.

"Elektron."—This is the title of a new monthly magazine hailing from Boston, and "devoted to electricity and its allied interests in their scientific and practical aspects." The first number is, for the most part, made up of short articles written in a more or less popular style, amongst which we may mention an article on "The Electro-Magnetic Theory of Light," by Prof. Dolbear; "The Buoy-Lighting of the Water-way to the World's Fair," by Commander J. J. Brice; and a reprint of Prof. Silvanus Thompson's review of the Chicago Congress, which originally appeared in these columns.

Railway Shunting by Electricity.—At the new textile machinery works of Messrs. Tweedale and Smalley, Castleton, near Rochdale, electric shunting on their railway siding and electric hoisting have been adopted. The raw goods, says *Industries and Iron*, are backed into the siding by the railway engines, and are then taken wherever required by an electric locomotive, worked on the overhead-wire system. The packing-room is provided with an electrical crane for hoisting the machinery either into railway trucks or on to waggons. The electrical energy is generated by a dynamo situated in the main engine-room, and driven from the works engine, which is of the horizontal tandem compound type.

Addition by the Slide Rule.—For those whose powers of mental calculation have become atrophied in consequence of the use of the slide rule, the following hint may be of use. Consider the following equations $a:b=1:x$ and therefore $a:a+b=1:1+x$. In these equations lies the method of adding two numbers by the slide rule. The first proceeding is to set the slider with its unit on the a of the scale; then b on the scale is opposite x on the slider. Add 1 to x mentally, and read opposite $(x+1)$ on the slider the value of $(a+b)$ on the scale. The method is equally applicable to subtraction, and the principle is easily grasped and extended. We are indebted to Prof. Ritter for the idea. We have tried this method, and find that it "works," but we fail to appreciate its utility.

Northern Society of Electrical Engineers.—The discussion which followed the reading of Messrs. Rider's and Clirehugh's Papers, abstracts of which will be found in another column, was adjourned to the next general meeting, to be held on Monday, April 9th, and was taken part in by the following gentlemen:—Messrs. Wordingham, A. B. Mountain, W. Fox-Bourne, J. Connolly, E. W. Cowan, L. Andrew, and R. Taylor. The following new members were elected:—Geo. Broughall (Manchester Edison-Swan Company), T. B. C. Nuttall (Siemens Brothers), A. Oughterson (W. T. Glover and Co.), F. A. Pocklington (Callender's Bitumen, Telegraph and Waterproof Company), R. P. Wilson (Wilson and Clirehugh). It has been arranged to hold a second smoking concert on Monday, April 2nd.

The Telegraph and the Late Australian Banking Crisis.—Speaking at a meeting of the Bankers' Institute on Wednesday night, Mr. Nathaniel Cork, in the course of a Paper read by him on "The Late Australian Banking Crisis," said: "An essential element to reconstruction (of the banks) was rapidity. But for the cable these reconstructions would not have been possible. Every scheme, balance-sheet, and circular had to be cabled, with all the directions as to meetings. They were not mere ordinary balance-sheets which were thus wired, as the Official Receiver required an analysis of each item. These were the only documents the Courts had to guide them, and it was not unusual for £400 or £500 to be spent on a telegram. One large bank which closed on May 16th was thus enabled to re-open at both ends of the world with its numerous branches on June 19th—in the same time as the mail brought the news of the stoppage."

The Telegraphists' School of Science.—The seventeenth annual distribution of prizes and certificates gained by the students of the Telegraphists' School of Science took place on Tuesday afternoon in the Postmaster-General's deputation room. The chair was occupied by Mr. H. C. Fischer, who was supported by Mr. J. C. Lamb, C.M.G., Mr. J. Ardron, Mr. T. Barlow, Mr. J. Slingo, the principal, and several other officials. The report showed that the students of this school obtained as many successes in the telegraphy examination as all the other schools in the kingdom put together. The City and Guilds Technical Institute conduct this examination and offer two silver and three bronze medals, accompanied by valuable prizes, for the students throughout the kingdom. The two silver and one of the bronze medals were obtained by this school. The Chairman congratulated the meeting upon the success achieved, and pointed out that the work of the school contributed materially towards the present efficient and economical working of the Telegraph Department. The awards were then distributed by Mr. Lamb.

The Pacific Cable.—At the meeting of the Intercolonial Postal Conference, at Wellington, on Thursday last week, the debate was resumed on the motion submitted by Mr. J. G. Ward, the president, recommending the Governments of the various colonies to consider the desirability of entering into an agreement with the other countries concerned in the enterprise to guarantee the interest, at the rate of 4 per cent. per annum, on a capital of not more than £1,800,000, to any company undertaking to lay a Pacific cable, provided the tariff charge does not exceed 3s. per word for ordinary telegrams, 2s. per

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word for Government telegrams, and 1s. 6d. per word for Press telegrams to and from Great Britain and the colonies. The motion was discussed at great length and eventually adopted. Mr. A. Wynne, the Postmaster-General of Victoria, declared during the deliberations that his colony was satisfied with the present cables; but that, if the whole of the colonies and the Imperial Government agreed to pay their proportion of the guarantee, he would support the scheme. Mr. W. H. Wilson, Postmaster-General of Queensland, announced that he was in thorough accord with the motion, and that the Government of Queensland would do everything in its power to help the promoters to carry the project to a successful issue. Dr. J. A. Cockburn, the representative of South Australia, and the Postmaster-General of Western Australia announced that they were unable to vote on the question.

English Anticipations.—The *Electrical World* of February 24th opens with the following paragraph, headed as above:—"In an otherwise able and interesting Paper, descriptive of the electrical industry in the United States, Mr. Preece, of London, makes the following remark in referring to the World's Fair: 'The American public were surprised to find how much we had anticipated their work.' We would be interested to know who those Americans were who expressed surprise at the supposed English anticipations, and also what those alleged anticipations were. We can think of only one, and that is the holding of exhibitions, as there were doubtless exhibitions in London before Columbus arrived here, and we do not think the American Indians held any. Probably Mr. Preece's sweeping statement was based on a passing flattering remark made by some Anglomaniac to tickle the vanity of an Englishman." How many smart comments a little attention to context would prevent. Detached from its surroundings the remark quoted certainly has a characteristically sweeping ring about it, but taken as a complete dose the paragraph, of which the sentence in question forms a part, is quite harmless, though it may, perhaps, be thought somewhat of an anti-climax. "The American public were surprised to find how much we in England had anticipated their work. Morse's first message, 'What has God wrought?' was sent only in 1844. Our history commenced in 1837. Our jubilee was celebrated in 1887. Theirs is to be celebrated this year."

The Physics of the Alternate-Current Arc.—In a recent number of *Electricité*, M. G. Claude gives an account of some experiments he has made on the alternating electric arc. In one of his experiments M. Claude joins two points, between which there is an alternating difference of potential of 2,400 volts (frequency about 80 per second), by about 12 incandescent lamps (16 c.p., 100 volt), a condenser of 0·1 microfarad capacity, and a make-and-break key all placed in series. When the key is closed, the circuit is traversed by the charge and discharge currents of the condenser, the magnitude of which can easily be calculated, and which suffice to make the filaments of the incandescent lamps just glow. If now the key is opened so that there exists a small spark-gap in the circuit (about 1mm.), an arc will be struck at this point. Now this arc is certainly an additional resistance in the circuit, small it may be, since it is formed between metal points, but which certainly cannot be less than that which existed when the metal points were in contact. It is now found that the lamps show an increased brilliancy, and this brilliancy increases as the arc is made longer. This increase is such that, for the longest arc obtainable (a little over 1mm.), the difference in potential between the terminals of each lamp rises from 30 volts to 90 volts, while the difference of potential between the terminals of the key is found to be about 1,200 volts. The author gives the following explanation of this experiment:—The arc is a discontinuous phenomenon, and requires a certain minimum value to start, and thus, while the electromotive force is below this value, no current passes, and the condenser remains uncharged. When the limiting electromotive force is reached the arc is struck, and the condenser is charged suddenly at a high potential. This charging of the condenser is limited to a fraction of the complete period, so that the charge current lasts a shorter time, and is of greater intensity than when no arc exists in the circuit. The absorption of energy in the lamps being proportional to the square of the current, is increased, for the mean square of the current in the circuit is increased when the arc is present. The material forming the points between which the arc is struck, exerts an important influence on the facility with which the arc is maintained when the difference of potential diminishes, so that, although a much longer arc can be obtained by using carbon terminals, the above effect is not nearly so well marked as with terminals of iron or copper. It is, of course, necessary to have a condenser placed in the circuit to obtain the increased brilliancy of the lamps, for otherwise during the time the spark is unable to pass no current passes, while when the current does pass it has the same value it would have at the same part of the cycle if the spark gap were closed. On performing the experiment M. Claude finds that when there is no condenser in circuit the luminosity of the lamps is slightly reduced when the arc is formed.

Brighton.—At a Local Government Board inquiry held last week, with reference to the proposal of the Town Council to borrow £32,500 for purposes of electric lighting, the counsel for the Corporation gave a succinct history of the Hammond undertaking, which the Corporation has agreed to purchase for £5,000. The Company, he said, not without reason, claimed to be the pioneer of electric lighting in Brighton. It was in 1882 that Mr. Hammond commenced to supply electricity, and in the following year his works were made over to the Hammond Electric Light and Power Supply Company. In that year (1883) the Corporation obtained their Order, but did not begin a supply for some years. In October, 1885, the Company became the Brighton Electric Lighting Company. In 1888 the Company became the Brighton and Hove Electric Light Company. The Company had lighted the borough without statutory authority by means of overhead wires. In June 1888, the Company gave notice of intention to apply for an Order. An inquiry was held, at which it was urged for the Company that they were the pioneers of the light in the borough, and that the Corporation were not supplying the inhabitants. Eventually the Board of Trade refused the Company's application. In June, 1889, the Company again gave notice of intention to apply again for an Order. The Council shortly afterwards resolved to establish electric lighting works, and in 1890 the second application of the Company was refused. In March, 1890, the Corporation resolved to extend their area of supply. In June, 1890, the Company gave notice of a third application for an Order. In March, 1891, negotiations were opened between the Company and the Corporation for the purchase of the Company's undertaking by the Corporation. In June, 1891, the Company gave notice of a fourth application for an Order. In November, 1891, negotiations for the purchase of the goodwill of the Company's undertaking were renewed, and a provisional agreement was drawn up; the consideration money therein was stated to be £7,000. The Lighting Committee recommended the acceptance of that contract, but the Town Council declined to adopt the recommendation. The result of that was that another (the fifth) application was made in June, 1892, for an Order. In November, also, they gave notice of their intention to introduce into Parliament a Bill to authorise them to supply electricity in the borough, and it became obvious that the Corporation would be put to very considerable expense again. On December 1, 1892, the second extension of the Corporation area of supply took place. A large part of the borough, however, was still not touched by the Corporation and was being supplied by the Company. In March, 1893, a Board of Trade inquiry was held in regard to the Company's fifth application, and the Board of Trade again refused its sanction, and in May the Company abandoned its Bill. The amounts and dates upon which the Corporation loans have been applied for in connection with electric lighting are as follows:—July, 1890, £32,500; April, 1892, £8,500; April, 1893, £30,000; and June, 1893, £12,531; and £2,700; making a total of £86,231. In October the Receiver for the debenture holders approached the Corporation, endeavouring to negotiate the sale of the goodwill of the Company, which was finally disposed of for £5,000. The present loan of £32,500 was for this purpose, and the extending of the Corporation's area of supply so as to include the whole of the borough.

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MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(*Continued from page 410.*)

First Law of Thermodynamics.—Thermodynamics is the science of the relation between heat and mechanical energy. The simplest relation between these forms of energy is thus enunciated in the first law: Heat requires for its production, and produces by its disappearance, mechanical energy in the proportion of 772·55 foot-pounds for each British unit of heat. The idea which is fundamental to this law is that which is expressed by the doctrine of energy conservation; and the law by no means implies that from a single heat unit, derived from a hot body, it is possible to obtain 772·55 foot-pounds of useful work. For it is not possible.

Specific Heat of a Gas.—There are two quantities which represent the specific heat of a gas; according as the gas is heated at constant volume or at constant pressure. The former alone is the true specific heat, and represents the function of the heat which raises the temperature. The latter includes both the heat required to raise the temperature and that required to perform internal and external work in expanding the gas.

Elasticity of a Gas.—The elasticity of a gas is expressed as the ratio of any increment of the stress which limits its volume to the decrement of volume produced per unit of volume. If the decrease of volume takes place without any of the generated heat being allowed to pass from the mass of the gas, the elasticity is said to be adiabatic or isentropic. If the change of volume occurs under a condition of fixed temperature, the elasticity is called isothermal.

Adiabatic Elasticity.—During the adiabatic expansion or compression of a gas, the entropy of the gas is a constant quantity. Entropy is a thermodynamic function of great importance in the theory of heat engines; but we cannot discuss it fully in this short abstract. It may be defined as the ratio of the quantity of heat to the temperature, whenever a substance absorbs that quantity of heat from a hotter body under a condition of fixed temperature. In other words, the change of entropy during any isothermal change is equal to the ratio of the heat transference to the temperature at which it is transferred. In adiabatic compression the whole of the work done is stored as heat in the body; and during adiabatic expansion the whole of the work done is done by the intrinsic energy of the body.

Isothermal Elasticity.—During any isothermal change of state of a substance, heat will pass through the bounding walls in such amounts and in such a direction as will suffice to maintain a constant temperature in the substance. In a perfect gas the intrinsic energy of the substance is not altered by any isothermal change.

Cycle of Operations.—We now pass on to consider the relation between the heat supplied to a working substance and the mechanical work which that substance may perform in an engine. When a working substance changes its condition by virtue of some external action an *operation* is said to have been performed. When any series of operations results in the conditions of the working substance being in no respect different at the end of the series than they were at its commencement, then that series is called a *cycle of operations*. When the nature of the working substance and of the conditions under which it is worked are such that any given cycle of operations may be carried out in a stated order or in the reverse order, so that the cycle may be arrested at any point and carried on in the reverse direction for any portion of the complete cycle or for the whole of it, then that cycle is called a *reversible cycle* and the engine in which the working substance performs the cycle is called a *reversible engine*. A cycle which cannot be reversed is called an irreversible cycle; and any engine for which there is no reversible cycle is called an irreversible engine.

* Condensed from a forthcoming work to be published by *The Electrician* Printing and Publishing Company. All rights are reserved.

Efficiency of a Reversible Engine—It can easily be shown that a reversible engine has an efficiency which cannot be surpassed by any irreversible engine working under the same conditions of energy supply and exhaust. Every engine which is working as a mechanical motor is receiving energy from a source under definite conditions; and the surplus energy which it does not transform into mechanical energy of motion of machinery it rejects into the outlet or exhaust under definite and different conditions. Thus a water motor may take water at one level and reject it at a lower level; or a steam engine may take steam at one temperature and reject it at a lower temperature. Now, if there are two engines working between the same source and the same exhaust, the one of these being a reversible engine and the other not reversible, then the efficiency of the irreversible engine cannot possibly exceed, and will in practice be less than the efficiency of the reversible engine. For if not, we may employ the hypothetically more efficient irreversible engine to drive the reversible engine backwards, whereupon we should derive an amount of mechanical work, W, from an amount of energy, e, by the action of the irreversible engine, and should obtain from the same amount of mechanical work, W, expended on the reversible engine, an amount of energy, E, greater than e. This would result in the creation of $(E - e)$ units of energy. Consequently, we may say that the irreversible engine cannot derive from any given energy source and exhaust any higher efficiency than could be derived from that same set of conditions by a reversible engine.

Possible and Impossible Economies.—But the efficiency of a reversible engine is not necessarily 100 per cent., and it is very often necessarily very much below 100 per cent. It is the custom to call a reversible engine a *perfect* engine; but the phrase is only to be interpreted in the sense that such an engine perfectly utilises all the energy which is represented by the difference between the energy supplied and the energy sent into the exhaust. In a reversible engine all the energy is under perfect control, and the available portion of that energy is completely utilised for the purpose of the engine. The efficiency of a reversible engine under any given condition of working is, therefore, the *theoretical limit of efficiency* of all engines working under the same condition. Unless the conditions of the energy source and exhaust are altered, either separately or together, no engine can be improved so as to effect any economy beyond the economy represented by that of the reversible engine. Possible economies are those which are represented by the difference between the actual working efficiency of any engine and the theoretical limit determined by reversible conditions. Impossible economies are those which lie beyond the perfection of the reversible engine; but these are impossible only in respect to any given conditions of the source and exhaust, and become possible when it is possible to alter the conditions of the source and exhaust. In engines of some types, notably heat engines, it is theoretically impossible to alter the conditions of the exhaust beyond certain restricted limits; so that in these engines some economies are absolutely impossible.

Unimportance of the Working Substance.—In a reversible cycle the nature of the working substance has absolutely no importance in relation to the efficiency. For if it were possible to employ two reversible engines, having different efficiencies by virtue of their having different working substances, then we might place them both between the same energy source and exhaust; and we should, by causing the more efficient to run the less efficient in the reverse cycle, cause a continual creation of energy in the energy source.

The Limiting Efficiency of a Heat Engine.—It can be shown that the limiting efficiency of any heat engine, working between a temperature, θ_2, of the source and a temperature, θ_1, of the exhaust, cannot possibly exceed but will always be equal to

$$\eta = \frac{\theta_2 - \theta_1}{\theta_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (67)$$

Consequently, the higher the temperature of the source, or the lower the temperature of the exhaust, the greater will be the

possible limit of efficiency of the engine. No known heat engine has a working efficiency as high as its highest possible limit, and for reasons which will afterwards be made clear.

Second Law of Thermodynamics.—At the same time the temperature of the exhaust cannot, advantageously, be lowered below the temperature of the coldest of the objects which surround the engine. This, the substance of the second law of thermodynamics, is usually expressed in the following terms: It is impossible, by means of inanimate material agency to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of surrounding objects. Thus, if the coldest object near a heat engine is at 60°F. it will be no advantage to allow the working substance to become cooler than 60°F. in the engine. There is no such theoretical restriction of the temperature of the source, as to the point to which it may be raised. Practically, however, there *are* limits, for the operation of raising the temperature of the source may be costly, involving increased cost of plant and a higher rate of wear and tear, and possibly incidental losses of energy, which more than compensate the increased efficiency of the engine. Thus, by supplying a steam engine with steam at a higher temperature, we shall always raise the limiting thermodynamic efficiency of the engine, but the increased losses in the boiler and furnace, due to increased radiation, leakage, &c., may put a limit to the commercial value of the practice. In general, however, those types of heat engine which derive heat from a high temperature have greater possibilities of efficiency than those types which derive their heat from a lower temperature.

Thermodynamic Scale of Temperature.—If we consider equation (67) we see that the mechanical work which will be done by a quantity of heat, H, derived from any heat source at a temperature, θ_2, when working in a perfectly reversible engine, is proportional to the range in working temperature as measured by the expansibility of a perfect gas. If, therefore, the reversible engine could be worked without artificial cooling down to the temperature at which a perfect gas has no pressure nor volume, the whole of the heat, H, would be expended in mechanical work, and 100 per cent. efficiency would be attained. Moreover, equal amounts of work would be done during equal falls of temperature, throughout the entire range of the scale of temperatures. We are therefore led to see that the volumetric scale of temperatures given by a perfect gas is identical with a thermodynamic scale of temperatures, in which equal degrees of temperature represent equal amounts of work done in a reversible engine. Now, it has been shown by Joule and others that air, at ordinary temperatures, expands without doing internal work; or, in other words, that air in this condition behaves sensibly as a perfect gas. Consequently, the scale of temperatures as fixed by equal amounts of expansion of air in an air thermometer, within ordinary ranges of temperature, is identical with the absolute thermodynamic scale of temperatures; and the absolute zeros of these two scales are sensibly the same. Now, the absolute zero of heat of a reversible heat engine is independent of the nature of the working substance. Therefore the absolute zero of temperature is identical for all substances, and is identical with the temperature of zero volume as fixed by the perfect gas or air thermometer. Its value is, approximately, -460°F.

Availability and Heat Transference.—As a consequence of the foregoing thermodynamic considerations, we see that although the mechanical equivalent of a given amount of heat, H, is a fixed and unalterable quantity, yet the amount of mechanical work which that heat will do when supplied to a heat-engine is by no means so unalterable. For example, assuming the lowest working temperature to be $60+460$ absolute degrees Fah., let us suppose that we have a working substance into which we put 100 units of heat, and thereby raise its temperature to just twice its former absolute value, namely to $580+460$ absolute degrees Fah. Then, we may possibly obtain an efficiency of 50 per cent. in the heat-engine, utilising 50 of the heat units, and necessarily wasting the other 50 heat units. But, if we had supplied the 100 heat units to, say, twice as much working substance, we should evidently not have raised this substance to so high a temperature. Let us suppose that we should thereby have raised it to $320+460$ absolute degrees Fah., then the possible efficiency would be only 33·3 per cent.; so that 66·6 heat units will now be wasted, instead of only 50 as in the former case. We may advantageously carry the idea a little further. Let us suppose that the 100 units of heat were originally supplied to a small quantity of working substance, so that a very high temperature was produced; but that, in some way or other, the heat suddenly became distributed over a greater amount of working substance, through the contact of the hot body with a large mass of much colder working material. No heat would necessarily be lost by the mere re-distribution of the heat throughout a larger mass, so that there would still be the 100 units in the working substance. But owing to the fall in temperature which would abruptly occur, on account of the contact of the colder mass, the availability of the 100 units would become seriously impaired. For example, we may have 100 heat units in a furnace at a very high temperature indeed, and, as a consequence, we may have a high degree of availability. But if we pass the whole of the 100 units of heat through a boiler plate into a mass of relatively cold water, and spread the heat over a large mass of water at a lower temperature than that of the furnace, we shall find that a much lower figure will represent the availability of those 100 units for useful mechanical work. Wherever, then, a heated working substance becomes cooled by the transference of the whole or a portion of its heat to a relatively colder portion of working substance, a sudden and irrecoverable fall in the availability of the heat will take place. Consequently, wherever, in a heat engine, the heat is made to pass from a hotter to a colder body, this degradation of the availability of the heat will occur. It is the *bête noir* of every heat engine.

(*To be continued.*)

THE SCARBOROUGH ELECTRIC SUPPLY STATION.

In the year 1891 the Corporation of Scarborough obtained a Provisional Order, enabling them to supply electricity throughout the borough. The Corporation, however, ultimately determined to transfer to other parties their powers and duties under this order. The Scarborough Electric Supply Company was consequently formed. The terms of agreement comprise power for the Corporation to purchase the undertaking at the end of 21 years, 32 years, or any subsequently completed period of five years. If the Corporation exercise their option of purchase at the end of 21 years, they are to pay the value of the undertaking as a current going concern. If the option be exercised by them at the expiration of 32 years, or any later period, they are to pay for the undertaking according to the terms specified in the Electric Lighting Acts at the end of 42 years. It is further agreed that the maximum price of electricity for private consumers be 7d. per Board of Trade unit, and for street lighting 6d. per unit. The price is to be reduced according to a specified sliding-scale, which, however, does not come into effect until a cumulative dividend, at the rate of 8 per cent. per annum, has been paid to the shareholders.

The Company having been formed with a nominal capital of £50,000, of which £24,200 is now subscribed, a site for the generating station in the western outskirts of the borough, within about 100 yards of a railway-siding for coal, was purchased.

The ground comprises about two acres, about one half of which has been converted into a condensing pond. The existing buildings cover a space of a little over 60ft. by 70ft., so that there is ample room for all the extensions that are likely to be required for many years to come. The condensing pond is about one acre in extent, with an average depth, when full, of about 4ft., and is calculated to be of sufficient size for condensing all the steam required for supplying 50,000 8-c.p. lamps. The chimney is 130ft. in height, and being 7ft. internal diameter at the base, is calculated to be of sufficient size for extensions of the plant up to 1,000 kilowatts. The engine-room is a handsome and lofty apartment, 60ft. by 34ft.,

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lined with glazed bricks, with a travelling-crane running over its entire length. It is shown in elevation in Fig. 1, and in plan in Fig. 2.

The generating plant, the whole of which has been supplied by Messrs. C. A. Parsons and Co., Newcastle-on-Tyne, at present consist of two Parsons condensing steam turbine alternators, each capable of an output of 150 kilowatts. Each engine is entirely independent of the other, and consists of a compound steam turbine, arranged for expansion from the 130lb. per square inch boiler pressure, down to a condenser pressure of ½lb. absolute, or a range of about 250-fold expansion. The turbine revolves at 4,800 revolutions per minute, and is coupled direct to a two-pole alternator, giving 75 amperes at 2,000 volts, with a periodicity of 80 complete alternations per second. To the same spindle is coupled the exciter. The whole is entirely self-contained, and stands in a galvanised iron drip-pan on rubber blocks, without any holding-down bolts. An automatic variable cut-off valve gear and governor, electrically controlled, maintains a constant pressure on the terminals, and enables the full range of expansion to be maintained at light loads, thus securing good economy of fuel on the all-day load. One of the two machines actually at Scarborough was tested as to steam consumption in March last by Prof. Alex. B. W. Kennedy, and from the diagram that accompanies his report it appears that while the steam consumed at full load was slightly less than 20lb. per e.h.p., at ¾ load it was only 21lb., at ½ load 23lb., and at ¼ load 29lb. per e.h.p.*

The turbine alternators stand upon a solid bed consisting of stone walls filled in with rubble and cemented over the top, which runs the whole length of the engine room, occupying a middle position between the two side walls. As already mentioned, there are at present only two machines, but the engine room itself and the bed have been constructed of sufficient size for five additional machines. There is ample room for these to be of larger size than the present 150 kilowatt type, so that there is space in the engine room for plant to the total output of 1,500 kilowatts, or, say, 2,000 e.h.p., without overcrowding.

The steam condensers are of the jet description, but differ somewhat from the usual type. A separate water pump is placed below the condenser, no injection water proper being admitted to the air pump, which is placed above. By this arrangement it is sought to produce a better vacuum than is usual with jet condensers, and at the same time the power required to work the pumps is considerably reduced. The condenser pumps, of which there are at present two, one for each turbine alternator, are contained in separate wells sunk in the ground, and are worked from the crossheads of two small tandem compound auxiliary vertical engines with cylinders 4½in. and 7in. diameter, and 8in. stroke, supported on girders so as to stand in the engine room above.

The main steam pipes, which are of cast iron with bends and closing length of solid drawn copper, are arranged on the ring system, and are fitted with valves, so that any section can be shut off for repairs without interfering with the running of the plant. It is difficult to see why so brittle and unreliable a material as cast-iron was selected for the steam pipes. Strength can, of course, to a certain extent be obtained by casting thick pipes with very great care; but the unreliability of the material is increased rather than decreased by a greater thickness of casting. The engine-room floor being raised there is a passage way underneath it on each side of the engine bed, and all pipes are taken along this passage with the advantage of keeping the engine room cool. Two Worthington pumps with case-hardened valve gear and gun metal water bodies supply feed water to the boilers, and the exhaust from these pumps is utilised in a Berryman feed water heater for heating the feed water before it passes to the boilers. The exhaust steam from the condenser engines can be similarly utilised or can be turned into the condensers at will. The exhaust pipes from the turbine alternators are also so arranged that either turbine can be worked with either condenser, or can exhaust into the atmosphere. The water for condensing as well as the feed water is drawn from the cooling pond already alluded to.

The first bay of the boiler house, at present erected, is designed to contain three Lancashire boilers. Only two have, however, so far, been put in place, and are each 28ft. long by 7ft. 6in. diameter. They have flues 3ft. in diameter and are fitted with three cross tubes in each flue. The working pressure is 140lb. per square inch. When additional boilers are required it is intended to add further bays to the boiler house. Behind the existing boilers is placed a Sykes superheater for superheating the steam on its way to the turbines. The superheater is placed in the main flue with by-pass dampers, so that it can be put out of use when required, and with additional dampers for allowing the direct flame from the internal flues of the boilers to reach the superheater immediately, instead of after traversing the side boiler flues, this arrangement being found advantageous when working at light loads. The use of superheated steam produced in this manner is found to

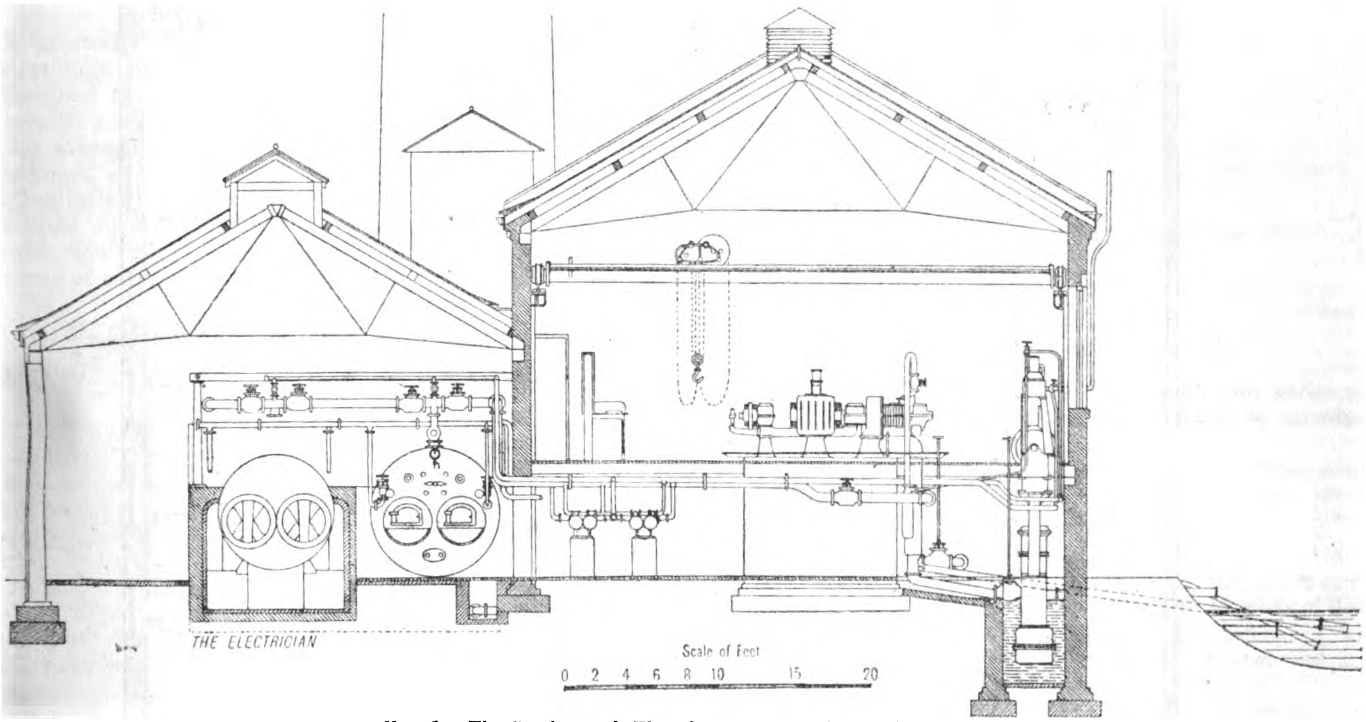

Fig. 1.—The Scarborough Electric Supply Station.—Elevation.

* See *The Electrician*, Vol. XXXI., pp. 303 and 315. *See also* Vol. XXX., pp. 25 and 34.

improve the economy of the turbines by about 10 per cent., and as in the Parsons turbines there is no internal lubrication or any packings to be burnt, the superheated steam has no deteriorating effect.

Along the entire side of the engine room opposite to the condenser engines, the switch board is arranged. Parallel running is not attempted, the exceptionally light load running of the turbine alternators rendering it of small value. The switch board is at present arranged for three alternators and four supply circuits, but is capable of being extended without alteration for dealing with seven alternators and twelve circuits. Each alternator has its own voltmeter, and each alternator and chief business quarters of the town the transformers are placed in sub-stations, consisting of cast iron boxes, with water-tight covers similar to the junction boxes, sunk beneath the foot pavement, as shown in Fig. 4. Each of these sub-stations is of sufficient to size contain a 50-h.p. transformer, but at present in most cases smaller transformers are in use.

The sub-station boxes are connected by two lines of cast-iron pipes, one being for the high-pressure and the other for the 100-volt low-pressure cables, and recesses in the sides of the sub-station boxes contain, in compartments with separate water-tight covers, the high and low-pressure fuses connected with each transformer.

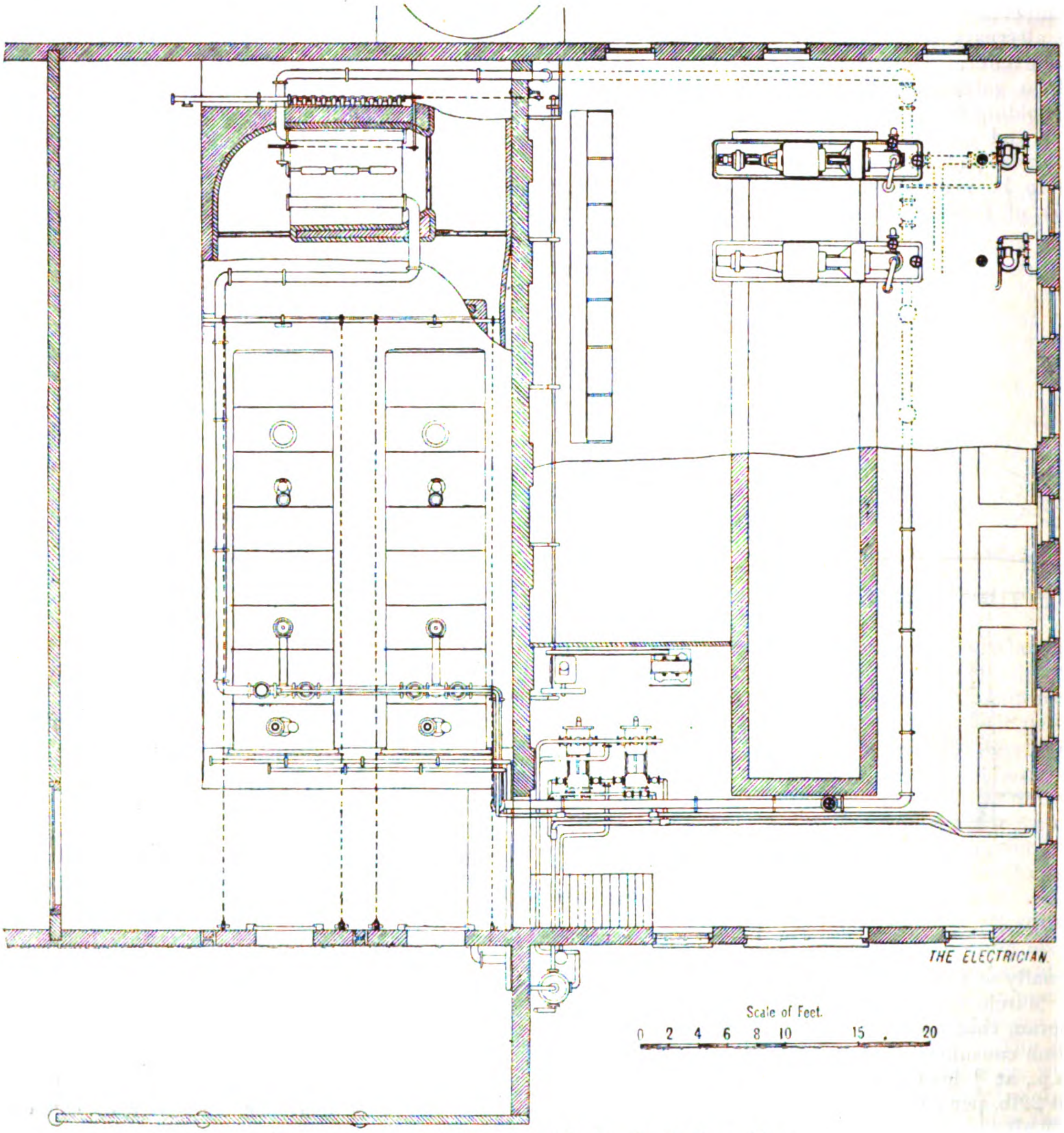

Fig. 2.—The Scarborough Electric Supply Station.—Plan.

each circuit its own ammeter. In addition, in circuit with each alternator is a recording Thomson wattmeter that measures the output in Board of Trade units. The switches are of the snap-over type, and so arranged that by their means any circuit can be thrown instantaneously from one alternator on to another without any cessation of the light.

The system of mains laid throughout the town consists of indiarubber covered cables drawn into cast iron pipes. The pipes near the station are 6in. internal diameter, in other portions of the town they are 4in. and 3in. diameter. The junction boxes are entirely of cast iron, the lids being screwed down and rendered water and air tight by means of indiarubber rings. A sectional elevation of a junction box is shown in Fig. 3. Connection to consumers is made by means of indiarubber-covered cables led through wrought iron pipes, the ends of which are screwed into the junction boxes. In the

All joints in the cast-iron pipes are run in with lead, and thus the whole system of pipes and boxes is made metallically continuous and water-tight. In order to keep the whole dry and free from gas, and also in order to provide against the mildew that is apt to attack the braiding of cables in confined and unventilated places, air is pumped into the pipes at the supply station at a pressure of about 2in. of water, by means of a small Root's blower worked by a small auxiliary steam engine, which also supplies power to work the automatic scrapers of the superheater. The Root's blower draws its air from outside the engine house, the air on its way to the blower being deprived of its natural moisture by being caused to pass backwards and forwards over a number of trays supplied with chloride of calcium. The air is allowed to escape at the extreme ends of the system of pipes, and thus a continuous forced ventilation of dry air is ensured.

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The cables, which are of Silvertown manufacture, are insulated with vulcanised indiarubber, all the joints being vulcanised *in situ*. The high-pressure cables, which are mostly 7/16, are rated at 6,000 megohms per mile, the low-pressure cables being rated at 600 megohms per mile. All cables are specially extra-taped overall, in addition to being braided. Fowler-Waring concentric armoured cable is used for conveying high-pressure current to one consumer, whose house is in an isolated position at some distance from the town. As already mentioned, there are low-pressure mains fed from street transformers in the part of the town where the density of lighting

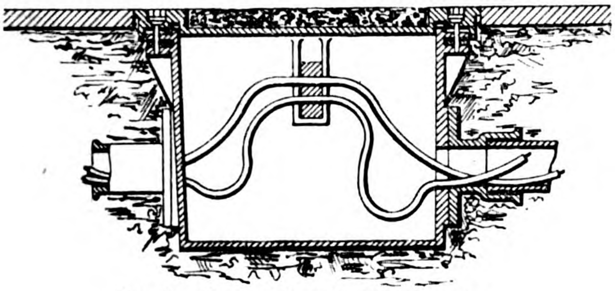

Fig. 3.—Section through Junction Box.

is greatest. Elsewhere the transformers are placed on the consumers' premises. The transformers have been specially designed to give a high all-day efficiency. The larger sizes give 90 per cent. efficiency at one-tenth load, which is about the average load on transformers in such a town as Scarborough, and even such a small size as a 4-h.p. transformer gives at low loads a very fair efficiency. This has been accomplished by reducing the all-day loss in the iron due to hysteresis and eddy currents to a minimum. The efficiency curve of one of the transformers is shown in Fig. 5. The small

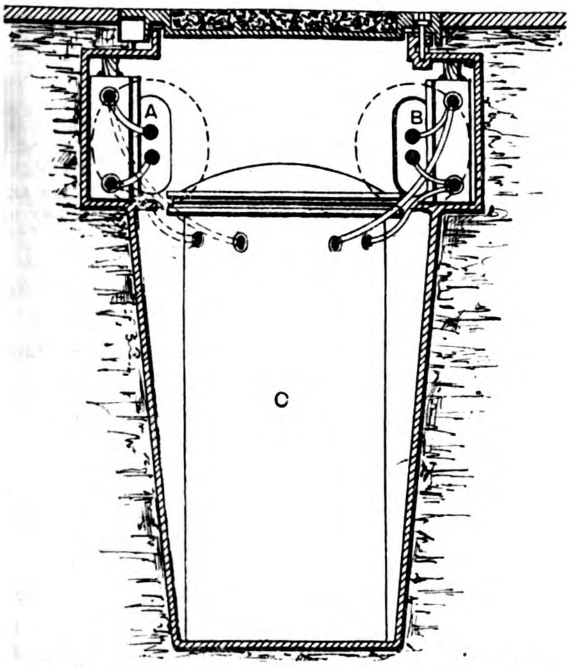

Fig. 4.—Section through Sub-station. A, High Pressure Mains and Fuses ; B, Low Pressure Mains and Fuses ; C, Transformer.

sizes are put in round cast-iron water-tight cases which are impervious to damp, the larger ones in square cases filled with oil. Before leaving the makers' works the transformers were all tested with an alternating pressure of 4,000 volts, or double the working pressure, for a considerable time. Each transformer is fitted with a Cardew earthing device. The consumers' meters are all of the Schallenberger type.

Altogether some $5\frac{1}{2}$ miles of cast-iron pipes have been laid for mains, containing about 18 miles of cable. At present 66 separate consumers are being supplied, and there are 12 substations and 38 transformers upon consumers' premises. The capital expenditure has been approximately as follows :—

Land for site of generating station and condensing pond...	£1,625
Buildings, chimney, and making of pond	3,341
Machinery (including boilers), engines, alternators, condensers, and equipment of station	7,934
Mains, including pipes, junction and sub-station boxes, cables and laying	5,445
Transformers, meters, electrical instruments, tools, and sundries	1,595
	£19,940

Regular working of the plant was commenced last September, and since December the supply has been continuous night and day. On September 1, 1893, the equivalent of only 468 8-c.p. lamps were connected to the mains, but by December 31st this number had increased to 4,114, by February, 1894, to 4,489, and by the end of March it is anticipated that nearly 6,000 lamps will be connected.

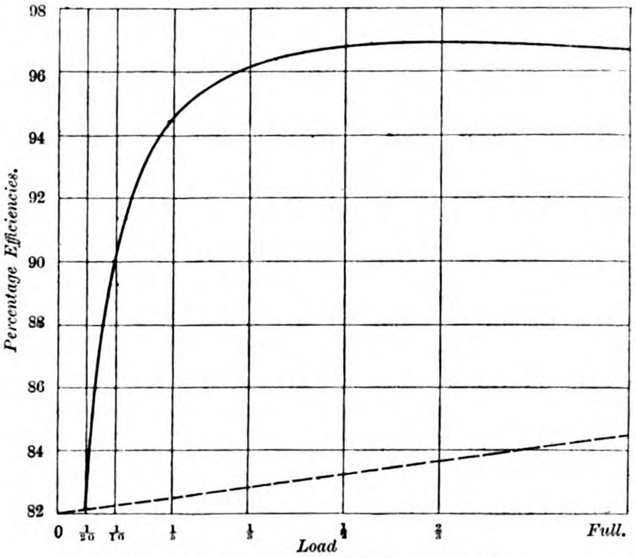

Fig. 5.—Transformer Efficiency Curve.

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Exceeding 800 units......	$5\frac{3}{4}$d.

Five per cent. discount is allowed for cash, and meter rent is charged at the rate of 2s. per quarter for any number of lights not exceeding the equivalent of 50 8-c.p. 35-watt lamps, with 6d. extra per quarter for every additional 25 such lamps or their equivalent connected.

The laying of the mains, &c., has been carried out under the superintendence of Mr. G. S. Peck, the resident engineer. Mr. Bernard Drake, the Corporation consulting engineer, has watched the interests of the Corporation. Mr. A. A. C. Swinton has throughout acted as consulting engineer and managing director for the Company.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, March 16th.

Institution of Electrical Engineers.

8 p.m. Students' Meeting at 28, Victoria-street. The following Paper will be read : "The Construction of Resistances," by D. K. Morris.

Royal Institution.

9 p.m. Evening Discourse: "The Scientific Work of Tyndall," by the Rt. Hon. Lord Rayleigh, F.R.S.

SATURDAY, March 17th.

Royal Institution.

3 p.m. Afternoon Lecture on "Light," with special reference to the Optical Discoveries of Newton, by the Rt. Hon. Lord Rayleigh, F.R.S.

TUESDAY, March 20th.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. The following Paper will be discussed : "The Prevention and Detection of Waste of Water," by Ernest Collins, M.Inst.C.E.

WEDNESDAY, March 21st.

Royal Meteorological Society.

8 p.m. Ordinary Meeting at 25, Great George-st.

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All letters intended for insertion in "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as evidence of good faith. No notice whatever will be taken of anonymous communications.*

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Alterations to existing Advertisements and copy for new Advertisements should reach the Publisher on Tuesday, but in any case not later than Wednesday mid-day.

ANONYMOUS JOURNALISM.

The practice of anonymity in journalism, is, we fancy, too deeply rooted, and its advantages too generally acknowledged for anything that may be said in disfavour of it to shake its established reputation, or to curtail its recognised power. That it is a power we readily admit; and Mr. WALKER, who writes on the subject in these pages to-day, will no doubt regard the admission as conceding the point which he raises, namely, that anonymity gives a fictitious or meretricious influence to unsigned writing. But he is mistaken, to begin with, in supposing that modern journalism derives its strength from anonymity. Does a novel fare any better for being published anonymously? Is a philosophical treatise or a theological disquisition more respectfully received when the author remains concealed? If the book is a good book the author's modesty commands public respect; and to that extent so, too, does the anonymity of individual journalists whose writings are of commanding excellence. The writer who wishes to face the public, standing in his own boots, seeks entrance into the magazines where signed articles are the rule. If, on the other hand, he enjoys the distinction of contributing, for example, to the *Quarterly Review*, he has to sink his individuality and, as Mr. WALKER would call it, hide himself behind a veil. The explanation is much simpler; and the result tells all against

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Mr. WALKER's theory. The one set of articles are a miscellaneous collection of isolated and often conflicting ideas; the other is a combination of intellectual forces directed towards a given object, or at all events consistently moving on one line. Mr. WALKER's assertion that a signed leader or leaderette would be as influential, or even more so, if it bore the author's name can only be sustained by asserting it of the older Reviews as compared with the modern Magazines; which would be absurd.

So much for what we deem to be Mr. WALKER's initial error. That we do honour to his good intentions will be evident from our giving them the publicity they deserve: but that we dissent from his conclusions is equally plain by the anonymous comments we are now making upon them. Here we can picture our esteemed correspondent—and not only him but many another reader who vaguely suspects the secret iniquities of anonymous journalism—exclaiming, "Why don't you put your name to it?" When the Governor of Tilbury Fort town proffered QUEEN ELIZABETH fifteen reasons for not firing a salute, and began with, "Your Majesty, we had no powder," the QUEEN cut him short with, "That's enough." We could give more than fifteen reasons for not putting a name to this or any other editorial matter in these pages. One will suffice: We have no name. The pen writes, and Mr. WALKER may identify the style of the nib if he think it worth while; but several hands direct it, to say nothing of heads. And this is at once the obligation and strength of anonymity in journalism. The picture of it as a coterie of individual items, each pursuing his own pet hobby, each indulging his own personal spite, each assuming the airs of an infallible judge, is wholly false to the reality. Some journals are, we understand, conducted on those lines, but they do not, and cannot, command any influence of the kind Mr. WALKER deprecates. If his contention is that the united and well-digested opinions of an editorial staff, put into readable shape by a competent writer, ought to carry no more weight than if it were the work of the printer's devil who takes it up to the compositors, it would ill become us to contradict him. All the same, it *does* carry more weight; and herein lies the reason and the justification for the editorial "we." It is not an individual, but a collective expression. One man, it is true, often writes an article from first word to last, with his own pen, and be he editor or no, not a single alteration may be made by another hand. None the less, if he understand his business, he sinks his personality, and the very use of this editorial "we" is valuable as a continual reminder to the writer that his private sentiments and opinions, his likes and dislikes, must be suppressed, and that the work in hand, be it only a five-line review of an insignificant *brochure*, is invested with a peculiar responsibility.

If we may do so without offence, we should like to illustrate our point from Mr. WALKER's own case. Very properly he writes under his own name. But the opinions to which he gives such strong expression would, we venture to suggest, have been far more effective without his signature; for it would then have been evident that the whole weight of editorial opinion was of his way of thinking. Of course, it would not be then identified with the real author's name; but this is where journalistic modesty comes in; journalism is bent on enlightening public opinion, and attains its end with a lamp of many candle-power rather than by a succession of penny dips. Not that we would class the enemies of anonymous journalism in this latter category; all that we mean is that they will make a greater shine when they have persuaded a number of other lights to cluster round them, and merged their personal identity in the object common to them all.

As to the general and too sweeping imputations contained in Mr. WALKER's article, we have little to say; for our conscience does not trouble us in respect of any of the counts in the indictment which he is at such pains to draw up. Anonymous letters very rarely appear in our columns, and when they do the reason is generally to be found in the contents, as for example in the grumblings which we have recently published about the remuneration of the subordinate members of the staff of supply companies. With regard to reviews of books, we occupy the somewhat unusual position of frequently adding the reviewer's name or initials when the work reviewed is an important one, our intention being, partly at least, to disclaim anonymity where the editorial functions, as such, have had no hand. For the minor reviews, requiring no assistance from an expert, they are subject to editorial censorship; and we are inclined to believe that elsewhere, as well as in this journal, there is no room for the personal bias on which Mr. WALKER so bitterly animadverts. Similarly, there is no room for the "tyro" whom he pictures as writing for technical journals under the cloak of anonymity. It is true that the professional journalist may remain unnamed to the end of his days; but to argue from this that he gets into the charmed circle on the easy terms, as Mr. WALKER seems to imagine, of not putting his name to what he writes, is at once a libel on the writer and an affront to the reader. Journalism, whether technical or political, cannot subsist on the work of amateurs, whose writing has "no face value;" and when a face value is there the owner's name would either give it a fictitious advantage or reduce it below its actual merits. If you want face value, surely you are more likely to get it by letting the face alone speak for itself. So, at least, thinks *The Electrician.*

ANONYMITY IN TECHNICAL JOURNALISM.

BY SYDNEY F. WALKER.

A French novelist has recently raised the question whether all articles, even in papers devoted to politics, should not be signed, as they are in France; and readers of technical literature can hardly help asking themselves whether it would be better for the advancement of science, and of engineering, if all articles and letters that appear in technical journals were signed with the true names of the writers. In the present writer's opinion it would, and for the following reasons:—

In the first place, he would ask: "What good reason can be given for concealing the name of the writer?"

If a man, or woman, has a message to deliver, as he or she presumably has if they write, should they not deliver it in the face of the world, not from behind a door?

If a man goes forth as a preacher, as a missionary, for no matter what cause, he does not preach from behind a screen, but from where all his hearers can see him. Often a preacher's own individuality does much to enforce the lesson he wishes to teach. And is not this equally true of science or engineering? If a professor lectures to an audience, whether it be upon some recent discovery, some old truth that is new to his present hearers, or on some point upon which he holds views at variance with previously accepted teachings, does he lecture from where he cannot be seen? Would it not be absurd for him to do so? Why, then, when his lecture is a written one, should his name be concealed? And does not the concealment take from the force of his message, just as a screen would if his lecture were delivered orally.

It may be said that a young writer would not be as well received if his name were disclosed as if he wrote anonymously, and, therefore, he should be allowed to write without signature. A little consideration will show that there is not much in this argument. A man's writings are read, in technical literature at least, for one of two reasons. Either because he is known to have something to say, the fruit of thought or experience, or because what he writes carries its face value.

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Now, if the writings of a tyro have no face value, surely there is no reason for him to write, nor any reason for concealing his identity. On the other hand, if what he writes commands attention, surely it would be best for him and for his readers that his name should appear.

Of course, where the concealment is transparent—as, say, when everyone knows that a certain man edits a certain paper, and writes a certain portion of that paper, the matter of his signature is almost one of indifference, but not always. Editors sometimes delegate their work to subordinates. They say, very properly, that they assume the responsibility of what is written for them, but unfortunately they cannot clothe the subordinate with their own style and their own thought and experience, so that the result is, an article or a leaderette given to readers as their own, which is not their own in any sense. Why not sign a leader or leaderette? Up again, it will be acknowledged, the writer presumes, that men do their best work over their own names. No man is so careful of his work when he believes that no one will know who has done it as he is when his name is attached to the work.

Taking the case of reviews of books also. If a review does its duty, it judges the book under review from the reader's standpoint. A reader is *supposed* to be, and would be, guided in the purchase of the book, if he had confidence in the review. The paper, in fact, appoints a judge for its readers, very much as an agricultural association appoints judges for its members and the visitors to its show.

This book, says the judge appointed by the paper, is well or badly written, is correct or the reverse, just as the judge appointed at a show may say, this fowl or this rose is well or badly formed, is of true breed or true type or not. Would it not be absurd for the committee of the agricultural or flower show to conceal the identity of their judges? Is it not equally absurd and equally destructive of confidence, to conceal the identity of the judge appointed to review a book?

It may be said that reviewers do their duty, and are more independent when they write anonymously. Unfortunately they do not always. In too many instances unsigned reviews of books consist merely of an extract from the preface, with a few remarks added. In too many others the anonymity of the reviewer is made the cover for a direct personal attack upon the author of the book, an attack that would not have been made if the reviewer had been obliged to sign his review. And this brings us to the real reason why many writers, especially those who write upon electrical subjects, prefer concealing their names, viz., that they may indulge in personalities and make unfounded assertions unchecked. Up there it is so easy to sit upon a high perch and call out sounding phrases when no one can see you. The writer who indulges in personalities does not add to the knowledge possessed by the world, nor bring a thought worth dwelling on, to the discussion of any problem, any more than a feathered parrot does. Like "Pretty Polly," he is amused at the sound of his own voice, at the annoyance he sometimes causes; and, like his feathered prototype, he is sublimely unconscious that he is degrading the God-like faculty of speech, or the noble art of writing. "Pretty Polly," of course, can hardly be expected to understand that time occupied in personalities is time wasted, doubly wasted. The time employed in writing an irrelevant attack would have been better employed in producing sound criticism, or original thought. The time employed in replying to the attack, if reply is made, is equally wasted.

Electrical engineers in particular should avoid anonymity. Even in the arena, when they stand face to face they are often unable to resist the temptation to give each other *one*. Is it not delightfully feminine? How much more, then, must they be tempted to do so when they are able to stab their adversary, even their friend, if a rival, and escape unseen.

An incidental result of writing letters over *noms de plume*—a practice the present writer is pleased to observe is dying out—is the absurdity presented when two writers holding diametrically opposite views adopt the same *nom de plume*, a by no means unusual occurrence.

The writer of this article trusts that his readers will think carefully over what he has written above. His object in writing as he has done is to raise the tone and status of electrical engineers, and particularly of writers upon electrical subjects.

NOTES ON DESIGNING A SYSTEM OF UNDERGROUND ELECTRIC LIGHT MAINS.*

BY JOHN H. RIDER.

The importance of a satisfactory system of underground mains in a scheme for town lighting may be estimated, when we consider that in generating the electricity we have only done half the work. We have still to convey it to the consumers, and in many cases this means to distribute it over a wide area. At whatever pressure we may generate, we are compelled by law to deliver to our customers at a low pressure. In the case of a general low-pressure system, this is done by means of a distributing network, fed at various points by feeder cables. When the generation is at high pressure we may use either a low-pressure distributing network, fed through transformers at various points, or we may place transformers on the consumer' premises, and so have practically no low-pressure network at all. The Board of Trade, however, will now only give its sanction for this latter course on the distinct understanding that when called upon to do so by them a low pressure distributing main will be laid down, and the house transformers removed. Therefore all arrangements using house-transformers can only be looked upon as of a temporary nature.

At the outset we should make a radical distinction between "distributing mains" and "feeders." Distributing mains are those from which the services to the houses are taken. It is therefore necessary to have them of such a cross-section that the fall in pressure from any feeding point to the farthest service on that section does not exceed, say, 2 per cent. when all the lamps are burning. In the case of an ordinary business street it will be found necessary to have the feeding points at not greater than about 250 yards apart in order to have the distributing mains of a reasonable size.

"Feeders" are mains going direct from the station to the various feeding points, and their use is to feed the distributing network through transformers or otherwise. While we may take more than one feeder to any feeding centre, yet in no case should we arrange any one feeder to supply more than one feeding centre. We should find it impossible to keep the voltage constant all over our distributing network if we did so. The pressure at the feeding centres must be kept constant by raising the pressure of the several feeders at the station, in proportion to the current flowing through them. As it is impossible to say that the demand for current will always be equal all over the network, it will be necessary to regulate each feeder independently of the others. On direct-current systems this means raising the pressure of the dynamos when the load comes on, and, when the feeders are supplied from omnibus bars, having a regulating resistance in each feeder. On alternating current systems the pressure of the machines need not be altered, as the necessary voltage may be added to the feeders by means of adjustable transformers in series with them.

The most satisfactory method of indicating at the station the voltage at the different feeding centres is to run back pilot wires from each, and to connect them to voltmeters on the switchboard. The attendant has then simply to regulate for constant volts, and the current in each feeder will take care of itself. In all cases the pilot wires should be connected to the low-pressure network, and not to the high-pressure side of the transformers, as has been done in some alternating current stations.

We may divide the many systems of laying mains into two chief classes, "drawn in" and "built in." By the former I mean those which are drawn into pipes or conduits, and by the latter those which are either laid direct in the ground, such as armoured cables, or run in solid with bitumen, &c., such as Callender's solid system. For low-pressure distributing mains the disadvantage of the "built-in" system of being unable to increase without reopening the streets need not be one at all, for if these mains be calculated with reasonable care for the requirements of the district they should rarely require enlarging. And if at some future time a greater demand comes at one point than the cables can carry, the simplest way is to run another feeder to that point, and to leave the low-pressure network as it was. This, of course, means that the feeders should be laid on a "drawn-in" system.

I venture to think that a combined system of "drawn in" for the feeders, and "built in" for the distributing mains, offers a number of advantages. The distributing mains should only require extending in order to light new streets, and opening the ground may be therefore allowed. But new feeders have in many cases to be taken through streets already lighted in order to reach the new districts, and so they should be "drawn in" to avoid opening the same streets a second time. Opening the streets is such a nuisance to everybody, besides being very expensive, that this point is well worth consideration.

Judging from recent experiences, a considerable difficulty in connection with a "drawn-in" system is the danger from gas

* Abstract of a Paper read before the Northern Society of Electrical Engineers, March 12, 1894.

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explosions. There can be little doubt that the gas comes from leaky or broken gas pipes in the vicinity of the conduit. It is useless to look to the gas companies to lay their mains so that leakage would become impossible. An unlooked-for subsidence of the soil may cause a drawn joint or a broken pipe, and it then only requires a spark to complete the mischief. A thorough ventilation of all electric pipes, conduits, and manholes, together with great care in the laying and subsequent inspection, seems the only way to minimise the risks. The perfect freedom of an armoured-cable system, laid direct in the ground, from such accidents, is without doubt a very strong point in their favour.

In most "drawn-in," and in some "built-in" systems, it is necessary to either make service boxes opposite the houses as the cables are laid, or else to build such boxes with iron pavement covers, when required. Both are expensive methods. But with an armoured cable we need make no preparation for future service connections. Each case is dealt with as it arises, and by the use of a small split junction box of cast iron, placed around the cable and afterwards filled up with insulating material, the joints can be well and cheaply made.

So far what has been said will apply with equal force to either continuous or alternating current systems. But alternating current mains require special precautions to be taken in their design, which need not be considered at all in the case of those for continuous currents. It is most essential that adjacent wires should be protected from induced currents, and the remedy that suggests itself is to entirely surround the alternating current conductors by a metallic sheathing, such as an iron or a lead covering. This, however, would only remove the disturbances from the neighbouring wires to the sheathing itself. It would not prevent them altogether, but may, in fact, increase them, and so cause a great waste of energy. To stop them it would become necessary to place both the flow and return conductors within the same pipe or sheathing, and if the system were a three-wire one, then all three wires must be so treated. A perfect cure is only obtained when the conductors are so placed with respect to the pipe or sheathing that their centres are practically co-incident. A concentric cable meets this condition, either when drawn into an iron pipe or when lead-covered and armoured. I believe many alternating current systems are working where this precaution is more or less disregarded, and the amount of power lost through waste currents is unknown. Considering that these losses are going on all the time the station is running, they must amount to a good deal in the course of a year, and in some cases may probably equal the magnetising current losses of the transformers.

It would appear that this question is either not understood, or else ignored, by many who have to design alternating-current mains. In a recent case it was specified by a well-known engineer that three separate lead-covered cables were to be used for a three-wire alternating system. In the scheme which I am at present carrying out, the actual arrangement for the low-tension mains was left open, so that every contractor might tender on his own lines, and for his own system. It was distinctly pointed out that alternating currents were to be used on the three-wire system, and yet out of twenty different offers no less than nine had entirely overlooked the question of induced currents. Some firms proposed to use separate lead-covered cables, drawn into cast-iron pipes. Others offered separate lead-covered and armoured cables, to be laid direct in the ground. Others, again, proposed to use two concentric armoured cables, the middle wire of the system being divided and placed half in each cable. Of course, when the loads on the two sides of the system were such that no current flowed in the middle wire, each cable would act just as a single-sheathed cable. These proposals came from firms of the highest standing in the cable trade, and would show that there are many persons who have not yet fully grasped the importance of preventing waste currents.

As I said before, the three conductors must be under exactly the same conditions, and within the same pipe or sheathing, to entirely do away with the difficulty, and a triple concentric armoured cable meets the case perfectly. But when a triple concentric cable is used as a distributing main, the question of service joints comes in, and it is not the easiest matter in the world to make a good branch joint on such a cable. Not only are the branches to be pieced in, but the cable itself must be left continuous. The low-tension cable we have adopted in Bolton is made by Messrs. Siemens Bros. and Co., and consists of three separately insulated conductors twisted up together into one cable, and then lead-sheathed and iron-armoured. The effect of the twisting is to make the three conductors have practically the same centre. The making of service joints is much simpler than with a triple concentric cable, as when the sheathings are cut through each conductor becomes accessible, and can be treated as desired.

With reference to a three-wire system, it is often stated that when the load is equal on each side, no current flows in the middle wire. But although this is often true it is not necessarily so, as it altogether depends whereon the particular main the lamps are taken off. Suppose we have a three-wire main going out from a station or supply centre, and that close to the station 100 lamps are taken off on one side. At 150 yards away let another 100 lamps be taken off, but from the other side. Then our meters in the station would show equal current in the two outer mains, and we might assume that none was flowing in the middle wire; but for 150 yards of its length it would be carrying a current equal to either of the outer cables. This, of course, is an exaggerated case; but it will show that it depends upon the positions, as well as upon the numbers of the lamps, how much current flows in the middle conductor.

A point of great interest in connection with an alternating current scheme is, that although the low-pressure distributing network may be laid on the three-wire system, yet it is only necessary to have two-wire feeders. The transformers must be made with three terminals on the secondary coils, and the primary current will then adjust itself to the mean of the loads on the two sides of the secondary. If the transformers be designed so that there is only a 2 per cent. total variation in pressure from no load to full load, then the difference in voltage on the two sides of the system can never be more than 1 per cent. even in the almost impossible event of full load being on one side, and none on the other. In such a case the primary would take a current equal to half full load. This is of great practical importance, as the station machinery and switchboards can be arranged for a simple two-wire system, while all the advantages of a three-wire distribution are retained.

At all the principal points of inter-connection in the distributing network, junction boxes should be placed, so arranged that the various sections may be easily connected or disconnected for the purposes of testing, repairs, &c. Soldered joints would be here out of the question, so the cable ends should be sweated into thimbles, which may be clamped together, or to properly arranged connecting bars, as desired. If the insulating material be other than rubber, then the boxes may be filled up with oil to keep out the damp. The oil could be pumped out in a few minutes, when it was necessary to make a disconnection.

A very important point in connection with an underground system of mains is the question of insulation resistance. A badly insulated joint has a wonderful effect in producing bad results, and is practically equal to a faulty place in the cable. Therefore all joints should be most carefully watched while making, and a guarantee obtained from the contractor, rather of an insulation resistance when the cables are laid complete, than when individual coils are tested in a tank of water. Conductors of bare copper should only be used for continuous currents of low tension. The liability of all such systems to stoppage from water flooding, and the large sizes of the conduits required, are points against their use. Their only recommendation appears to be in the question of prime cost.

VARIOUS SYSTEMS OF UNDERGROUND MAINS AND METHODS OF LAYING SAME.*

BY S. V. CLIREHUGH, ASSOC. M.INST.C.E.

The author commences by stating that whilst the questions of direct coupled or rope-driven dynamos and the advantages or disadvantages of water tube boilers as against Lancashire boilers, and vertical engines as against horizontal engines, have been much discussed, the question of the best system of mains has been left severely alone. Having detailed the various points which the author considers desirable in a system of underground mains, he proceeds to consider to what extent these can be combined in any one system, and what are the various materials available.

There are, broadly speaking, three systems to be considered:— 1. Insulated cables in conduits. 2. Armoured cables. 3. Bare copper in culverts.

One of the oldest systems was that of laying cast-iron pipes into which were drawn insulated cables, boxes being built at first about every 80 yards merely for the purpose of drawing in the cables and making straight joints. This plan, in the author's opinion, is very suitable for a district in which it is difficult to ascertain the probable demand and which is served by a high-tension alternating current. With regard to the question of insulating material, cables insulated with vulcanised india-rubber stand no doubt from a scientific point of view at the top. In some places the difficulty offered by being unable to keep a "vulcanizer," is serious as the men are highly paid and on a small station there is not of course sufficient to keep even one fully occupied. In such cases it is sometimes necessary to use mechanical jointers, *i.e.*, cast iron boxes which are placed over the joint bolted together and filled with a bituminous compound. This makes a

* Abstract of a Paper read before the Northern Society of Electrical Engineers, March 12, 1894.

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thoroughly good job but it is very difficult to break the joint should it for any reason become necessary. Another plan is to insulate the joints with pure rubber strip, and when there are sufficient number of them say 20 to 30 ready to be cured get the cable manufacturer to send a "vulcanizer" down for a week or so. A rough test as to whether a joint is properly cured is to try and mark the rubber when cool with the thumb nail, if it is just right it will yield to the thumb nail but leave no mark, if it leaves a mark it is undercured, and if it feels hard it is probably overcured. The only objections therefore to the use of cables insulated with indiarubber are practically its high price and the difficulties in jointing. The author specially warns engineers to be very chary of purchasing low priced rubber cables as it is almost impossible for anybody not an expert to tell whether the rubber is good or bad quality.

Bittite, the material used by the Callender Company, is believed to be bitumen refined to purity and vulcanised. The conductor is covered with a solid sheath of this material put on in one operation under pressure, and is served with a tape and covered with an insulating compound and again taped, then braided with a hemp yarn and passed through a bath of hot asphalte compound. Joints in the cables are insulated by wrapping the conductor with bittite which has been half vulcanised, up to the diameter of the original insulation, and then protecting it by a wrapping of compounded tapes. The joint is then heated by means of a lamp to make the wrappings solid and to complete vulcanisation. This system of jointing is very simple, and no particular training is required for the purpose.

Turning to cables of the second class, *i.e.*, the insulation of which is not in itself damp resisting, but which has to be protected by a metallic envelope, the author states that he feels some difficulty in expressing himself lest he should appear prejudiced, as he was for two years engineer to the British Insulated Wire Company, whose speciality is fibrous insulation applied in the form of a paper. The question is whether a fibrous cable will answer as well as a rubber cable. Decidedly yes, if we are prepared to treat it with sufficient care. Very frequently, however, fibrous cables get into the hands of jointers who have been given no special instructions, and they treat it as they have been accustomed to treat a cable insulated with indiarubber, with, of course, unsuccessful results. Fibrous cables are not so flexible as those insulated with indiarubber, but for nearly all practical purposes they are quite flexible enough.

The manufacture of lead-covered fibrous cables is fairly well known. The fibrous material, be it in the form of yarn or paper, is laid spirally round the cable, pressure being applied to solidify the mass as much as possible to the required thickness, the cable is then thoroughly dried out at a temperature of about 250°Fahr. for 30 to 40 hours to expel every possible trace of moisture, and it is then immersed in wax, resinous oils, or similar materials at a high temperature. From this tank, without any further contact with the air, it is passed through a lead press and so hermetically sealed. The great danger in these cables to guard against is the possibility of the formation of "pinholes" during the process of lead covering. These are produced by a variety of causes, but probably the most troublesome one is produced by impurities in the lead. These "pinholes" are very difficult to perceive during manufacture, but they are generally found by testing after prolonged immersion under water. It is very important in buying this class of cable to find out what insulation resistance the manufacturer recommends, and to see that all cables of the same class have approximately the same insulation resistance after one minute electrification and 24 hours immersion in water. The electrification being very marked in this form of cable, it is essential to see that this limit is adhered to.

The author states that he has found by experience that it is better not to insist upon too high an insulation resistance, but to insist on its being uniform. Cable manufacturers are a good deal bothered by having high insulation resistance specified. It can be produced if desired, but at the expense of the life of the cable caused by excessive drying out. The pressure test is a very useful one, and cables of this class should certainly be tested after immersion with at least double the pressure at which they are intended to work. The cables should again be tested for insulation resistance, and the result should be the same as before the pressure was applied.

Coming to the treatment of the cables after they are delivered in the streets the author assumes they are to be drawn into cast-iron pipes. Cables which are to be thus treated should be either taped or braided outside the lead, preferably the latter, to prevent any roughness in the pipe scoring the cable. If the cable is a heavy one, some lubrication is often desirable, and for this purpose there is nothing better than soft soap. In a straight run with a moderate-sized cable 80-100 yards may be drawn in in one length, great care being taken to avoid kinks or sharp bends. It will be noticed that the end of the cable is sealed up, and when this end is cut it must be resealed as soon as possible, as the insulation being very hygroscopic, the insulation resistance of the cable is quickly lowered if the end remain exposed too long to the atmosphere. A good temporary way of sealing the end of a cable is to lap it with dry cotton tape and plunge it into hot pitch.

Samples of fibrous cable joints in various stages of manufacture were shown by the author. Other things being equal, paper insulation has, the author thinks, an advantage from the fact of its cleanliness in jointing. The power of paper as a dielectric for resisting disruptive discharges is very high, and ¼in. radial thickness of insulation has been found sufficient to withstand a pressure of 20,000 volts.

The author then refers to Brook's oil insulation system, which he is of opinion might be suitable for feeders, but difficult to work on a system of distributing mains.

The principal object in the use of armoured cables is their supposed cheapness, which, however, is overrated. They may be of service in outlying districts, and possibly in some cases for feeders, but there are many drawbacks to their use, one of the principal ones being the difficulty of fault finding, as in any draw in system whenever the fault is arrived at within say 20 yards that length of cable can be drawn out and examined at leisure whereas with an armoured cable you have to open many yards of ground before you actually arrive at it.

Messrs. Crompton and Co. are the great exponents of bare copper in conduits. The culvert consists of a concrete trench laid under the footway. The culverts are constructed of cement concrete the wall in no case being less than 6in., and the bottom 4in. They are covered with York stone bedded in cement, and the culverts are rendered inside with cement thus making it thoroughly waterproof. Boxes are built every 15 yards along the trenches and these are the only places in which the cable is supported so that the insulators are always open for inspection. The insulators are mounted on oak crossbars (which are mounted on the concrete about 2in. off the bottom) and are made with a notch in the top on which the conductors rest. The culverts are connected where possible to the main drains. It might be thought that a film of moisture would collect on the insulators, thus giving rise to considerable leakage, the electrolytic action of the current however is said to be sufficient to resolve this moisture into its two component gases. We seem here to have a system which combines most of the desired qualities in a system of mains, however this has its drawback like all others. Firstly, in many of our great cities it is impossible to find room for this class of conduit, and then recourse is had to insulated cables. Secondly, a water main bursting might possibly cause a stoppage of the supply, this, however, is not very likely to happen. Thirdly, gas is apt to accumulate in the conduits, giving rise to explosions, it is however less likely to get into a water-tight conduit than into a system of iron pipes where there is no attempt made to keep out the water. Whether bare conductors are more likely to ignite the gas is a much debated question. Only recently two of the technical papers had an article on the subject, one said it is easy to see how the gas gets into the conduits, but what fires it; the other, however, wondered how the gas got in, but understood how once in, it was fired. The author is inclined to believe that most explosions occur from lighted matches, candles, &c., being introduced into the boxes. As regards the life of this culvert system, it seems that we have at least got hold of materials which have stood the test of time, viz.—oak, concrete, and copper.

ON PARALLEL WORKING, WITH SPECIAL REFERENCE TO LONG LINES.*

BY W. M. MORDEY.

In his reply at the end of the discussion on his Niagara Paper, Prof. Forbes alluded† to some experiments which he had witnessed, and which he considered showed that alternators of my design would not run properly in parallel. The passage is as follows:— "At the time when I recommended the Mordey machine I said that, before deciding to adopt it, tests must be made with a resistance between the dynamos in parallel. Does Mr. Mordey forget that, when he kindly placed at my disposal the means of making this test, by putting 'Sunbeam' lamps in series—that is to say, between the two dynamos working in parallel—the lamps went up and down in brightness with the periodicity of a few seconds, and that the tendency was to rise to maximum brilliancy, showing that the dynamos were rather working in series than in parallel? From the moment of those experiments, I felt that that type of machine was not suited for our purposes, though I never mentioned that until I was compelled to by Mr. Mordey's claims for his special mode of working." I heard his remarks with the utmost astonishment, as the experiments, rightly interpreted, appeared to afford the very strongest proof of the exceedingly powerful synchronising effort exerted by these machines, and because I then

* Paper read before the Institution of Electrical Engineers, March 8, 1894.

† *Journal*, XXII., 607.

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heard a contrary view expressed for the first time. And in another passage Prof. Forbes stated that they must have alternators at Niagara that will run without any synchronising or waste current.

The matter is of some moment, and demands an explanation. With your permission, I will make this explanation the text and starting point of a Paper on parallel working, and on the allied subject of the use of alternators as synchronous motors. The experiments were made in July, 1891, and were the subject of a leading article in *The Electrician* of July 16, 1891, and were mentioned in the *Electrical Review* and elsewhere, in each case as having afforded an illustration of the thoroughly satisfactory parallel working of alternators when directly coupled to high-speed engines—a matter with regard to which there was at that time some uncertainty. It had been supposed that some flexible or yielding coupling was necessary between the engine and alternator. For my own part, I never had any doubt on the subject; but in order to place the matter beyond dispute some tests were carried out by the Brush Electrical Engineering Company and Messrs. Willans and Robinson. The former provided two of my alternators, the latter fitted them to two Willans engines. Amongst others, Prof. Forbes received an invitation to witness the trial, and was present.

When all the tests of ordinary parallel working had been satisfactorily carried out—including shutting the steam off the engine driving one of the alternators, and then applying a brake to its flywheel in a vain attempt to force it out of step—a further test was made (as an interesting experiment bearing on the subject of synchronous motors) to ascertain what would occur if the two alternators were coupled together with a resistance between them so great that the resistance alone would be sufficient to absorb the whole power of one machine, even if the machine at the other end were at rest; and the remarkable fact was established that even under these conditions (which would be absolutely absurd or impossible in practice) the two machines did not break out of step.

The resistance used consisted of "Sunbeam" lamps, which happened to be the only suitable resistance available. These lamps, being made for 80 volts and about 5 amperes, would have a resistance, hot, of about 20 ohms each, and a much higher resistance when cold—probably more than 30 ohms. Seven of these lamps were placed in series between the alternators. There was no other external circuit. It was then found that there was a current passing through them which rose and fell with a slow pulsation; the alternators, although not actually breaking out of step, evidently getting a good deal out of true co-phasal synchronism, and only being pulled in when this slowly pulsating current rose to a considerable amount. Synchronism being regained, the current decreased again. This current was not measured, but was probably about 7 amperes, as the lamps were a good deal over-incandesced. The experiment was then discontinued.

Properly interpreted, this test appeared to show that, even when a line of an enormously high resistance was interposed between two alternators arranged to run in parallel (or one as generator, the other as synchronous motor), and when no adjustments were made to help them to keep together, the tendency to get out of step was corrected with a surprising amount of success; the correction, instead of being instantaneous and powerful, as with machines connected through a small resistance only, being sluggish, and greatly weakened by the effect of the very high resistance of the line. To show how utterly unfair and unjust Prof. Forbes's interpretation is, and to reassure those who may desire to use synchronous motors, it is only necessary briefly to examine the conditions of the test.

The two alternators used in the experiment were 37·5-kilowatt 2,000-volt machines. At full load each would therefore give nearly 20 amperes. Now, suppose it is desired to run one machine as a generator, driving the other as a synchronous motor (to take the illustration that may best suit the case of power transmission over a considerable distance), it will be seen that, if the line is to be designed to give such a percentage loss as is proposed for the Niagara-Buffalo transmission (that is, 3·5 per cent.),* the loss at full load should be 70 volts, and, the maximum current being, say, 20 amperes, *the line resistance should be 3·5 ohms*. In the actual experiment, the machines did not break out of step even when the line resistance was *more than* 100 *ohms*—that is, relatively more than thirty times greater than Prof. Forbes proposes to use even for his long-distance transmission. This is the more striking as a proof of their powerful synchronising when it is considered that, even if it had been intended to expend the whole power of the generator in the line, that line should only have had a resistance of 100 ohms. That these machines did not act quite perfectly in parallel under these conditions, even with no load, is not to be wondered at. The only cause for surprise is that they exerted any sensible synchronising effort at all. It is exactly as if an attempt had been made to run two 1,200-kilowatt alternators in parallel through a line constructed to allow a reasonable loss for a couple of 40-kilowatt machines. Even unloaded, such a test would be unreasonable.

* *Journal*, XXII., 516.

I now wish to refer to the "hunting" or regular pulsation of current, shown by the slow changing of the lamps from blackness to high incandescence, which is a matter of considerable interest. It may have been caused by self-induction, or, as, in this connection, it is sometimes termed, armature reaction—that is the effect of the self-induced field produced by the armature in disturbing the impressed field of the field-magnet. Although this effect may in some cases be considerable, I think we must look elsewhere for it in this case, because in the machines in question such reaction would have been inconsiderable, even if the phase relation had been most favourable to it. This I may illustrate by saying that if the armature current had been commuted, and passed round coils on the field poles having turns equal in number to the armature coils, the effect on the field would have been inconsiderable.

I think an explanation of the "hunting" will be found in the character of the resistance, and in the governors of the engines. The change in the resistance of the lamps accounts largely for the pulsation. When black they would interpose a very high resistance—probably about 200 ohms—then, as the machines got a little out of step, the synchronising current would heat them, reduce their resistance, allow a much readier transfer of power, and so bring about a restoration of true synchronism, and a reduction of current through the lamps. This series of effects, being constantly repeated, goes a good way towards explaining the pulsation. Probably without this lowering of the resistance by the incandescing of the lamps, synchronism would not have been maintained at all. Then, again, the governors of the engines must be considered. If they pulsated with the same period, but opposite phase, the action is explained; they would, at any rate, accentuate the "hunting," if they did not start it. Messrs. Willans and Robinson have kindly sent me an indicator card, taken by Mr. Willans at the time, which supports this view, the steam being shown as having been widely varied during the taking of the card. This must not in any way be taken as a reflection on the governors. The conditions were very trying for any governors, there being no load, and no opportunity occurred of specially adjusting them. If we had governed by hand at the stop valve, this "hunting" would not have occurred. Nor would it have occurred if we had adjusted

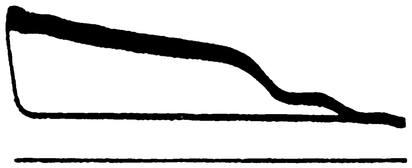

Fig. 1.

the E.M.F. of one machine so as to allow it to run as a motor all the time. What happened appeared to be a repeated change in the functions of the two machines, from generator to motor—first one racing, and then the other, driving the second one as a motor.

The condition of entire absence of synchronising current or of correction can only be obtained by driving by engines that are very even in power always. I think this is more likely to be approached by turbines than by reciprocating engines. By "synchronising current" I do not mean necessarily an actual current passing from one alternator to the other—this only occurs when one of them is driven as a motor—I mean the variations of the current contributed by each machine to the circuit. But I would like to point out that the condition laid down by Prof. Forbes as an essential—namely, that they must have alternators at Niagara that will run without any synchronising or waste current—is an absolute impossibility. Alternators will run without synchronising current only when there is no necessity for them to exert any synchronising effort. However, I am glad to find that Prof. Forbes has set himself to solve this problem of getting an alternator motor to run without any current (for that is what it amounts to), because I am sure that in solving it he will also have disposed for ever of that other interesting problem—making a motor that will run without any back E.M.F. This is a new and significant outcrop of the "perpetual motion" idea. I am sure that if Prof. Forbes had really considered or understood this matter he would not have expressed the opinion which I have quoted. At the same time, I wish to say I am convinced that his criticism was not unfair by intention.

The necessity for correcting a false impression has forced me to take the first opportunity of bringing this matter before the Institution. I regret that Prof. Forbes is abroad, but he will of course have an opportunity of sending on for the *Journal* any observations he may wish to make.

It was not my intention to do more than make the above explanation, feeling sure that it would be sufficient to enable the Institution to form a correct judgment on the circumstances; but as I am permitted to occupy more of your time than I expected, I wish to refer to some tests that I have been able to make. It

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appeared desirable to give the results of actual trials, preferably working one machine as a synchronous motor, and not merely as one of a pair of parallel connected generators. It will be granted that the action of synchronous motors and of parallel alternators is very similar. But with regard to the trials just referred to it might fairly be argued that as each alternator had a steam engine behind it, on which it could fall back for assistance, something more is wanted to actually prove that the explanation is applicable to the case of a synchronous motor relying entirely on its own motor properties. I am, therefore, glad to be able to place before you the results of some tests made in the works of the Brush Company.

Some Tests of a 25-Kilowatt Mordey-Victoria Alternator Used as a Motor.

This test was carried out by my instructions on February 18, 1891, four months before that witnessed by Prof. Forbes. A 2,000-volt 25-kilowatt alternator was run as a motor, driven by a 37·5-kilowatt generator. The motor drove a dynamo which was loaded until the alternator motor was taking about its full normal current, it being assumed that this represented full power. Separate tests* have proved this assumption to be justified. The following readings were taken with a resistance of straight platinoid wire between the machines :—

Test A.

Volts. Generator terminals.	Volts. Motor terminals.	Amperes.	Resistance in line. Ohms.
2,340	2,002	13·74	32
2,358	1,932	13	48

The volts of the generator were raised above the motor volts sufficient to supply approximately the line loss.

This test was quite satisfactory, and of course settled, so far as we were concerned, any question that might at any time arise as to power transmission over long lines by synchronous motors—a matter that was from time to time coming up in connection with proposed installations. As a result, I always considered it quite safe to quote for work up to a line loss of 20 per cent. But, my attention being recalled to the subject by the extraordinary statements of Prof. Forbes, I took the opportunity, after writing the foregoing explanation, to make some tests having a particular bearing on the details of the question before us. In some respects they are rather wanting in completeness—I was not always able to carry them as far as I wished—but I feel sure that you will approve of my supplementing my explanation by an account of such tests as the facilities at my disposal at the moment rendered possible.

Tests of 50-Kilowatt Alternator as a Motor.

The object of these tests was to ascertain the effect of inserting resistance between two alternators one of which ran without load as a synchronous motor. It was desired to find—

(*a*) What resistance was required to cause the motor to fall out of step ; (*b*) How much the current varied ; and (*c*) Whether any "hunting," or pulsation, was set up. Two similar 2,000-volt 50-kilowatt alternators were used.

Generator.—This was driven by a separate engine capable of working it up to full load. It was run without governor, and controlled by hand at the throttle valve.

Motor.—This was started and brought up to synchronism by a small direct-current motor, driving by a belt which was thrown off as soon as the large motor was running synchronously.

The two machines were excited from a separate dynamo, their fields being in parallel. The E.M.F. at the generator terminals was measured, and the current from armature to armature. The field currents were not measured, nor the E.M.F. at the motor terminals. The generator was excited to give 2,000 volts, and then the motor field was adjusted till the current received by the armature was a minimum. This will be understood from Fig. 2, which is reproduced from a Paper I had the honour of reading before this Institution last year.† It may be remembered that I showed that there is a well-marked excitation that reduces the armature current to a minimum for any given load, and therefore gives a maximum power-factor and maximum efficiency. If the excitation be varied on either side of that value, the armature current taken by the motor rapidly increases.

In working a motor it is desirable always to adjust the excitation till the bottom of this V curve is reached—that is to say, until the armature current is a minimum. In the case before us this current was found to be 1·5 ampere. Having got this, the excitation was not disturbed, and the following readings were taken :—

Test B.

Volts at generator terminals.	Current.	Resistance in external circuit between generator and motor.	Remarks.
2,000	1·6	0	Current steady.
"	1·6	10	"
"	1·6	20	"
"	1·7	35	"
"	3·5	63	"
"	3·6	69	Current rather unsteady.
"	5·3	77	"
"	...	90	Current increased rapidly at this point, and the motor slipped quietly out of step.

In the first place, it is to be noted that there was no "hunting," or pulsation. The unsteadiness of the current was not regular. Examining this test with a view to its practical aspects, it will be seen that it fully supports the explanation given at the commencement.

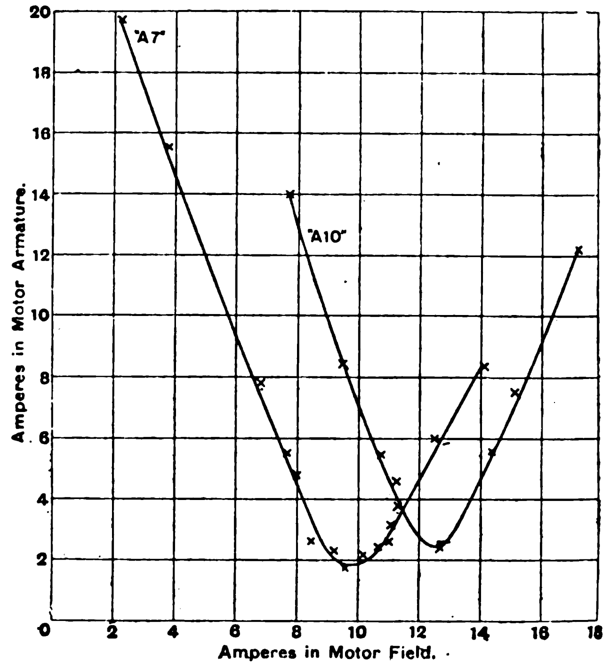

Fig. 2.

Applying to it a similar comparison, we see that, as the alternators were 2,000-volt 50-kilowatt machines, a line proper to these, in order to comply with the Niagara-Buffalo condition of allowing a loss of 3·5 per cent. in transmission, should have a resistance of

$$\frac{2{,}000 \times 3\cdot5}{25 \times 100} = 2\cdot8\ \omega\ ;$$

and that the resistance of external circuit that would be sufficient to dispose of the whole load of the generator, supposing it to be merely working on that resistance as a load, would be

$$\frac{2{,}000}{25} = 80\ \omega.$$

Exactly as in the case of the trial witnessed by Prof. Forbes, we find that a resistance of about 30 times a reasonable working amount had to be inserted before synchronism was interfered with, and it will be observed that more than 20 ohms had to be inserted before any effect appeared to be produced.

But it may be said that the line loss, even with this enormous resistance, is comparatively trifling, as the current is not large, and that there ought to be plenty of power left to keep the motor in step. There *is* plenty of power, but it cannot be applied to the motor advantageously. The line loss, even with 5·3 amperes and 77 ohms, is only 408 volts and 2,156 watts (I am considering only resistance and current), whereas the generator was capable of supplying 50,000 watts. But it must be remembered that the E.M.F. of the motor being kept up, it can only receive current under these conditions by letting itself get partly out of phase (and so into a disadvantageous position), and that then every increase of current intensifies the evil by causing a further

* *Journal*, XXII., 127.

† "On Testing and Working Alternators," *Journal*, XXII., p. 128, February 23, 1893.

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loss of volts on the line, and therefore a further reduction in the E.M.F. impressed on the motor. Had I lowered the E.M.F. o the motor, or increased the E.M.F. of the generator, the line resistance could have been still further increased without loss of synchronism. Such a change of the relative E.M.F.s of the motor and of the generator would have allowed current to get into the motor against the lower ordinates of its E.M.F. waves, without the necessity for any serious shifting of phase. If the motor E.M.F. had been lowered in this way the driving current would have increased, and synchronism would have been maintained much longer and through a higher line resistance, and would finally have been lost by the power being wasted in the line, and by "armature reaction" on a weakened field.

Or, again, if the excitation of the motor had been raised, it should be found that it would go out of step with a smaller external resistance than before. This matter is of practical importance, as perhaps others than Prof. Forbes may wish to work through a line 30 times too long, and therefore some tests were made to prove the truth of this explanation.

Test C.—The machines were run under the conditions of the fifth line of the readings given above, that is, with the excitation as before, and with an external resistance of 63 ohms, the current being 3·5 amperes. The excitation of the motor was then increased, probably about 20 per cent. Before there was time to take any reading the motor went out of step. This was satisfactory, as proving the correctness of the explanation.

Test D.—Another test was made with the motor acting as a dynamotor in the manner shown in Fig. 3.* One half, M, of the

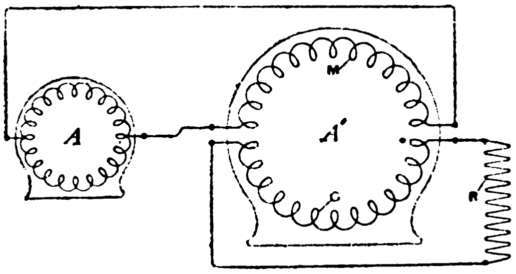

FIG. 3.

armature winding was used as a motor; the other half, G, as a generator working on a separate circuit, R. In this instance a load of 5 amperes and 2,000 volts was put on this generator portion, the lowest armature current being obtained with an exciting current of about 11 amperes. The field of this dynamotor was then reduced from 11 to 6 amperes, but it did not show any signs of getting out of step. The driving current rose to 15 or 16 amperes. But on increasing the dynamotor field to 17 amperes it went out of step, the driving current being about 15 amperes. This test is not on all fours with the other, as there is the effect to be considered of the varying load on G, but it is a confirmation in a general way of the explanation.

Test E.—A test was then made to find, when working with no appreciable resistance between the machines, whether any "hunting" or pulsation was set up by varying the excitation of the motor till the armature current rose considerably up either slope of the "V." On decreasing the excitation till the armature current rose from 1·6 to 6 amperes the current became rather unsteady or irregular; the motor evidently getting a little out of step sometimes, and being pulled in by slight rushes of current of very short duration, which probably over-corrected the irregularity, causing the machine to run for an instant without current, or to act as a generator and itself to give current—that is, to act as an electro-mechanical fly-wheel, converting mechanical to electrical energy, and *vice versâ*. On increasing the excitation again, passing the bottom of the "V," and rising up the opposite slope to the same height (about 6 amperes), it was found that the current was rather steadier than under the conditions last noted; that is, when the current was about 6 amperes it was rather more unsteady in a strong field than in a weak field. The explanation of this difference is that with a weak field the motor could receive current during its whole phase; whereas with a strengthened field the E.M.F. waves would be higher than those of the generator and some want of co-phasal synchronism would be needed to allow current to get in. In neither case was there any "hunting" or regular pulsation of current.

(To be concluded.)

The Salève Electric Railway.—The Geneva papers announce the opening, on the 4th ult., of the last section of the electric railway to the summit of the Salève, about 5,000 feet above sea level.

* Also reproduced from last year's paper.

TELEPHONE RATES IN THE VARIOUS COUNTRIES OF EUROPE.

The following particulars about the rates for telephones in various countries may be of interest:—

In Austria-Hungary the rates are uniform for all the State telephone exchanges. The State telephones cover the whole of the country, except the city of Vienna. The total charge is made up of an installation charge, which for a distance of not above 500 metres amounts to £5 (50 gulden), and for every additional 100 metres £1; then there is annually a station charge of £3, and what is called a working charge of £2, so that the annual charge is about £5.

In Switzerland the charge has been by degrees reduced to about £3. 3s. (80fr.) As a result of this low tariff the number of telephones has rapidly increased, and at the end of 1891 there were about 12,595 telephones.

In France the telephones are a State affair; the annual charge for towns with over 25,000 inhabitants is £8 (200fr.), and for smaller towns £6 (150fr.)

In Italy the telephones, in accordance with the Telephone Act of 1892, may be worked either by the State or by private enterprise. For the smaller and medium-sized towns the annual subscription ranges from £5 to £6.

Sweden boasts of an exceedingly well-managed and greatly developed telephonic system, which comprises both an extensive and ever growing State telephone system and numerous private concerns. The rates are on the whole very reasonable; as a rule, a subscription of £4. 10s. will cover an area of about a mile from the exchange. For smaller towns the rates are somewhat lower (£1. to £1. 10s.). Private companies have as low annual subscriptions as £1. 13s.

In Norway the subscriptions vary according to the size of the towns, but are on the whole moderate; they range, as a rule, from £2. 4s. to £4s. 9s. It is at present under discussion to erect a very extensive system of State telephones in Norway.

In Spain most of the telephone companies are private concerns; the annual subscriptions vary considerably, say from £3 to £11.

In Holland, the Netherlands Bell Telephone Company has almost monopolised the telephones, and the subscriptions are fixed according to the size of the towns. In Amsterdam, for instance, the subscription is about £10 (118 gulden); in Rotterdam, £10; in Grovenhagen, about £8. 10s. (110 gulden); in Haarlem, Utrecht, Arnheim, Groningen, and Zaandam, which are towns with something like 30,000 inhabitants, only £5 (60 gulden). In still smaller towns the annual subscriptions are reduced to £4 or £3. 10s., and even these low charges are subject to further reductions by contracts extending over several years, &c.

The telephones of Belgium are partly State and partly private affairs. There are no uniform subscriptions, but the charges are registered according to the distance from the central station, and the term of subscription. The charges for the State telephones are, for a distance from the exchange of 1 kilometre, £6. The usual charges for private companies vary from £5 to £6. In Luxemburg the charges vary between £3 and £4.

In Luxemburg the charges vary between £3 and £4.

In Denmark the Copenhagen Telephone Company, which through a State telephone cable has connection with Sweden, charges about £8. 6s. 6d. (150kr.) annual subscription. The subscriptions in the provincial towns vary considerably, from about £1. 12s. 6d. to £4. 4s.

In Germany the telephones are almost exclusively State institutions, and the charges are on the whole high.

In England, finally, the National Telephone Company charges from £20 annually in the City of London down to £10 or £8 in smaller towns.

LEGAL INTELLIGENCE.

Muirhead v. The Commercial Cable Company.

MONDAY, MARCH 5TH.

On the hearing of the case being resumed, Mr. J. SWINBURNE was sworn and examined by Mr. Moulton.

WITNESS was of opinion that Fig. 1 of the 1880 patent (*see* p. 528 last issue), and Fig. 1 of the 1876 patent (*see* p. 529 last issue), were electrically the same. He took it that the V-shaped resistance in 1876 meant any convenient way of adjusting electrically. Electrically there was no difference between the function of circular rheostats, working with a handle, and coils plugged out by moving plugs. The nomenclature was rather loose. For instance, in Gordon's treatise on Electricity, published in 1880, there was an illustration of Sir William Thomson and Mr. Varley's slide coils. The letterpress showed that Sir William Thomson and Mr. Varley had arranged a resistance box where the resistances were varied. Then an illustration of what in the present action would have been called a rheostat was given, it was a rheostat

that went up to 100,000 ohms. The essential part of Fig. 2, of 1880, was the insertion of the condensers in the bridge arm. Fig. 3 of 1880 was the same as Fig. 2 with the resistances r^1, r^2, reduced. Speaking as an electrician he did not see any difference between Figs. 2 and 3 of 1880 and Fig. 2 of 1876. Fig. 2 of 1876 was shown more diagrammatically.

Cross-examined by Mr. Bousfield, WITNESS admitted that he had had no practical knowledge of duplex telegraphy until he took it up in reference to the action. In 1876 he was serving an apprenticeship as an engineer. He did not take up electricity professionally till 1881. In 1876 he did not know what duplex telegraphy was. His view was that because there was a balance to be adjusted that it must be meant to be done in Fig. 1 by adjusting the resistances in the arms. He should not have thought that the whole of the pictures in the 1876 patent were consistent with the view that by those curly wires the inventor meant to imply fixed resistances and not adjustable ones. He should not think it possible to obtain an adjustable balance in Figs. 4 and 5 of 1876 without adjusting the bridge wires proper. The artificial cable was meant to be a copy of the real cable. It was easy enough to make the whole resistance of the artificial cable right. It was easy enough to make the whole capacity of the artificial cable right. But the resistance and capacity are not necessarily distributed in the same way along the length of the artificial line as along the length of the cable, and such discrepancies would cause little kicks in the receiving instrument.

Mr. BOUSFIELD: Now I ask you whether or not, in fact, the rheostat actually used in accordance with Fig. 3 of 1880 does not furnish what you have spoken of as the last refinement?—No, I think not.

You are speaking now with some confidence about what would be read out of a specification of 1876. I ask you, having regard to the state of knowledge at that time, was not the use of the rheostat in the 1880 patent to give a final adjustment of the smallest kind which was never dreamt of being got at all so far back as 1876?—No, I think not.

Continuing, WITNESS stated that adjustable resistances in the bridge arms gave no capacity adjustment. The adjustment shown in Fig. 4 of 1876 might give the same sort of adjustment as he had suggested ought to be got by an adjustable resistance in the bridge arms. Counsel then quoted Mr. Preece and Mr. Sivewright (1876), and witness admitted that the adjustment there was obtained by what was called a rheostat. But witness could not agree that that was the sort of arrangement the patentee described in 1876 in his patent. There was no question of capacity so there was no difficulty whatever in adjusting the resistance of the artificial line as a whole. The land duplex and the cable duplex were alike in that, in both cases they had to make a resistance adjustment. But in the case of the submarine duplex where one had an artificial cable with capacity, they could not adjust the resistance of the artificial cable, without throwing the capacity adjustment wrong.

Mr. BOUSFIELD: Take Fig. 4 or Fig. 5 of the 1876 specification: cannot you by either of those methods make the resistance adjustment without altering the capacity?—Quite so. You can. But those are not the same as that figure in Preece's book. In Figs. 4 and 5 you do not adjust the resistance of the artificial cable.

Witness was then cross-examined at considerable length as to the alleged advantages of employing a rheostat and as to whether or no a condenser in the receiving circuit was a matter of common knowledge in 1876.

Re-examined by Mr. Moulton, WITNESS stated that there was no electrical advantage in using a circular rheostat which could not be obtained by adjusting the resistances in other ways.

Mr. H. R. KEMPE, examined by Mr. Moulton, stated that he was a Technical Officer of the Engineer-in-Chief's office, General Post Office, under Mr. Preece. He had been 22 years in the engineering department of the postal telegraph office. He was acquainted with the land-line duplex upon its first introduction into the Post Office about 1873. He had no practical experience with submarine working duplex. Looking at Fig. 1 of 1876 a competent electrician would have understood that the two arms were to be adjustable in some way or other—either two arms, or artificial cable, or both. Circular rheostats were in use in 1872. Looking at Fig. 2 of 1880, in his opinion, in order to obtain the effects of such an arrangement, it was not necessary that the rheostat should be at the vertex.

Cross-examined by Mr. Bousfield, WITNESS stated that in his opinion the rheostat was no use at all. He had made experiments in a laboratory only a few days ago to try whether the rheostat itself made any difference, but it did not. He had never been to offices where cables were practically worked. In his view it was absolutely unnecessary to have the resistance in the arms of the bridge adjusted if they had condensers there. The daily temperature and atmospheric changes which occurred, where land lines were concerned, were to a large extent absent where cables were concerned. Nevertheless he thought that in the year 1876 the importance of having a daily adjustment for small changes in the submarine duplexing must have been foreseen. As regards Fig. 2 of the 1876 specification, taking the full line figure, he thought it might work perfectly on a short submarine line—a cable 200 miles long—without requiring any provision whatever for adjustment. Possibly in regard to Fig. 2 when the apparatus was finally set up and finally balanced in a cable 200 miles in length, there would be no further requirement for variation. Witness was then examined at some length with regard to some statements contained in Mr. Preece's Presidential Address of last year, in which he stated that although in 1877 duplex working on land lines was fairly good, the imperfect balancing of appliances at their disposal made duplex working to Dublin very unsatisfactory; whilst in 1884 a single signalling condenser was applied to duplex circuits, and the balance condensers were divided into three adjustable portions, with the result that the duplex speed to Dublin was raised to 140 words per minute. Witness said that referred to automatic fast-speed working on what was practically a land line, which was different to ordinary cable signalling.

Mr. JOHN GOTT, examined by Mr. Moulton, said he was a telegraph engineer and electrician to the defendant Company. He had had 33 years' experience with submarine telegraphy. In 1876 a competent electrician, looking at Fig. 1, would adjust the arms of the bridge. That was common knowledge at the time. Fig. 2 was an improvement on Fig. 1, the improvement being the placing of the condensers in the bridge arms. In the specification of 1880, Fig. 2, it made no difference in the effect produced having a rheostat at the vertex, or having a rheostat or resistance coils adjustable in the arms. Before 1876, in experimental duplex submarine working he had used the receiving condenser. In Fig. 3 the rheostat did not produce any different or other effect than it did in Fig. 2. In practice it was immaterial to keep the resistance of the arms constant. In working, key K was to earth. In practice they generally put the end of the artificial cable to earth through probably 10 ohms. A current passed down K when they were receiving. In the ordinary arrangement of the bridge, if the instruments were taken from the usual place, and placed in the circuit of the key, one would get as good signals there as one would in the ordinary position.

Cross-examined by Mr. Finlay, WITNESS stated that by the Muirhead 1880 duplex system a 10 or 15 per cent. improvement was obtained over the duplex system hitherto in vogue—*i.e.*, 95 per cent. over the simplex system.

Re-examined by Mr. Moulton as to the number of adjustments wanted in a day's duplex cable working, WITNESS stated that all the adjustments were made early in the morning before commencing work, and then there were three or four or five adjustments a day at the outside. They could make the adjustments just as finely with plugs as with any other arrangement.

TUESDAY, 6TH MARCH.

On the hearing of this case being resumed, Mr. FRANK JACOB, examined by Mr. Moulton, stated that he had been for the last 21 years in the service of Messrs. Siemens Bros., and had been for the last 15 years their chief electrician and sole electrical adviser. He had had experience in the manufacture of cables, and the laying of the cables. Looking at Fig. 1 of 1876, he would have understood the curly lines to represent resistance, the word "bridge" would mean that they must be adjustable. Electrically there was no difference between the circular thing with a handle and the square box with plugs. In Fig. 1 of 1880, supposing the adjustable resistance were put in one of the arms, the instrument would work equally well, there was not the slightest practical importance in keeping $r^1 + r^2$ constant. In his opinion there was no difference whatever between the invention shown in Fig. 2 of 1880 and in the 1876 patent.

Cross-examined by Mr. Pollard, WITNESS stated that he would not take it that the 1876 patent, taken as a whole, assumed that whatever had to be done had to do with high resistances in the arms.

Sir HENRY CHRISTOPHER MANCE, examined by Mr. Moulton, stated that he had been connected with submarine telegraphy since 1863, and gave evidence in the same sense as the previous witness as to the meaning of Figs. 1 and 2 of 1876, the immaterial nature of the exact locus of the rheostat, &c.

Mr. FINLAY: Take the alternative arrangement of *m n* with the condensers on the far side between the receiving circuit and the cable and the artificial cable respectively; these condensers will not enable you in any way to reduce resistances in the arm?—I do not know what the arms are supposed to have been then.

You have got the arms shown with the coils and resistances. I ask you whether it is not the case that if you put the condensers on the far side of the receiving circuit these condensers in no way help you to reduce the resistance on the arms?—Therefore I should put it on the other side myself.

Do you agree that that is so, that if they are on the far side they in no way help you to reduce the resistances in the arms?—They would not help you.

Now do you mind looking at page 3, line 26:—"In this method of working the terminals of the receiving instrument may be connected on the line side of the condensers with the cable and artificial line respectively as shown at *a b* (Fig. 2), or the receiving instrument may be connected with the opposite poles of the condensers on the bridge side as shown by the dotted lines *m n* in the same figure. I prefer the latter arrangement." You would prefer, you just told us, the former?—Yes, the other.

Mr. JUSTICE KENNEDY: Then it reads as if the inventor had made a mistake there, because he certainly attributed it to both.

The WITNESS: Probably he wished to do away with the condenser in the receiving circuit. I think that is possibly what might have been in his mind when he said that.

Mr. MOULTON then stated that all the evidence for the defendants had been given, and proceeded to review the case. A patent meant, he said, one and the same thing, whatever the form of litigation, and whoever the litigants. If that were borne in mind a great part of the points which had been raised in cross-examination of his witnesses or in examination of the witnesses on the other side, with regard to the patent of 1880, would disappear. The position of the Court was just the same in interpreting the grant as if it were an action for infringement of the 1880 patent. In that case what witness would have ventured to come up and say that it was a question of turning a handle instead of putting a plug, which was to get a man out of infringement of the patent. They had got to believe, first, that the patentee tied himself down to something so narrow that it could be avoided, without in the slightest degree losing the benefit of the invention, and secondly that the courts were going to be so blind that they would not apply in defence of the patentee the common knowledge of every electrician in order to protect his invention being stolen by a trivial alteration which anybody, even the merest beginner, could have made. The evidence put forward proved that

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that very issue as to the particular position of the adjusting device was immaterial in getting the benefit of the patent. If the action had been in the form of an action for infringement, he submitted with the greatest possible confidence that no variation of the position of the rheostat or its shape would have made any difference to the question of whether the arrangement was or was not an infringement. If a man could adjust his bridge, if he had the condensers in the bridge arms, if he had the condenser in the receiving circuit, it would be said that he had taken the invention. The next argument was that there was a difference between 1880 and 1876 because the reduction of resistances in the arm was so much that, in Fig. 3, the resistances were all in the rheostat. Turning to the 1876 patent, however, they found a statement that if one had condensers as bridge condensers it was found that the arms of the bridge might be greatly reduced in resistance, and a consequent reduction in the retardation of the signals effected. In other words, it pointed out in 1876 the advantages of the 1876 device. In 1880 the patentee pointed them out, and he figured them ; but they were consequences of the 1876 device. He now came to the next thing in the matter, which was the most astonishing point that he had ever heard—the left-hand arrangement, *m n* in Fig. 2 of 1876. It was only the right-hand arrangement that would enable a man to reduce or dispense with resistance. But because the patentee had made a mistake that did not prevent his having patented, and told the world of the right-hand one, and told the world that the right hand would diminish resistance. How could the other side better their case by saying that their patentee made a blunder in his earlier patent. Because he wrongly thought the left-hand method was the best, how could that affect the fact that he had taken a patent for the right-hand method, and told the world that the right-hand method did exactly what according to the 1880 patent it did do, namely, enable one to diminish resistance. He submitted that this in 1880 was identical with that of 1876, and that the American patent had lapsed.

WEDNESDAY, MARCH 7.

On the hearing of the case being resumed, Mr. A. J. WALTER argued at length the points of American law involved in the case. He contended that there was no necessity for an express declaration in America that a patent had come to an end by reason of the expiry of a similar foreign patent. By reason of the identity of the two patents and the American statute, the American patent came to an end *ipso facto* at the date of the expiration of the foreign patent. The next point was, who might be the patentee of a foreign patent, so as to bring the American patent of the same invention under the provisions of Section 4,887? "But every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent, or if there be more than one at the same time with the one having the shortest term, and in no case shall it be in force more than 17 years." There were no words limiting the foreign patent to the patent of any person. But even so, they had it on evidence from Dr. Alexander Muirhead, that he was the inventor of the 1880 patent, and they had it proved, on the face of the documents themselves, that the 1876 patent was a communication partly from abroad by Dr. Alexander Muirhead. He now came to the question which was at the root of the whole of the case. What was the degree of identity that was required according to American law between an American invention and a prior foreign invention in order to bring into operation the provisions of Section 4887? He (Counsel) held that with regard to the 1876 patent and the 1880 patent there was that degree of identity which would bring the patentee, Alexander Muirhead, within the terms of the statute and rules.

Mr. BOUSFIELD, on behalf of the plaintiffs, contended that the question was a very simple one, namely, whether the combination claimed in the 1880 patent was in substance identical with that claimed in the 1876 patent. Well, the fact was that the patentees, as regards the 1880 combination, never dreamt of it before 1880. A singular proof of this was to be found in a fact which was mentioned in the 1876 specification, Fig. 2, of which showed two arrangements, one with dotted lines and the other a full line. The dotted line arrangement was absolutely useless for the purpose of arriving at the 1880 result. That was a fact that they absolutely stated in the 1876 patent, that they preferred an arrangement which was absolutely inconsistent with getting that result which they got in the 1880 patent. Could anything show more clearly that that knowledge was not in their grasp at the time? The other side did not say the 1880 combination was in the 1876 patent absolutely upon the face of the specification. It was quite obvious that it was not there upon the face of the specification. But what they did say, was :—Yes, all the parts of it that are missing, and so on, would be inferred, because of common knowledge, and that although the inventors in 1876 had not got that combination, and did not themselves infer it from what they knew. Counsel then referred to what the United States procedure was with reference to the granting of patents. The whole American law, he said, was based upon the idea that upon the expiry of a foreign patent, the whole of what was in that foreign patent became absolutely free in America. To apply that to the particular case. Upon the expiry here of the English 1876 patent, all that was in that 1876 patent became free to the American public, and no patent could be taken out afterwards which would prevent any American citizens from using everything that was in the 1876 patent. Now a man might invent a new genus, then any species belonging to that genus was substantially the same as any other. If he invented only a new species, then no other species of that genus was substantially the same. If he invented a new variety, no other variety was substantially the same. When one had grasped the way in which the Americans decided these things, one saw how very close the identity must be in order to establish any such case before an American Court. As regards the question of the identity of a rheostat with a resistance box, of course, they were identical for some purposes. But a resistance box put into the 1880 combination would not do the same thing as the rheostat shown in the 1880 combination. That was the point. The real test was, were the American public free to do all that the 1876 patent told them to? He submitted they were absolutely free to do all that the 1876 patent told them to. They were free to make any combination of that patent, they were free to use a resistance-box in the arms of the bridge in Fig. 1 or Fig. 2, or anything else. They were free to adjust by the means shown in Figs. 4 to 14. They were free to use bridge condensers, they were free to use receiving condensers. But he submitted, by reason of the 1880 patent, which was valid, they were not free to use a combination of bridge condensers, receiving condensers, receiver cables, and rheostat, placed in that particular relation. They were not free to use that particular combination because that combination had never been disclosed before. All his side had to show was that the 1876 patent was free to the American public, and he put it that on any fair construction of the 1876 patent, every portion of it and every possible combination of it was free to the American public unless they introduce something that was not there, namely, the rheostat, and put it into that particular place with the other elements to make the 1880 patent, when, of course, they would infringe.

Mr. FINLAY then dealt with questions of law. According to his friend's contention a patentee could present the public with a needle in a haystack. He might say : "I will claim A B C D E F G and H. I claim them separately, and in all possible combinations," and, although it might take a man, as it in this case took Messrs. Muirhead, years of work to discover the one combination which would answer, one could still say : "Oh, then, that is anticipated, and because your patent of 1876 ought to have shown you, though it did not, that that was one of the many possible combinations, therefore your patent of 1880 is not for anything new, but is the same as the patent of 1876." But he (Mr. Finlay) thought he was entitled to say that the 1880 patent even stood on stronger ground than it would have stood on if it had been a mere combination of elements, all of which were to be found in the 1876 patent. It went further than that—in Fig. 3 of the 1880 patent it totally eliminated resistance. Further, not only were resistances in the arms totally eliminated from Fig. 3 of the 1880 patent, but the rheostat was introduced. The line which the defendants had taken really involved an attack on the propriety of the grant of the American patent to Mr. Alexander Muirhead. He submitted that the matter was one which should be left for the American Courts, and that the American Courts, as these cases showed, unless it was shown to them, and established by very clear evidence, that the patent of 1880 was wrongly granted, would allow it to stand. The agreement showed that what the defendants contracted was to pay the royalty for the face term of the patent, while his clients agreed for the face term of the patent to give them the benefit of any improvements.

After some further remarks from Mr. WALTER on some points of law, the hearing of the case came to an end. Judgment reserved.

Hall v. Charlesworth.

This was a motion before Mr. Vice-Chancellor Robinson, in the Lancashire Chancery Court, Manchester, for an injunction to restrain the defendant from retaining certain letters addressed to the plaintiff or taking advantage of the information contained in them. Mr. Roby, for the plaintiff, stated that some time ago the defendant, Mr. Sheard Charlesworth, carried on business at the Richmond Hill Ironworks, Oldham, as a printers' engineer. The plaintiff, Mr. Joseph Platt Hall, joined him in partnership, their joint business being that of electrical engineers, and having nothing to do with the defendant's own business of printers' engineer. In September, 1892, the style of the partnership was altered to "Charlesworth, Hall, & Co." In February of this year the partnership was dissolved. Under the partnership agreement it was provided that when notice to dissolve had been given by either party, notice was also to be given as to the price either was prepared to give for the partnership property and assets. Upon the dissolution the plaintiff sent in a notice for £2,800, and the defendant, who had offered £3,000 but withdrawn the offer by consent, accepted it. Immediately after the dissolution difficulties arose as to the letters addressed to "Charlesworth, Hall and Co.," which the plaintiff contended passed to him by virtue of his purchase.

Mr. MABERLEY, for the defendant, submitted that the purchase for £2,800 did not include the goodwill.

The VICE-CHANCELLOR granted an order restraining the defendant till the hearing of the action from retaining, opening or reading any letters, telegrams, parcels or communications addressed to the partnership firm, and from supplying any orders contained in such letters, the plaintiff to give an undertaking as to damages, to hand over to the defendant any letters intended for him personally, to preserve all letters addressed to the original firm, and to keep an account of profits obtained from orders contained in such letters

Wise v. Metropolitan Electric Supply Company (Limited).

The hearing of this action was commenced before Mr. Justice Stirling on Tuesday last. The plaintiff, who resides and conducts a business at 43, Manchester-street, Manchester-square, acting with another resident in the street, Mr. Grant, sought to obtain an injunction against the defendant Company to restrain them from continuing the nuisance arising from the noise and vibration caused by the working of the engines at their electric station in Manchester-street.

Mr. Graham Hastings, Q.C., and Mr. Beaumont appeared for the plaintiffs, and Sir Richard Webster, Q.C., Mr. Phipson Beale, Q.C., and Mr. Vernon Smith for the defendants.

Mr. GRAHAM HASTINGS, in opening, described the nature of the vibration, which he said was of a very peculiar and varying character. Sometimes the upper part of the house was affected, and at others the lower rooms. The defendants acquired their lease in 1888, and got to

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work in July, 1890. The vibration had gone on increasing, and was now intolerable. Inmates of the adjoining houses had their rest broken, and suffered in health in consequence; clocks were stopped, and other annoying effects produced.

Prof. S. P. THOMPSON gave evidence of having observed vibration in different rooms in the house, both by personal sensation when sitting upon sofas and chairs, and by observation of the rattling of windows and the shaking of walls. He produced a phonograph which had been placed in the rooms for the purpose of recording the sounds produced.

On Wednesday, Mr. WISE, the plaintiff, gave evidence corroborating the opening statement of counsel, and stating that his nervous system had been greatly upset, whilst he had experienced considerable falling off in his business, and he received frequent complaints from his lodgers.

Mr. W. H. GRANT, of 17, Manchester-street, gave similar evidence, after which,

Sir RICHARD WEBSTER commenced his opening speech for the defence, relying mainly upon the conditions under which persons were entitled to acquire land for the purposes of gas and electric lighting works.

At the conclusion of the sitting the case was adjourned over the Vacation.

A full report of this case will appear in an early issue.

CORRESPONDENCE.

TESTING THE HYSTERESIS IN IRON.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of March 3rd you gave Mr. Kapp's very interesting method of measuring, in workshop practice, the hysteresis in the iron plates used for transformers and armatures. As was pointed out, what is wanted is not so much absolute measures of the hysteresis as relative ones, so that the manufacturer can compare different samples of iron, and can ensure that he is getting iron of uniform quality. We have for some time past used a very simple method of comparing different samples of iron, depending on the rise of temperature of the sample when subjected to an alternating magnetic field.

Two solenoids on wood frames, and identical in every respect, are coupled in series on an alternating circuit. Into each of these a core is put, consisting of a definite weight of iron plates, insulated from one another with paper, and having in the centre a piece of wood with a slot for a thermometer; one of these cores is prepared of plates which are considered standard, and the other of the plates to be tested. Readings of the thermometers are taken at intervals, and the one which shows least rise of temperature is considered the best iron. The induction in the iron can be varied both by varying the E.M.F. on the coils, and by varying the weight and number of plates in the cores. The whole apparatus is so simple that it can be worked by an intelligent apprentice.

We may say that we have found no advantage to be gained in annealing the plates as obtained from the makers, but unless insulated from one another by some medium such as paper, the loss is largely increased.—Yours, &c.,

C. A. PARSONS AND CO.

Heaton Works, Newcastle-on-Tyne, March 12, 1894.

LOCALISING FAULTS IN STREET MAINS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Personally I have never used the test, as suggested by Mr. Collis, for localising faults in lighting mains, and concerning which he desires mental light; but the following comments upon his letter may be useful to himself and others interested in the subject.

Reference to his diagram will show that the galvanometer circuit is established through the earth and *fault*. For "dead earth" and fairly constant faults the plan should give accurate results, with rapidity of adjustment, balancing to the false zero, of course, being necessary, and care being taken to keep the compensating wire well insulated.

In the case, however, of small and varying faults it would seem open to this objection: The resistance of the fault must govern the current passing through the galvanometer, and sudden and capricious changes (so frequent) in this resistance would produce corresponding galvanometer disturbances, thus rendering it difficult practically to obtain a balance. In other words, the test would be made extremely uncertain by rapid variations in the false zero.

Mr. Collis does not state the kind of galvanometer he proposes using.

I doubt whether a needle instrument is sensitive enough. He probably would require a portable astatic, with daylight transparent scale, and no lamp. With such a galvanometer it often is possible to dispense with a battery, and localise instead with the fault current.

The higher the conductivity ratio of the compensating wire to that of the faulty main the better. The first-mentioned need be only of large enough gauge to preclude undue heating effect from the battery current.—Yours, &c.,

March 14, 1894. H. W. SULLIVAN.

THE CALCULATION OF MAINS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with great interest the leading article in your issue of February 9th. This article, and some former remarks on the same subject which appeared in your esteemed paper, have led me to suppose that the question of a more accurate calculation of mains for electric supply is beginning to meet with a marked attention in your country. As however, in your discussion of the matter, you come to the conclusion that the method of calculation, as it is used in Germany, is not much more than a pleasant pastime for mathematicians, I beg by the following lines to express my own opinion, which is somewhat different. In doing so I think I am speaking, not only in my own name, but in that of most German electricians engaged in projecting networks for electric supply.

A difference must be made between *projecting a plant*, the execution of which is not yet certain, and between *designing a network for immediate execution.* Whenever a large community wishes to have tenders for a system of electric supply it will give all firms desirous of competing the same data for the load of the network, *i.e.*, the number of lamps and their distribution among the various streets. It matters little whether these indications are exactly in harmony with the actual circumstances (such indications being altogether impossible to be made), the chief object being to offer an equal basis for the examination of all tenders received. For this reason special care must be taken in determining the sections so as not to waste copper, and to place it instead where it is more useful, in order to obtain the highest effect possible.

The estimates of the various firms are generally submitted to a jury with a view to accurately examine the density of current, drop, and balancing of tension, &c. Their opinion on these points, in connection with the estimated outlay, will be decisive for the result of the adjudication.

It is quite natural that, under such circumstances, the greatest care must be bestowed on the mathematical determination of the site for the feeding points, and of the sections generally, much more care than there would be necessary in designing a network for immediate execution. Indeed, in the latter case, it would be perfectly right to proceed in a more off-hand manner, because, as set forth in your article, the inexactitude of the elementary figures, the variability of those figures in the course of time, &c., would have to be taken into consideration.

The ability, however, of working in that off-hand manner requires some experience, which can only be obtained by a careful study of the properties of a network. The way proposed in your article, *i.e.*, to draw in more copper when the loss increases, will enable only a very limited number of people to obtain this experience, and even these only after a very long time. A much easier way is, in my opinion, to design some networks in the said off-hand manner and to *scrutinise the same afterwards by mathematical calculation* as to the distribution of current and drop, in order to determine before all the influence exercised on the distribution of the current by any modification of the sections or the load or by the junction of new conductors. Such researches are particularly interesting; they will facilitate an insight into the properties which a network has, or should have, much better than the examination of the drop of existing networks, such an examination being moreover possible only on very rare occasions.

In many German towns the networks have been calculated in this manner after laying, consequently the conducting engineer has gained a perfect knowledge of the properties of the network

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under his control, as well as of its working under different loads. He is able to say whether any particular service main is capable of bearing an increase of load or not. The possibility of easily obtaining such a perfect knowledge is a further argument in favour of accurate calculations in connection with *laid networks*, and it is of special importance when special guarantees have been taken for the cable, as for instance that the load of a cable must not exceed a certain limit.

The above considerations have guided me when establishing my method of calculating systems of electrical supply, which has appeared in the *Elektrotechnische Zeitschrift*, No. 37, of September 15, 1893. It has been my ambition to form that method so as to allow the calculation to be executed in accordance with it in the easiest possible way, and—after the system has once been calculated—easily to modify the calculation according to the modifications of load and section; further, to make the calculation so lucid that the influence of the said modifications will clearly appear in the course of the calculation.

I may hope that my method will in some way form a useful contribution to the solution of the problem, as in this country the systematic calculation of mains is being carried out, not only by mathematicians, but more especially by electrical engineers engaged in practical work.—Yours, &c.,

Mülheim-am-Rhein, JOACHIM TEICHMÜLLER,
March 12, 1894. Elektro-Ingenieur.

COST OF GAS AND ELECTRIC LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I enclose some figures respecting the relative cost of gas and electricity, which seems to me of some value and interest. They are based on the figures supplied by the bursar of Hertford College, Oxford.

I may remark that in the first table the year 1892 was not available for purposes of comparison, because it was a "broken" year, electricity being employed during only a portion of it. In 1891 it was impossible to separate the cost of "heating" from that of "lighting" gas, so that the cost of "heating" gas has been included in both years' accounts.

The balance in favour of electricity might, as a matter of fact, have been considerably increased, for in 1891 the college paid a sum of £15. 1s. 8d. for lighting its dining hall with oil lamps, while the cost of lighting the dining hall by electricity is included in amount given for 1893. The total cost for 1891 would then have been £95. 7s. 4d., as against £75. 17s. 11d. in 1893, making the saving by electricity, as compared with gas and oil, £19. 9s. 5d., instead of £4. 7s. 9d. As, however, this cost of lighting the hall by oil in 1891 was obviously abnormal and due to exceptional circumstances, it seemed fairer to omit it altogether. This has been done and no allowance has been made in the ac ount for 1893, so that in these figures there is *no hypothetical element whatever*. The figures in the second table are not at all unique. I have frequently observed a saving of 40 per cent. effected by care and attention.

It appears conclusively from this, that under careful management electricity at 8d. costs less than gas at 3s. 2d., and, besides the direct saving in money, yields indirect saving in greater illumination, greater cleanliness, and greater convenience.—Yours, &c., L. A. SELBY BIGGE.

University College, Oxford, March 8, 1894.

(1) Figures showing the relative cost of gas and electric light in Hertford College:—

	£	s.	d.	£	s.	d.
1891.—Cost of gas at 2s. 8d. per 1,000 used for public lighting and heating				67	12	2
1893.—Cost of gas at 2s. 8d., 2s. 10d., and 3s. 2d. per 1,000 used for public heating ...	14	19	7	75	0	3
Cost of electricity at 8d. per unit used for public lighting	60	0	8			
NOTE.—The cost of gas consumed in 1891, if taken at the present price of 3s. 2d. would have been				80	5	8
The cost of gas consumed in 1893, if taken at the same price of 3s. 2d. for the whole year, would have been £15. 17s. 3d., making together with electricity a total cost of				75	17	11
This shows that with gas at the present price of 3s. 2d. and electricity at 8d., the positive saving in money to the college by the introduction of electricity is ...				4	7	9

(2) Figures showing the saving effected in the consumption of electric current by economy and good management:—

Consumption in "units" in — College.

		1892.		1893.		
Week ending	Nov. 1,	124·8.....	Corresponding week,	80·2......	Saving	44·6
„	„ 8,	126·8	„	58·6......	„	68·2
„	„ 15,	138·0......	„	85·0......	„	53·0
„	„ 22,	146·0	„	78·0......	„	68·0
„	„ 29,	108·0	„	72·0......	„	36·0
„	Dec. 6,	131·0......	„	72·0	„	59·0
„	„ 13,	152·0......	„	72·0......	„	80·0

Total for seven weeks in 1892, 926·6. At 8d. per unit = £30. 17s. 8d.
Total for seven corresponding weeks in 1893, 517·8 = £17. 5s. 2d.
Total saving, 408·8 = £13. 11s. 6d, or about 43 per cent.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.—The General Manager of the Glasgow Corporation Tramways invites offers from firms in a position to contract for the electric lighting of about 240 tramcars for one or more years. Offers to Mr. John Young, City Chambers, Glasgow.

TENDERS ACCEPTED.—The Bolton Town Council have accepted the tender of Mr. W. Pollit for the construction of four transformers in connection with their electric lighting undertaking. The Corporation have also accepted the tenders of Messrs. Crumbelhulme and Sons for 100 lamp pillars, and of Messrs. Siemens Brothers and Co. for electric mains to the Town Hall and on to Messrs. Wood's foundry. The operations at the Spa-road works are approaching completion.

———— The Yarmouth Town Council have received 26 tenders for the laying down of the electric light installation, only six of these being complete. The lowest tender is Messrs. Crompton and Co.'s, at £12,578. 4s., and the highest Mr. H. South's, £19,624. Messrs. Crompton and Co.'s tender has been accepted.

———— The tender of Messrs. Penman and Co., of Glasgow, has been accepted by the Belfast Harbour Commissioners for the supply of a Cornish boiler for the electric light station at Abercorn Basin.

BUSINESS CHANGE.—Mr. W. J. Hassard has acquired the business of optician and philosophical instrument maker lately carried on at 209, Sauchiehall-street, Glasgow, by Mr. Mathew Edwards, and since his death by the trustees.

AUCTION.—Cadby Hall, the Kensington works of Messrs. Woodhouse & Rawson, is shortly to be put up to auction by Messrs. G. A. Wilkinson & Son.

DISSOLUTIONS OF PARTNERSHIP.—Messrs. Rains, Middleton and Co., electrical engineers, Connaught Mansions, 34, Victoria-street, S.W., have dissolved partnership.

APPOINTMENT.—Mr. C. H. Wordingham has accepted the position of chief engineer to the Manchester Corporation Electric Works, at the invitation of the Electric Lighting Committee. Mr. Wordingham superintended the carrying out of the several contracts for the establishment of the central stations at Manchester and Whitehaven on behalf of Dr. Hopkinson, and has been running the Manchester station during the last three months.

PLANT FOR SALE.—Messrs. Wheatley Kirk, Price and Goulty advertise several complete electric light installations for sale, cheap. Particulars will be found in our advertisement columns.

LIQUIDATIONS.—Mr. C. J. Stewart, the official liquidator of the Medical Battery Company (Limited), gives notice that the following persons have been appointed a committee of inspection to act with him:—Messrs. L. J. Greenberg, J. H. Lile, A. L. Poulter, C. B. Harness, and Major Charles Elers.

———— A petition has been presented for the compulsory winding up of the South Staffordshire Tramways Company, and is down for hearing at the Royal Courts of Justice, Strand, W.C., on the 21st inst.

———— The Official Liquidator has issued a statement of the affairs of R. Bolton and Co. (Limited), in which he says that by an agreement dated April 22, 1893, made between Mr. Bolton as the vendor and Mr. H. Coward on behalf of the Company, it was stipulated (*inter alia*) that the Company should purchase as from January 1, 1893, the goodwill of the business and the copyrights appertaining thereto, the book debts incurred after December 31, 1892, and all patents, licences, &c., together with the interest of the vendor in a stock of carbons, &c. The purchase price was fixed at £8,000, payable in cash and shares on or before April 15, 1894. The insolvency of the Company is attributed by the secretary to depression in business owing to the low state of

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the Italian and Sicilian markets, where the chief business was done, to depreciation in value of a large stock of carbons (the vendor's interest in which was taken over by the Company), and to bad debts. The statement of affairs discloses liabilities £2,259, of which £1,293 are unsecured, with assets estimated to produce £77 net, the deficiency as regards contributories being returned at £8,248.

BANKRUPTCIES.—Mr. Louis Swaby applied last week at the Brentford Bankruptcy Court, before Judge Bagshawe, for his discharge. In the affidavit filed in support of the application Mr. Swaby urged that his bankruptcy had been caused by circumstances beyond his control, and that he was unable to pay his just debts on account of the malicious persecution and fraud to which he alleged he had been subjected whilst carrying out his duties as a Director of the Maxim-Weston Electric Light Company. Mr. Swaby further states that Mr. Hugh Watt, who was on the directorate of the Maxim-Weston Company, was responsible to his estate for various sums. The Official Receiver (Mr. Mercer), however, stated that the bankrupt had contributed to his bankruptcy by rash and hazardous speculations. He (the Official Receiver) had made every attempt to collect the bankrupt's debts, but without avail. He had written to Mr. Watt, who denied all the charges preferred against him by Mr. Swaby, and the judge observed that a letter received from Mr. Watt, in reference to his alleged indebtedness to the bankrupt's estate, was a very significant commentary upon the affidavit put in. The judge held that the speculations in which the bankrupt had indulged were to an extent rash and hazardous, and he suspended the discharge for two years, to date from December last.

——— A first and final dividend of 4s. 5¼d. in the £ is announced in the bankruptcy of Harry Austin and James Myers, lately trading as Austin and Myers, electrical engineers, 7, Florence-terrace, Armley, near Leeds.

PHONOPORE COMPANY (LIMITED).—This Company have just issued a circular, calling attention to further improvements lately made in utilising existing telegraph wires, and increasing their carrying capacity. The Company claim that their instruments have received the approval of the Board of Trade, and are guaranteed to meet their requirements. The system can be seen at work at the Company's offices, Faraday House, Charing Cross-road, London, W.C., between 10 and 5, except Saturdays.

DOMESTIC ELECTRICITY.—Messrs. Crompton and Co. gave an exhibition of electrical heating and cooking appliances at the Sanitary Institute on Friday last, before the Duchess of Albany and a large company of ladies. Mr. H. J. Dowsing, who had charge of the exhibition, showed electric ovens, hot-plates, radiators, foot-warmers, &c., at work. Her Royal Highness took great interest in the apparatus, and was particularly attracted by the perfect cleanliness of the cooking arrangements, and asked questions with regard to the principles of construction. At the close of the exhibition, Her Royal Highness expressed herself delighted with what she had seen, and thanked the demonstrator for the explanations he had given as to the working of the apparatus.

ANTI-SULPHURIC ENAMEL.—Messrs. Griffiths Bros. and Co. issue a circular giving particulars of their "Anti-Sulphuric Enamel." This material, which was first prepared at the suggestion of Messrs. Crompton and Co. to meet the need of a protection for metal and woodwork from the destructive action of the fumes and spray in battery rooms, is now in use in many of the principal central stations in which accumulators are used, the reports from which are very favourable. This enamel is also found to be of use for a variety of purposes in the electrical trade. It is found to be a good insulator, and dries quickly. We learn that at Aberdeen it is used to protect the wood and metal work from the action of the acid fumes and spray of the batteries.

MAUDSLAY, SON AND FIELD (LIMITED).—This firm announce that they are now prepared to supply the "Belleville" water-tube boilers. We have received a circular, from which we find that not only are safety and rapidity of steaming claimed, but a guarantee is made in regard to steaming capacity. Five types of "Belleville" boilers are manufactured—stationary, portable, marine, auxiliary, and steam launch. The circular contains prices of both stationary and portable types, and a form of agreement setting out the conditions the Company are prepared to enter into in supplying these boilers, which have been adopted by the British, French, Russian, Greek, and Spanish navies, electric light companies, &c.

ANTWERP EXHIBITION.—The Electricity and Hydraulic Company, of Charleroi, Belgium (whose agent in this country is Mr. D. McNaughton), have secured the contract for the lighting plant for the forthcoming Exhibition at Antwerp.

NEW ELECTRIC LAUNCH.—Messrs. Paul Jones and Son, of Gourock, have just launched a new electric launch, 18ft. in length, for Baron Barreto, of Brandon Park, Suffolk. The launch was designed by Mr. Jones, jun., is constructed of light, substantial materials, and weighs less than 4cwt. The launch is to be used as a tender to the steam yacht "Asteroid."

ABERGAVENNY.—Mr. Manville has been instructed by the Improvement Commissioners to prepare a report as to the advisability of proceeding with the electric lighting scheme, and its probable cost, at a fee of £36. 15s.

ACTON.—At a meeting of the Local Board the Chairman stated that they were about to enter into an agreement with Mr. Medhurst, under which the streets of the district were to be lighted by electricity at the same rate as the Board now paid for the gas lighting.

BEDFORD.—The local electric light company have lodged with the Board of Trade their reasons for asking that department to dispense with the consent of the Bedford Urban Sanitary Authority to the Company's application for a Provisional Order. The reasons for dissenting are thirty-nine in number. Replies have also been lodged to the objections of the Urban Sanitary Authority and of Mr. W. Roff and others, and the Company submit that the objectors have shown no good or valid objections against the grant to them of a Provisional Order.

BLACKPOOL.—On Wednesday, Mr. T. Codrington held a Local Government Board inquiry on the application of the Town Council for power to borrow £24,000 for the extension of their electricity works. The Electric Lighting Committee of the Town Council have decided to accept the tender of Messrs. John Fowler and Co. (Leeds) (Limited) for the extension of the Corporation's electricity supply station, subject to the firm entering into a satisfactory contract to be prepared by the Town Clerk. The total amount of the tender is understood to be £9,000, and includes all the machinery likely to be required. Two new tramway cars are to be purchased, either with separate motor trucks or on the bogey principle, or both, at a cost of about £200 each.

BRADFORD.—It has been proposed by the Gas and Electricity Supply Committee, and adopted by the Corporation, that the charge for electric current supplied for motive power, from April 1st to October 1st, be 3½d. per unit.

BRIGHTON.—The proprietors of the Brighton and Rottingdean Seashore Electric Tramroad Company, have, in extraordinary meeting, approved the Board of Trade licence.

BROMLEY AND BECKENHAM.—The Clerk to the Beckenham Local Board has written the Bromley local authorities inviting them to appoint a small committee to consider the advisability of a joint installation of the electric light. The proposal has been referred to the Bromley Electric Lighting Committee.

BURTON.—At the last meeting of the Town Council the report of the Electric Lighting Committee was discussed, and a question was asked as to the remarks concerning the re-opening of Station-street for the laying of larger pipes. Alderman Lowe, Chairman of the committee, said the contractors, Messrs. Fowler and Hammond, included in their tender cables to be laid in cast-iron pipes of a certain size. When it was found that the tubes were not large enough, the contractors at once agreed to bear the expense involved in laying down another set of pipes and in opening and relaying the footpaths. The loss amounted to £300, and would be borne by the contractors.

BUXTON.—The Local Board have decided to apply to the Board of Trade for an Electric Lighting Provisional Order.

CANTERBURY.—An extension of time to June 30th has been granted to the Brush Company to enable them to form the Canterbury Electricity Supply Company. The Town Council have asked the Brush Company to issue a prospectus of the new company, as, until this is done, the whole matter is at a standstill.

CASTLEFORD.—A special meeting of the Local Board was held yesterday (Thursday) to consider a report from Mr. R. Hammond on the question of installing the electric light at Castleford.

CORK.—A sitting of the Judicial Committee of the Privy Council was held in Dublin last week, at which the Cork Tramways Company submitted a scheme for a system of tramways to be constructed to run through the city of Cork, with a right to use electricity as motive power. Mr. Ronan, Q.C., who appeared for the Tramways Company, said the scheme was before the Committee in 1892, and was practically passed. The Corporation of Cork were in favour of the scheme, and the Harbour Commissioners had consented to the tramway so far as it affected their interests. An objection had been taken by the Board of Trade to a portion of the route suggested to be opened, and the Lord Chancellor stated that the Committee could not make an order irrespective of this suggestion. The scheme was agreed to as submitted, excepting so far as the Board of Trade's objection, regarding which the promoters were recommended to agree with that body.

DESTRUCTIVE FIRE.—On Saturday last a fire broke out on the premises at Birkenhead occupied by the Hope-Jones Electric Organ Company. Considerable damage was done before the conflagration was subdued.

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DERBY.—The opening of the new Midland Institute supplies an occasion for several of the leading provincial journals to call attention to the vastness of the Midland Company's undertaking. The capital of the Company is £100,000,000. It possesses two thousand miles of railway and a staff of 54,000 men, and the Institute itself has grown out of a small gift from the Company in 1850 to a body of earnest men employed in the locomotive department to form themselves into a reading society. The town of Derby alone contains no less than 12,000 employees of the Company. The Institute building covers an area of 960 square yards, and has been built from the designs of the Company's architect, Mr. Trubshaw. In the library two electric arc lights are used, and throughout the large hall, which is one of the finest in Derby, the advantages of the electric light are fully appreciated. The plant for lighting has been put down by the Company's electrical engineer, Mr. W. Langdon, and the light is supplied free to the Institute.

——— On Tuesday, Mr. F. H. Tullock conducted a Local Government Board inquiry regarding application from the Corporation to borrow £5,000 for electric lighting purposes. The Town Clerk explained that this £5,000 was in addition to the £30,000 already granted, and was required for new machinery and mains to be used in the extension of the lighting area.

DERRY.—The members of the Corporation inspected the generating plant at the electric light station, on Monday, previous to a test being taken of the street lamps. Amongst those present were the representatives of Messrs. Siemens Bros. and Co., Messrs. Johnson and Phillips, and Messrs. Alex. Brown and Sons. Great satisfaction was expressed at the admirable way in which the contractors had completed their tasks. The inspection was followed by speech-making, and "Success to the undertaking" was proposed by Mr. Councillor Magee, the Chairman of the Electric Lighting Committee, coupled with the names of the representatives of the contractors. A similar compliment was paid to Mr. Magee by the Mayor, who spoke in high terms of the energetic and disinterested character of Mr. Magee's laborious work in connection with their electric lighting scheme.

——— Mr. John Christie, who, as stated in our last issue, has been appointed electrician-in-charge of the Londonderry Central Station, is to receive a salary of £180 per annum.

EDINBURGH.—The Town Council have decided to charge 6d. per unit, with discounts ranging from 1 to 25 per cent. according to the amount of current consumed, the charge for electric current for motive power purposes to be 3½d. per unit. Mr. McKenzie, in proposing the above recommendations of the Lord Provost's Committee, entered fully into the financial aspect of the electric lighting question, and in the course of his remarks referred to the series of articles recently published in *The Electrician* on the relative cost of electric light and gas. In proposing a further recommendation of the Committee, for the appointment of Mr. E. W. Monkhouse as resident electrical engineer at a salary of £300 per annum (not £180 as mentioned in our last issue) it was stated that Mr. Monkhouse had the largest experience of all the 98 applicants in the kind of work which would have to be done in Edinburgh.

EXHIBITION.—An Art and Industrial Competitive Exhibition was held at Hebden Bridge on the 3rd and 5th inst., which was illuminated by the electric light, under the supervision of Mr. R. S. Blackburn. As usual the electric cooking display proved a great attraction, as did also the motive-power installation used in driving sewing machines, fans for ventilating, knife cleaners, coffee grinders, and other domestic apparatus.

FOLKESTONE.—It is evidently the intention of many of the members of the Town Council that the electric lighting question shall not have a patient hearing. The Electric Lighting Committee have obtained a supplementary report, but its discussion has been adjourned for another fortnight.

GREAT YARMOUTH.—In reference to the tenders received for the electric lighting scheme the Surveyor, at the last meeting of the Town Council, pointed out that the cost of the installation would be, according to the tenders accepted, £16,200, whilst the loan sanctioned by the Local Government Board was only for £15,000. The Council resolved to apply for sanction to borrow a further £1,500.

HALIFAX.—Notwithstanding the many improvements introduced into this town during the past 20 years, including electric lighting, the rates stand at only one halfpenny in the £ excess over those of 1873.

HAWICK.—A proposal is before the Town Council that the electric light be introduced into this town.

HENLEY-ON-THAMES.—The new launch-charging station built by Mr. Weyman for the Upper Thames Electric Launch Company on Rod Eyott is nearly completed, and the barge used for this purpose last season is to be removed.

LONDON COUNTY COUNCIL.—By 37 votes against 10 the report of the Highways Committee, embodying a proposal for placing electric light pillars in the centre of the carriageway of the Victoria Embankment, has been rejected.

LOWESTOFT.—The Town Council have instructed their surveyor to make inquiries regarding the difference in cost of lighting by gas and electricity. It is probable that the Council may consider the adoption of the electric light at an early meeting.

MANCHESTER.—The telephone question which has dragge itsd slow length along and proved a source of much concern to the local authorities, has at last been settled. The report of the Paving and Sewering Committee, which recommends that the proposals made by the National Telephone Company should be accepted, have been adopted. The overhead wires are to be taken down and placed under the streets. The annual subscription to subscribers to the National Company's system in Manchester is to remain at £10 per annum. In proposing the adoption of the Committee's report, Mr. Alderman Milling stated that in Paris the annual charge to subscribers was £16, in Lyons £12, in Madrid and Barcelona £11 17s., in St. Petersburg and Moscow £39 11s., in New York £50, in Boston £37, and in Philadelphia £25. The recommendation of Mr. Alderman Leach that the Corporation should open the streets and put down the pipes to carry the underground wires, and to hire the same to the National Company, was rejected. Several speakers urged that the suburban residents should be included in the £10 rate, and it was pointed out by the Lord Mayor that something in this direction would doubtless be conceded by the Company.——We learn that the Athenæum officials are considering the advisability of adopting the electric light throughout the building, and have commissioned Mr. S. V. Cirehugh to prepare plans and specifications for the necessary work.

MONTROSE.—Two or three members of the Police Commission propose visiting the metropolis shortly, in connection with the suggested electric lighting scheme.

OLDHAM.—The Electric Lighting Committee of the Town Council announced at their last meeting that the electric current was to be turned on yesterday (Thursday).

SALFORD.—The Gas Engineer's report to the Town Council announces that the whole of the contracts for the electric lighting works, amounting to £25,500, have been let, three of them to local firms.

STAFFORD.—The Town Council have received a communication from the Local Government Board, giving sanction to the borrowing of £20,000 for electric lighting purposes for a term of 25 years. Tenders have been invited for the erection of the necessary buildings, and the Lighting Committee have decided to obtain engines, boilers, and dynamos from certain well-known and established firms, whose names have been submitted to the Committee by Mr. J. F. Bell, the Corporation's engineer. This course was adopted in preference to advertising, because the Committee "felt it was important that the work should be done well."

STIRLING.—The members of the Corporation continue divided in opinion as to whether the Corporation should itself apply for a Provisional Order or permit the Caledonian Electric Supply Company to proceed with its application. As matters stand at present, the Board of Trade have notified the Corporation that, before taking into consideration the objections of the Corporation to the grant of the Provisional Order to the Caledonian Company, it is important that a notification should be made as to the intentions of the Corporation on the question. On Monday, at a special meeting of the Town Council, called to determine whether the Corporation should apply forthwith for a Provisional Order (after hearing an influential deputation in favour of this course being adopted), an amendment was proposed, and, on a division, was carried by a majority of ten to eight. This latest decision annuls the previous resolution of the Council to apply for a Provisional Order, and makes confusion worse confounded.

SWANSEA.—The parish church is to be lighted temporarily by electricity, through the munificence of a firm of purveyors of children's games and exercises. An attempt to use lamps bearing the legend "Studt and Son," the name of the aforesaid purveyors, was speedily "spotted," and the bulbs were substituted for others minus the advertisement.

TAUNTON.—The Electric Lighting Committee report to the Town Council that the work in connection with the electric lighting extensions is progressing favourably. A sum of £5. 5s. was voted to purchase a present for Mr. J. A. Robinson, of the Great Western Railway, whose assistance and advice has been of great value to the Committee during a period of difficulty and anxiety.

TIVERTON.—At the last meeting of the Town Council the report of the Electric Lighting Committee was referred back, with a view to considering a cheaper scheme for adoption in the borough, having regard to the proposed closing of the gas works.

WOLVERHAMPTON.—The Local Government Board have sanctioned the application of the Town Council for borrowing powers for £30,000 for their electric lighting scheme.

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COMPANIES' MEETINGS AND REPORTS.

Oriental Telephone and Electric Company (Limited).

An extraordinary general meeting of the shareholders of this Company took place on Monday at the Cannon-street Hotel, to consider the confirmation of the resolutions passed at the meeting on the 21st ult., expressing the desirability of winding up the Company voluntarily with a view to its reconstruction, appointing Mr. Henry Grewing and Mr. George Bland Frost liquidators; and incorporating a new company with the same name, with a nominal capital of £200,000, in shares of £1 each, the consideration for the transfer of the assets of this Company to the new company to be the allotment to the liquidators, or as they might direct, of 171,497 fully-paid shares of the new Company. The chair was taken by Mr. William Addison.

The SECRETARY (Mr. Alex. Chalmers) read the notice convening the meeting.

The CHAIRMAN then said: Gentlemen, we are met to confirm the resolutions passed by the meeting on the 21st ultimo, but before proposing that they be confirmed I should like to say a few words. In the circular sent out by the Board on February 9th it was stated that the Directors hoped the reconstruction would be carried out before the ordinary general meeting of the Company, when a dividend for the past year would be declared. It was pointed out by a shareholder that this statement of the Board was somewhat inaccurate, as the Company would be in liquidation whenever the resolutions were confirmed, and, therefore, the Company could not pay a dividend. This was no doubt technically correct, but you will have a dividend, or, at any rate, a distribution, whichever you like to call it. The Directors have been advised by the Company's auditors that the new Company can only earn a dividend as from the period of registration, consequently the dividend the shareholders will receive next year would only be from the profits of the Company for say some 9¼ months. We, therefore, propose that the distribution which the liquidators will make to you as soon as they possibly can will be for the period from the January 1, 1893, to March 12, 1894, *i.e.*, for 14½ months. This distribution will be made on the whole of the paid up capital of the Company, this being a part of the agreement of the scheme we are now carrying out. It will be equivalent, as nearly as possible, to 4¼ per cent. per annum from January 1, 1893, to March 12, 1894, on the amount of the reduced capital, and be free of income tax. Nothwithstanding that the Vendor shares participate in the dividend, the holders of Ordinary shares of 11s. will receive a slightly improved dividend on that paid last year. You will shortly, therefore, receive from the liquidators a letter stating that on your returning your old certificates to be exchanged for new ones you will receive a cheque for the amount of your respective distributions.

The SOLICITOR (Mr. Joseph Addison) said that if the shareholders had no objection the resolutions would be moved *en bloc*, to save time.

The CHAIRMAN then proposed, and Mr. GREWING seconded, the confirmation of the resolutions.

Mr. NORRIS asked whether the statement now made that the dividend was to be paid to the Vendor shareholders was not a distinct breach of the the arrangement put forward by the Directors.

The SOLICITOR replied in the negative, adding that the scheme as they understood it was this—that the Ordinary shareholders and the Vendor shareholders, as from December 31, 1892, would participate in a certain way.

Mr. NORRIS said that he distinctly understood from the remarks made at the previous meeting, and from the wording of the report, that there was no intention for the year 1893 to distribute any dividend to the holders of the Vendor shares.

The CHAIRMAN: That was never the idea of the Board at all in the arrangement with the Vendors; it was intended that the Vendor shares should come in now.

Mr. NORRIS: But not for the past year.

The CHAIRMAN: Yes, for the past year.

The motion was then put and declared carried, and the meeting closed with the usual complimentary vote.

Oxford Electric Company (Limited).

The third ordinary general meeting of this Company was held at the offices, 45, Broad-street, Oxford, on Saturday last, under the presidency of Sir Henry Mance, C.I.E.

The CHAIRMAN said it had been extremely satisfactory to the Directors that, in consequence of a general settlement with the contractors, they had been able to open the accounts of 1893 without bringing forward the adverse balance which appeared in the balance-sheet for the preceding year. As he was Chairman of the Construction Company when the contract was entered into, he was well qualified to speak as to the intentions of the contracting parties, and he took that opportunity of expressing the Directors, entire satisfaction with the manner in which the contractors had carried out the work and fulfilled their obligations towards them. With regard to the accounts generally, he had some doubt whether the expenditure on College installations should properly be included in the capital account. In these matters, however, they were entirely in the hands of the auditors, and practically it made little difference whether it was shown in the capital account or balance-sheet. He wished them, however, to understand that this sum had been expended in fitting up certain colleges with the necessary installation in order to enable the Company to supply the light, all expenditure of this kind being guaranteed by the college authorities. If necessary, we are able to borrow what money we require for this purpose, and we receive interest from the colleges sufficient to pay the interest on the loans. The colleges have the option of purchasing the installations at any time they please, and are bound to purchase eventually at the original price. Since January 1st about £800 of this sum had been paid off. They have still a small amount of Debenture capital unissued, but this would probably be required for various extensions which were contemplated during the year, and when they required funds he had no doubt they would be able to issue the debentures at par without difficulty. Considering the short time the Company has been in operation he thought the revenue account should be regarded as extremely satisfactory. They had written off nothing for depreciation, but on the other hand, there was an item of £396 for the maintenance of machinery and plant. The proper policy was to keep the plant in thorough working order, and, with the exception of the batteries, their plant was in better order now than when it was first laid down. The cost of new battery plates would be included under the expenditure for maintenance, and proper provision made for the renewal of worn-out machinery. With regard to the £546 profit on installations and other work, the Company had carried out some important installations during the year, and also derived a reasonable profit on the sale of lamps and other articles. The balance at their banker's was very satisfactory for so young a company; and the stock on hand, represented by meters, service boxes, cable, coals, &c., would all be useful to them. After providing for debenture interest, there remains a balance to the credit of the net revenue account of £68. 8s. 5d., which had been carried forward. The number of 8-c.p. lamps connected to the system had increased from 4,040 to 7,012 on December 31, 1893. The number of consumers has increased from 65 to 100, colleges being counted as one only, unless there are separate installations within the same college. Amongst their customers were 10 colleges, 51 shops, five hotels, six clubs, and 15 private houses, the remainder consisting of the theatre, a church, and various offices. We are steadily adding to the number of our customers, and the following university buildings were now considering the advisability of installing the light: Magdalen Schools, Wadham, Exeter College, and the University Galleries. Trinity College was expected to make a large extension of their light almost immediately. Should all these be connected to the system it would probably mean the equivalent of an additional 1,500 8-c.p. lamps. Another 1,500 might be reckoned from other quarters, and as they had at the present moment about 7,500, at least 10,000 lamps would be installed before the end of 1894. Their length of trenching had increased from 6,500 to 7,490 yards, and low-tension supply mains from 12,000 to 13,980 yards; 1,025 yards of iron piping had been put down, and the lengths of high tension mains had been increased from 10,500 to 12,700 yards. Two new sub-stations have been established, and one transferred; 103,000 Board of Trade units were supplied to customers during the year, our best week's revenue being £144, as compared with £86 during 1892. Eighteen per cent. of the current sent out to customers has been supplied from the batteries while the machinery has been at rest. The use of a small bank of storage cells had enabled them to dispense with one shift of men, and rendered it unnecessary to move the machinery before the hour when a remunerative load might be expected. The careful record which had been kept, and the experience of the past twelve months, enabled them to estimate with accuracy when it was necessary to set in operation the tranformers at the different sub-stations. They proposed still further extending the mains almost immediately, and a further extension, to embrace the residential district in the north of Oxford, is receiving serious consideration. Throughout the year there had been a complete absence of any accident, and they had been able to keep up the constant pressure in the mains which is required by the Board of Trade. The cost of the production of the current at the works came out rather less than 4d. With regard to the efficiency of the system, it worked out at about 62 per cent., and compared favourably with other systems.

Mr. L. A. SELBY BIGGE seconded the motion for the adoption of the report (given below). He said that the results shown by some of the Oxford College accounts as to the cost of electric lighting are remarkable. The Bursar of Hertford had favoured him with the lighting accounts of his College for this last year, and assured him that the cost of electricity as used in the College in 1893 was actually less than the cost of gas used in the College in 1891; and these calculations made no allowance for the price of gas in 1893 having increased. The result was that the public lights of this College when supplied with electricity at 8d. per unit was less than when supplied with gas at 2s. 8d. per 1,000.

The report and accounts were adopted unanimously.

The CHAIRMAN proposed that Mr. Robert Buckell and Mr. John Irving Courtenay be re-elected Directors, which was seconded by Mr. GARCKE, and carried unanimously.

Mr. Carver was re-appointed auditor, and a vote of thanks to the Chairman terminated the meeting.

The following is the report of the Directors referred to:—

The Revenue Account shows a gross profit of £1,105. 7s., and after providing for the full interest on the Debentures issued up to December 31, 1893, there remains a balance of £63. 8s. 5d., which the Directors recommend should be carried forward to next account. The balance of £612. 9s. 1d. appearing to the debit of the profit and loss account, 1892, has not been brought forward into the account for the past year, as the contractors under a general settlement with the Company have refunded an amount which the Directors have applied to cancelling the preliminary expenses and the balance to debit of the revenue account referred to. During the past year the running of the plant has continued to give entire satisfaction. About

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3.000 8-c.p. lamps have been added to the system, and the Directors have every reason to hope that the progress during the present year will not be less satisfactory. Since the last report extensions have been made to King Edward's-street, Holywell-street, Mansfield-road, St. Giles', St. Aldate's, and Magdalen College. The total number of lamps installed on December 31st was equivalent to 7,012 8-c.p. lamps. Ten colleges are now connected to the system, and others are expected to instal the light during the present year; 103,895 Board of Trade units were delivered to customers during 1893. The expenditure of coal per unit delivered and metered has been 0·718 of a penny, which compares favourably with the results obtained by the majority of central supply stations.

Cambridge Electric Supply Company (Limited).

The annual meeting of this Company was held at the offices, 2, Sidney-street, Cambridge, on the 6th inst., the Rev. G. B. Finch presiding.

The CHAIRMAN, in moving the adoption of the report (which appeared in our issue of the 2nd inst.), said he thought they might say that the anticipations which they all had at the outset had been even more than realised by the success of the Company. The statement in the second paragraph of the report was certainly very satisfactory to the town. They had had applications for many more lamps, and the work of extension showed no signs of being arrested. The Colleges were beginning to take the light for the rooms of the undergraduates. There was a feature in the report which they ought not to pass over, and that was with regard to carrying all receipts and expenditure under the head of profit and loss up to June 30th to capital account. The Directors thought it would be much better to treat all receipts and expenditure as belonging to the capital account up to a certain date. They hoped that the shareholders would agree with the course adopted. They all knew that in the summer months they could not carry on the concern so as to make a profit, and that was the experience of all companies at the beginning. During the summer months at Newcastle the losses had been gradually dwindling down until at last there was no loss whatever; they were so situated that they made a profit all the year round, and this they anticipated would be the case at Cambridge. From October 1st to February 20th last the Company made a profit of £768. The coal strike imposed a burden of £50 a month upon them, or they would have had a profit of £9:8 in the five months. The shareholders would notice an item in the balance-sheet, "Debentures, £7,000 at 5 per cent." This was a sum borrowed from Fosters' bank, which held a charge over the Company's property. It should properly be described as a debt owing to Fosters'. What the Directors desired to do now was to raise a sum not exceeding £10,000 on Debentures of 4½ per cent., and offer these to the members of the Company in the first instance on terms to be afterwards arranged. The Directors hoped this money would come from the shareholders in preference to any persons outside.

Sir BENJAMIN BROWNE, in seconding the adoption of the report, said he believed they had come to the point of the Company when probably it was going to be a source of more material profit than it had been in times past. He believed the Company had now arrived at a satisfactory point. They were preparing to make extensions in various directions. He was told that an extension to Newnham would probably be profitable. The question of introducing the electric light into the lodging houses, which of course was a very large item in any calculations in Cambridge, was under consideration, and a great many places of business seemed to be favourably considering the advisability of taking the light. All these extensions were very satisfactory, but they required more capital. There was no more satisfactory way of obtaining capital than by people taking up Ordinary shares; that was what identified the people with the town, and it showed confidence in the Company. At Newcastle, of which they had so often heard, they found now if they wanted another £5,000 or £10,000 for the ordinary purpose of extending their mains they had only to hold their finger up and it would come in. When he compared Newcastle with Cambridge, it seemed to him that on the whole the Cambridge Company's prospects were better.

In answer to several questions,

The Hon. C. A. PARSONS explained that the expenditure had been kept down to the very lowest figure. A large number of new lamps were coming on, and they hoped to run during next summer without any loss at all in the working expenses. They had laid 18½ miles of single cable, and 5½ miles of piping.

Mr. STURTON thought that £7,000 ought to be borrowed at 4 per cent.

The CHAIRMAN: These terms were insisted upon. We could get it when we liked. If the shareholders take up the debentures, the amount of interest will not so much matter.

Mr. YOUNG: What form of security do Messrs. Fosters' hold?

The CHAIRMAN: A debenture mortgage.

The report was adopted, and Mr. J. B. Simpson, Dr. P. W. Latham, and Mr. W. C. Hall were elected as Directors, and Mr. Arthur Rutter was re-elected auditor.

An honorarium of £150 was, after some considerable opposition, voted to the Directors for past services, and the meeting terminated with a vote of thanks to the Chairman, who retires from the Board.

Hove Electric Lighting Company (Limited).

The second annual general meeting of this Company was held on Wednesday at the Town Hall, Hove, Col. H. Woods, C.B., the Vice-Chairman of the Board of Directors, presiding.

The CHAIRMAN, in moving the adoption of the report (which appeared in our last issue), said he had to regret the absence of the Chairman of the Directors, who had had to go to India and would not return till next month. He had the pleasure of congratulating the shareholders on the continued satisfactory progress of the Company. As they would have seen from the report, the number of lights connected continued to increase, and it was expected that before the end of the current year the number of lights would be more than double the number on December 31st last, and that they would then have 14,000 or 15,000 connected up. The exact number now was 12,600. When it was considered that the actual expenditure of the Company would probably at that time not exceed £35,000 or £40,000, it must, he thought, be admitted that, compared with what was done by many other companies, this was extremely satisfactory. In addition to the private lights, it was hoped that before the end of the year the Hove Commissioners would put up some public lamps along the Front, if not in some of the streets, and this would add materially to the business of the Company, and be an advantage to the public in Hove. The success of the Company was far in excess of what was anticipated, and the shares were consequently a good investment. But to ensure the continued success of the Company, and to enable them to meet the calls upon them by intending consumers, further capital was required. Hitherto their contractors, Messrs. Crompton and Co., had promptly executed all orders, and had met the Directors in every way, but considerable extension was necessary on such a scale that it would not be prudent for the Directors to enter into any fresh contracts unless further capital was subscribed. There was another matter upon which the Directors were able to congratulate the shareholders—the retirement of the opposition Company from the field, thus giving this Company the monopoly. Dealing with the present condition of affairs, the Chairman said the Directors proposed to offer the balance of the shares to the public, and at the same time issue a debenture prospectus. The shareholders would be asked to empower the Directors to issue more debentures than by the Articles of Association they had now the power to do; but it was not intended to make a higher issue than £12,500 for the present, though it was proposed that this sum should form part of a total of £25,000 when the magnitude of the works justified the Directors in making such an issue. He concluded by proposing the adoption of the report

Mr. C. F. TUFNELL seconded the motion.

In reply to remarks by Mr J. CASH, who questioned the wisdom of the Directors in laying mains outside the compulsory area, the CHAIRMAN said that there were already a large number of lights supplied by these mains, which had been laid with regard to future development, after advice from certain inhabitants and from the engineer of the Company.

Mr. J. F. ALBRIGHT congratulated the Directors upon the report they had submitted. He was himself a Director of several important electric lighting companies, some larger and some smaller than this, and he claimed to be able to judge as to how a company was being managed and of the progress it was making; and he considered the prospects of this Company, in which he was largely interested, were exceptionally good. The Company was in possession of a contract with the Hove Commissioners, which was equivalent to a Provisional Order, and a Provisional Order was considered a valuable property. They were also in possession of an extremely good district for electric lighting, and, most important of all, they were in possession of an assured consumption for their electric current, which would give them all the work they could do for several years to come. Other companies started with the probability of getting into such a position after two, three, or four years' working, but this Company had started at that point, and the result was that after carrying on their business for twelve months they showed a profit of £1. Moreover, he had got to study every item of the expenditure of the electric lighting companies with which he was connected, and he could assure the shareholders of this Company that it was worked at an extremely low cost, bearing in mind that the work was carried out under difficulties as to plant, and as compared with companies which had been established with more permanent plant from the commencement. It was, he reminded the shareholders, to their interest to support the Directors in the matter of capital.

Mr. G. B. WOODRUFF having also expressed his satisfaction at the prospects of the Company, the motion was carried.

On the motion of Mr. TUFNELL, seconded by Mr. ALBRIGHT, Colonel A. J. Filgate, R.E., and Colonel H. Wood, C.B., the retiring Directors, were re-elected; and Mr. Robert Payne, F.C.A., was re-elected auditor.

The CHAIRMAN then proposed—

"*That the Directors be and they are hereby empowered to borrow or raise any sum or sums of money on such security and upon such terms as to interest or otherwise as they may deem fit, and for the purposes of securing the same and interest, or for any other purposes, may create, issue, make, and give respectively perpetual or redeemable Debentures or Debenture stock, or any mortgage or charge upon the undertaking, or the whole or any part of the property, present or future, or uncalled capital of the Company, provided that they shall not, without the further sanction of a general meeting of the Company, borrow or raise any sum of money exceeding in the whole £25,000.*"

He said it was necessary for carrying on the business of the Company that they should have more money. They had authority to raise by debentures £10,000, but unless the shares were taken up, as they hoped they would be, they found they would have to expend £12,500. That was the extent to which they proposed to go for the present, and the remaining sum would be required only by the enlarging of their business.

Mr. TUFNELL seconded, and the SECRETARY having explained that it was necessary for the shareholders to agree to this resolution before the Directors could raise more than £10,000 by debentures, and that this total sum of £25,000 would include this £10,000, the motion was agreed to.

A vote of thanks to the Directors for their services during the past year terminated the proceedings.

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Birmingham Electric Supply Company (Limited).

The fourth annual meeting of this Company was held on the 8th inst., at the offices, Dale End, Mr. Henry Buckley presiding. In moving the adoption of the report, the CHAIRMAN said he considered the progress made by the Company was satisfactory. On December 31, 1892, the total number of 16-c.p. lamps, or their equivalent, on order was 8,329, and on the same date in 1893 the number was 10,223. Since then there had been a still further increase, and the number was now more than 11,200. The consumers in the same time had increased from 223 to upwards of 300, and the current, measured by units, 214,088 to 352,096. The percentage of increase had been : in lamps, 22·7 ; in consumers, 30·3 ; and in current, 64·5. The lamp patents had expired, and they could now supply a good article at 10s. per dozen, whereas twelve months ago they cost 3s. 9d. each. Additions had been made to the supply mains. He reminded those present that at the last annual meeting he referred to the question of new areas ; but in deference to the wishes of the City Council the matter was deferred for a time. The subject was brought before the Council in July last, and as the result of what then took place the usual Parliamentary notices had been given, and by the autumn the Directors hoped to be possessed of powers to extend their system to the districts named. In consequence of those extensions, additions to their plant would have to be made, and it was probable that the Directors would call up another £1 per share.

The report was carried, and a dividend of 4 per cent. was declared, which will absorb £2,715. 6s. 7d. ; £1,872. 18s. 1d. was carried to the credit of the depreciation reserve fund, and a further sum of £250 was placed to the general reserve fund, leaving a balance of £409. 12s. to be carried to next year's account.

Messrs. H. Buckley and J. F. Albright were re-elected Directors, and Messrs. Sharp, Parsons and Co. auditors.

Elmore's German and Austro-Hungarian Metal Company (Limited).

An extraordinary general meeting of this Company was held on Monday, at Winchester House, E.C., under the presidency of Mr. John MacFarlan.

The CHAIRMAN said : We meet you to-day with greater pleasure than in May last year, for now we are able to report to you a far better state of things than existed at that date, and that the working of the Company is unquestionably now a success. During the past ten months the Company has been passing through a most trying time, owing to the want of the necessary capital, and it has only been by the Directors personally assisting the Company to a considerable amount that they have been able to prevent it going into liquidation, and to-day they look with confidence to a speedy reward for the troubles and trials of the past. We have received a German Government contract for the supply of all copper tubes between 7in. and 12in. in diameter that will be required by the docks at Kiel, Wilhelmshaven, and Dantzig for the next three years, and believe we could obtain even larger orders from them if we were in a position to execute them. This means that our goods have been thoroughly tested by the Government, and have not been found wanting, and that we have obtained preference over all other copper manufacturers, and when we consider the short period that our factory has been in existence your Directors think there is cause for congratulation. We have not only received this particular contract, but have had many others offered. On the formation of the Company the Directors were informed, and believed, that £50,000 would be ample. We have however, never received the whole of this amount, but only about £45,000. At the commencement of the present year £5,000 Debenture stock was subscribed for, but we have not yet got the whole of this money paid up. On November 4th last the final instalment upon the property fell due, and although we had tried every possible means in our power to raise money in Germany, we had not been able to do it The vendor became very pressing, and eventually commenced proceedings against us with a view of seizing the property and putting it up for auction. This would, of course, have been simply fatal to us, and it would have had almost the same effect had the sale been even advertised. Finding our efforts to obtain money unavailing, the secretary saw Mr. Berger (the vendor) several times, who ultimately agreed that if the sum of £3,000 was paid him on February 1st he would allow the balance to stand over for two years. At this time we were refusing large orders at the factory owing to the want of copper, additional machinery, &c., which we were unable to purchase owing to the want of the necessary capital. The Directors are aware that the issue of Preference shares is a very stringent measure to adopt, but they believe it to be the only feasible method of saving the Company and of averting heavy loss to the shareholders. The Preference shares now to be issued are of £2 each, and will be allotted to the shareholders at the rate of one share for every five Ordinary shares, which is equal to a call of 8s. per Ordinary share. It is proposed that only 15,000 of these shares shall be allotted ; this should give us £30,000. Nearly the whole of this capital will be expended upon the factory and in copper, and in paying the £3,000 already mentioned. Therefore, this issue is not so severe after all, and in order to enable every shareholder to take up his proportion we shall extend the time for payment until January, 1895, and, as the calls are for but small amounts, I feel confident that it will be in the power of every shareholder to subscribe. The Directors are in every way satisfied with the work that has been done and the prospects of the Company, should the capital we ask for be subscribed. We have worked for the last eighteen months without fees, although the business has been of the most harassing nature. Had it not been for the way in which we have been supported by Mr. Ellis (the secretary) and Mr. Preschlin (the works manager) it would have been quite impossible to have carried on the business of the Company.

The CHAIRMAN then moved a resolution approving the issue of Preference shares, which was seconded by General Fraser.

Shareholders asked various questions as to the amount of business and profits made ; whether the plant was fully utilised ; how much capital had been raised ; and whether the Directors had any guarantee that this issue of Preference shares would be taken up ; to which the Chairman said their position was that they required £5,000 within a fortnight, and they therefore asked shareholders to adopt the proposal for the issue of Preference shares. It would only be put in force as a last resort, and failing any better scheme being proposed. They had a guarantee that the Preference shares would be taken up.

Mr. F. L. RAWSON also spoke, urging an alternative scheme which had been advocated by Mr. W. Elmore, who was unable to be present. He urged the shareholders not to agree to any such sacrifice of their interests as that indicated by the proposed issue of Preference shares taking 90 per cent. of the profits. In his opinion the German Company should be in a far better position than any other Elmore Company, because of its splendid water power, which, necessarily, saves so very large a proportion of the cost of manufacture ; and, secondly, on account of the high protective tariff in Germany, where the Company's productions have to be sold. They could produce tubes and other copper goods of a quality infinitely superior to the products of their competitors, as was proved by the large and profitable orders offered to the works. He suggested that the required capital could be provided by an issue of £30,000 in Ten per Cent. Preference shares in the Elmore's German Metall Actien-Gesellschaft. These should be cumulative, and be preferential in both capital and dividend, and after the 10 per cent. they should rank as to 25 per cent. of all that remains, the other 75 per cent. of the profits going to the other shares. Banking arrangements should then be made for an overdraft with which to purchase raw copper, such as had recently been negotiated for the English and Wire Companies at Leeds. As the issue would be upon the Elmore's German Metall Actien Gesellschaft, and not upon the Elmore's German and Austro-Hungarian Company, it would be free from the numerous complications of the various issues of debentures in the latter Company, and an investor will be able to see his position quite clearly.

The CHAIRMAN, in referring to Mr. Elmore's proposal, said that the fact of their having secured the German Government contract necessitated their having command of a considerable sum of money, for they would be required to turn out up to 15 tons per week. If they were placed in the possession of £5,000 within the next fortnight, to meet the more pressing liabilities, they were content to agree to Mr. Elmore's scheme, which would, however, have to be carried through within the next two months.

Ultimately the Directors' proposals were agreed to.

Direct Spanish Telegraph Company (Limited).

The following report of the Directors of this Company for the half-year ended December 31st last is to be presented at the general meeting of shareholders, to be held on Tuesday next, at Winchester House, E.C., at 1:45 p.m. :—

The accounts for the half-year show, after providing for debenture interest, a balance to the credit of profit and loss of £4,996. 7s. 1d. The traffic receipts show a decrease of £509. 15s. 4d., as compared with the corresponding period of 1892. This falling off in the receipts is entirely owing to the general depression of trade during the half-year. The working expenses are £35. 18s. 6d. less than those for the corresponding period of last year.

After adding the usual sum of £2,500 to the reserve fund, the balance of profit and loss amounts to £2,496. 7s. 1d. Out of this amount the Directors recommend the payment of the dividend at the rate of 10 per cent. per annum on the Preference shares, and a dividend at the rate of 4 per cent. per annum (free of income-tax) on the Ordinary shares, and to carry forward the balance. The reserve fund will then amount to £37,551. 11s. 10d.

The Company's cables, and the land lines in connection with them, have with one exception continued in good working order throughout the half-year. The Falmouth-Bilbao cable became interrupted on August 16, 1893; it was, however, promptly and effectually repaired on August 24th by the Eastern Telegraph Company's cable ship "Electra." The cost of these repairs, amounting to £1,453. 18s. 9d., has been taken from the reserve fund, and it is intended to repay this amount to that fund out of future profits.

A branch telegraph office of the Company was opened on November 6, 1893, in the Foreign Auction Hall, Covent-garden Market, where a great portion of the fruit trade with Spain is carried on. The results are satisfactory.

Sir John Pender, G.C.M.G., M.P., and Mr. Etlinger are the Directors retiring by rotation, and offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths and Co. also offer themselves for re-election.

W. T. Henley's Telegraph Works Company (Limited).

The following is the report of the Directors of this Company for the year 1893, to be presented at the ordinary general meeting to be held at the Company's Offices, 27, Martin's-lane, Cannon-street, London, E.C., on Thursday next, at 2.30 p.m. :—

The accounts show that a net profit has been made of £10,777. 6s. 2d. After payment of interest and income-tax, and making allowance for depreciation of plant, there remains £7,256. 14s. 1d., to which must be added £13,399. 10s. 1d. brought forward from last year. Deducting £1,050, the half-year's dividend on Preference shares paid in October last, there remains a disposal balance of £19,606. 4s. 2d. The Directors have added £10,000 to the Reserve Fund, and they propose the payment of a further half-year's dividend on the Preference shares at the rate of 7 per cent. per annum, and a dividend for the year at the rate of 5 per cent. free of income-tax on the Ordinary shares ; these payments together absorb £4,468. 10s., and leave a balance of £5,137. 14s. 2d. to be carried forward.

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A further sum of £4,000 has been paid off the £30,000 B Debentures created in 1891, which has reduced their amount to £12,000.

The improvements and extension of the Company's factories at North Woolwich, which were contemplated when the Preference capital was subscribed, have been completed, and the buildings, machinery, tools, &c., of the Company are now in first-class condition. The general business of the Company has been satisfactory, and a few hundreds of miles of submarine cables have been manufactured for various telegraph companies and for the British Government.

The Directors who retire are Mr. Frederick Newton and General George Hutchinson, C.B., C.S.I., who offer themselves for re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

ELECTRICITY USERS' ASSOCIATION (LIMITED).—This Company was registered on March 9th, with a capital of £2,000, in £1 shares, to insure against all kinds of accidents to electrical apparatus generally; to replace broken or worn out parts, lamps, &c., with new; to make all necessary repairs and keep up installations to as high a standard of efficiency under competent inspection as is possible: to provide for competent inspection of engines, boilers, pumps, all running machinery, accumulators, switches, mains, meters, and other apparatus connected with the supply of electric light, heat or power; and to advise generally upon specifications and estimates for the erection of electric lighting or other installations. The subscribers (with one share each) are Arthur E. Samuell, W. T. Lawrence, J. W. Winch, G. H. Smith, R. H. Behrend, G. Earle, and W. H. Page. The first Directors are to be nominated by the signatories to the Memorandum of Association.

ORIENTAL TELEPHONE AND ELECTRIC LIGHT COMPANY (LIMITED).—This Company was registered on March 12th, with a capital of £200,000, in £1 shares, to acquire and take over as a going concern the undertaking, assets, property, and effects of the Oriental Telephone and Electric Company (Limited), now in liquidation, upon the terms set forth in the special resolutions of the old Company, passed February 21, 1894, and confirmed March 12, 1894, to acquire any letters patent, rights, privileges, concessions, or monopolies for the use, sale, working, or manufacture, or otherwise, relating to any telephone or telephonic apparatus, or any other invention, instrument, or apparatus for the transmission of messages, or the generation, employment, or utilisation of electricity or magnetism, and to carry on the business of transmitting messages, by telephone or other means, or any business connected with the generation, employment, supply, or accumulation of electricity. The subscribers (with one share each) are:—W. Addison, Thomas Lloyd, George B. Frost, Alexander B. Chalmers, Benjamin St. John Ackers, Henry A. Hentsch, and Henry Grewing. The first Directors are:—Messrs. William Addison, Benjamin St. John Ackers, Henry Grewing, Thomas Lloyd, and George B. Frost.

WILLANS AND ROBINSON (LIMITED).—This Company was registered on March 8, with a capital of £300,000, divided into 30,000 £6 per cent. Cumulative Preference and 30,000 Ordinary shares of £5 each, to acquire and take over as a going concern the business of Willans and Robinson (Limited), incorporated in 1888, carrying on business at Thames Ditton, Surrey; with a view to such acquisition to enter into and carry into effect the agreements referred to in Clause 4 of the Company's Articles of Association, and to carry on the business of mechanical and electrical engineers and contractors, boiler makers, iron and metal founders, launch and ship builders, iron and steel converters, metal workers, smiths, wood workers, builders, painters, timber merchants, metallurgists, &c. The subscribers (with one share each) are:—M. H. Robinson, Chatley, Fassett-road, Surbiton, engineer; Sir G. A. C. East, Hall-place, Maidenhead; Capt. M. P. H. R. Sankey, R.N. (retired), Bawnmore, Arterberry-road, Wimbledon, S.W.; G. W. Anderson, Fenwick-chambers, Liverpool; T. O. Lazenby, Tiverton, Devon; P. A. Low, Maybury Lodge, Thames Ditton; James E. Thorn, Red Cottage, Thames Ditton. The number of Directors is not to be less than three nor more than seven. The first are:—Mark H. Robinson, Sir Gilbert A. Clayton East, and Capt. M. P. H. Riall Sankey, R.N.

CITY NOTES, &c.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended March 11th were £930, as against £859 in the corresponding period of last year, being an increase of £71. The total receipts for the half-year amount to £9,474, as against £9,532 for the corresponding period of 1893, a decrease of £58.

COMMERCIAL CABLE COMPANY.—The report of this Company for the year 1893 shows that the gross receipts were $1,842,346, the working expenses $784,600, and the net income $1,057,746. As compared with 1892 these figures exhibit decreases of $48,030, $6,189, and $41,841 respectively. Dividends were paid at the rate of 7 per cent. per annum, absorbing $613,376, and of the remaining $444,370 the sum of $389,600 was applied in January last to the repayment of the remainder of the debenture bonds. The Company's new cable, now being manufactured and laid by Messrs. Siemens Bros. and Co., is to be completed by July 15th. Its guaranteed working speed is to be a third greater than that of the Company's present main Atlantic cables.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announce the payment, on April 13th next, of interest of 3s. per share, less income-tax, being at the rate of 6 per cent. per annum on the Preference shares of the Company for the quarter ended March 31st, and the usual interim dividend of 2s. 6d. per share on the Ordinary shares, free of income-tax, in respect of profits for the quarter ended December 31st last. The register of transfers will be closed from April 6th to 13th, both days inclusive.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED). The Directors of this Company have decided upon the payment on account of the dividend of the current year, at the rate of 5 per cent. per annum, less income tax, on the "A" shares of the Company, for the half-year ended December 31, 1893. This will work out as follows:—On the 89,261 Ordinary shares (£3 paid), 1s. 6d. per share; on the 5,000 shares (£5 paid), allotted to the Edison Electric Light Company (Limited), 2s. 6d. per share; on the 12,139 shares (£5 paid), alloted to the Swan United Electric Light Company (Limited), 2s. 6d. per share; less income-tax. The dividend warrants will be issued on the 20th inst.

GOLD RECOVERY PATENTS.—It is announced that the African Gold Recovery Company has resolved to proceed against those companies who have ignored the African Company's patent rights.

HASTINGS ELECTRIC LIGHT COMPANY (LIMITED).—In the Directors' report for the year ended December 31st last it is stated that a considerable sum has been spent on new plant and extensions to meet the large increased demand for electric lighting, and although the receipts are much in excess of last year, the full advantage of the outlay will be derived in the future. The sum of £964. 15s. 7d. remains for dividend. Out of this the Directors recommend the payment of 5 per cent., and the carrying forward of the balance of £75. 11s. 10d. The retiring Directors, Messrs. F. A. Langham, J. Reeves, and J. Woolhams, offer themselves for re-election.

PONTYPOOL ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—At the second annual meeting of the shareholders of this Company a dividend of 2½ per cent. was declared for the year 1893.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed to-day (Friday) the special settling day for the further issue of 20,000 Six per Cent. Cumulative Preference shares, No. 20,001 to 40,000, of the City of London Electric Lighting Company (Limited).

SUBURBAN TRAMWAYS.—The *Financial Times* says:—"It is rumoured that an application is to be made to Parliament next Session for powers to construct an electric tramway from Croydon to join the South London tramway either at Clapham or Tooting, the idea being to eventually extend the line as far as Redhill. If this scheme be put through the tramway might compete to some extent with the Brighton Railway for suburban traffic. At present it is hardly more than talked about."

UNITED ALKALI COMPANY.—A further dividend of 4s. per share is declared, making a total distribution of 5 per cent. for the year ending December last. £42,581 are placed to the reserve fund.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the week ended March 9th (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £3,252.

WESTERN UNION TELEGRAPH COMPANY.—A quarterly dividend of 1¼ per cent. has been declared, although only ⅞ per cent. has been earned.

WILLANS AND ROBINSON (LIMITED).—The prospectus is issued of Willans and Robinson (Limited), with a capital of £300,000, divided into 30,000 Six per Cent. cumulative Preference shares and 30,000 Ordinary shares, all of £5 each. 14,463 Preference and 14,462 Ordinary shares, will be allotted in part payment of the purchase-money, and 7,500 shares of each class are reserved for future issue. Applications are, therefore, invited for 8,037 Preference and 8,038 Ordinary shares, payable 10s. on application, 30s. on allotment, 30s. on the 31st July, and 30s. on the 31st October. The Company has been formed to take over and extend the well known engineering business of Willans and Robinson (Limited), of Thames Ditton, Surrey, which was converted into a private Company in 1888. Owing to the vast increase in the demand for the Company's manufactures, large increases are necessary in the works and plant; hence the reconstitution of the Company upon a much extended basis. The new Company takes over the assets and liabilities as from December 29th last, together with book debts and the benefit of contracts in hand. The works at Thames Ditton are freehold, and were rebuilt and fitted with the newest appliances in 1889. In the year 1893 (just ended) the contracts obtained by the Company aggregated no less than 18,950 i.h.p., and a satisfactory increase is announced for the expired proportion of the current year. Out of 23 public lighting stations in London, 19 are engined (16 wholly and 3 partly) by the Company. With the prospectus is issued a list of some of the more important users of the Company's engines and machinery. The necessity for extending the Company's operations is owing to the pressure for orders for electric lighting engines having prevented the old Company from giving adequate attention to other profitable branches of engineering work, large orders for which the new Company will be in a position to execute. In addition to its steam engine business, it is proposed that the new Company shall commence the manufacture of gas engines and water-tube boilers, for which only a small outlay for special plant will be necessary. The old company accept £3,875 in cash and £144,625 in shares. According to the statement of Messrs. Cooper Bros. and Co., dated the 13th inst., the net profits for the past five years are stated to have been £71,955. 8s. 6d., and have shown steady growth from 1889 (£11,052. 12s. 4d.) to 1893 (£18,800. 14s. 10d.), after allowing ample depreciation on an annual average of £4,077. The certified average profits, based upon the previous figures, shows a balance profit equal to 12 per cent. on the Ordinary shares. The Directors, Messrs. Mark Robinson, M.I.C.E. (Chairman), Sir G. A. Clayton-East, Bart., and Capt. H. Riall Sankey, R.E. (ret.), M.I.E.E., are all actively engaged in the business, and have been so occupied for a number of years. Two of them give their whole time to the Company, and are under agreement not to engage in any other business. No alteration is to be made in the existing management or organisation. A feature of the prospectus is that all contracts are disclosed, except those which for trade purposes it is considered unnecessary to enumerate. The expenses connected with the formation and registration of the new Company are borne by the old Company up to and including allotment. The old Company are the promoters. Forms upon which

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applications for shares should be made can be obtained from the bankers, the London and County Banking Company (Limited), 21, Lombard-street, E.C., and branches; of the solicitors, Messrs. Farrar and Porter, 2, Wardrobe-place, Queen Victoria-street, E.C.; of Mr. Hugh Campbell, 16, Tokenhouse-yard, E.C.; and at the offices of the Company, Thames Ditton, and 14, George-street, Mansion House, E.C. The subscription list will be closed on or before Wednesday next for London, and on Thursday for the country.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price, Mar. 7.		Price Wednesday, Mar. 14.		Rate per Cent. Yielded.	Dividend Due	Business Done During Week Ending Mar. 14. Highest	Lowest
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,134,640	Stock	13/6	Anglo-American	42	44	42	44	5 13 8	Jan., Apr., July, Oct.	42¼	42
£2,932,680	Stock	27/0	Do. Preferred	78	80	78½	79½	6 8 3	" "	80	79¾
£2,932,680	Stock	5/0	Do. Deferred	7	7½	6¾	7¼	..	..	7¼	7
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	100	103	100	103	3 17 8	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	11¾	12¼	11¾	12¼	5 4 0	Mar., June, Oct., Dec.	12⅛	11⅞
£18,700	£100	5%	Do. 5 per Cent. Bonds	99	102	99	102	4 18 0	January and July	..	–
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	..	–
10,000,000	$100	7%	Commercial Cable Capital Stock	135	145	145	150	4 13 4	Jan., Apr., July, Oct.	..	–
16,000	10	8/0	Cuba Submarine	12	13	12	13	6 3 1	February and August	12½	12⅜
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2	3	2	3	5 6 8	April and October	..	–
6,000	5	10%	Do. Preference 10 per Cent.	8	9	8	9	5 11 1	" "	..	..
60,710	20	8/0	Direct United States Cable, 1877	10¾	11	10¾	11	6 2 6	Jan., Apr., July, Oct.	11	10 11/16
400,000	10	2/6	Eastern	15	15½	14¾	15	4 6 8	" "	15 3/16	14¾
70,000	10	6%	Do. 6 per Cent. Preference	15¾	16¼	15¾	16½	3 13 10	" "	16½	16 1/16
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	115½	114
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	106	109	106	109	4 11 9	February & August	..	..
250,000	10	2/6	Eastern Extension	15½	15¾	15½	15½	4 10 4	Jan., Apr., July, Oct.	15¾	15¼
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	114	117	113	116	3 9 0	February & August	114½	113
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103	106	103	106	4 14 4	January and July	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	103	106	103	106	4 14 4	" "	103½	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103	106	103	106	3 15 6	February & August	..	..
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	107%	110%	107%	110%	3 12 9	May and November	108	..
180,227	10	1/3	Globe Telegraph and Trust	8¾	9	8⅝	8⅞	5 1 5	Jan., Apr., July, Oct.	9	8⅝
180,042	10	6%	Do. 6 per Cent. Preference	15½	15½	15½	15½	3 17 5	" "	15½	..
150,000	10	5/0	Great Northern	21	22	21	22	3 18 0	Jan., April, and July	..	..
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 13 6	March & September	..	..
17,000	25	12/6	Indo-European	43	45	43	45	5 11 1	May and November	44	..
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	..	" "	–	–
£100,000	100	6%	Do. 6 per Cent. Debentures	104	107	104	107	5 12 2	March & September	..	–
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red 1942	102	105	102	105	3 16 2	..	..	..
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	–	..
3,881	£100 Cert.	25/0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	" "	–	..
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July	..	–
£249,900	100	5%	Do. 5 per Cent. Debentures	98	101	98	101	4 19 0	March & September	99	..
30,000	10	2/0	West Coast of America	2	2½	2	2½	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	97	101	97	101	7 18 5	June and December	99	..
88,321	10	1/0	West India and Panama	1⅛	1⅜	1⅛	1⅜	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10	10½	5 14 3	May and November	10½	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	" "	9 1/16	8½
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	106	109	106	109	4 11 9	June and December	..	..
64,242	15	4/6	Western and Brazilian	7¼	7¾	7½	8	..	May and November	..	..
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5½	6	5¾	6½	..	..	6	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¾	2¼	1¾	2¼	..	..	..	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	104	107	104	107	5 12 2	February & August	–	..
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910.	104	107	104	107	5 12 2	" "	..	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	115	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	100	104	100	104	5 15 5	March & September	103¾	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	2	3	1½	2½	..	–	1 9/16	1½
224,850	10/0	3¼d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
220,000	£1	4·76d.	Oriental Telephone and Electric (11s. paid)	¼	⅜	¼	⅜	5 6 5	Yearly	..	–
484,597	5	2/6	National	4½	4¾	4½	4¾	5 5 3	June and December	4¾	4 11/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½	15½	14½	15½	3 17 5	" "	..	..
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	14	15	14	15	4 0 0	" "	14⅞	14 11/16
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¼	5½	5¼	5½	4 10 11	..	5 7/16	..
925,017	£100	4½%	Do. Deb. Stk. 4½%	113	115	113	115	3 18 3	January and July	115	114½
58,000	5	1/0	United River Plate	1½	2	1½	2	..	" "	1¾	–
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	–	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11	12	11	12	–	..	11¾	11½
20,000	10	6,0	Do. 6 per Cent. Cumulative Pref. (fully paid)	13	13½	13	13½	..	–	13 7/16	13
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	–	–
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	–	–	–
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	–	–
8,322	£5	..	House to House Electric	..		..		–	–	–	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		–	–	–	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	–	–
30,000	£5	1/9	Liverpool Electric Supply (£4 10s. paid)	5 7/16	5 9/16	5¾	6¼	..	–	–	–
15,000	£5	2/6	Do. (fully paid)	6⅝	6⅞	6⅝	6⅞	..	–	–	–
111,000	5	..	London Electric Supply	¼	¾	¼	¾	.	..	..	–
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	8¼	8¾	8¼	8¾	2 5 9	..	8½	–
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	106	109	106	109	4 11 9	June and December	107¾	–
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	–	–	..	–
19,980	£5	4/6	St. James' and Pall Mall	6	6½	6	6½	..	–	6½	..
20,000	£5	7%	Do. 7 per Cent. Preference		8½	8	8½	4 2 4	–	..	..
59,900	5	2/6	Westminster Electric Supply (fully paid)	5½	6	5¾	6¼	3 4 0	–	6¼	5 15/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅝	2⅞	2¾	3	6 0 0	–	2 15/16	2⅞
90,000	.	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	–	2 5/16	2 3/16
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	106	109	107	110	4 1 10	March & September	..	..
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	3½	4	3½	4	..	January and July	..	–
12,139	5	..	Edison and Swan United	–		–		..	–	..	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	–	–	–
120,000	2	..	Electric Construction	¼	¾	¼	¾	..		..	..
12,845	2	..	Do. 7% Cumulative Pref.	1½	2	1½	2	..	..	..	–
91,195	2	10/0	Elmore's Patent Copper Depositing	⅝	⅞	⅝	⅞	–	–	..	
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	–	..	..
50,000	10	15/0	India Rubber, Gutta Percha &c., Works	23	24	23	24	5 4 2	February & August	24	23⅝
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	103	105	103	106	4 4 11	March & September	..	..
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	–	–	–	–
16,000	£10	..	Do. 8 per Cent. Preference	..		–		..	December and June	–	–
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	—	⅛	—	⅛	..		–	..
78,949	5	3/6	Swan United (£3. 10s. paid)	2	2½	2	2½	..	May and November	..	–
87,350	12	36/0	Telegraph Construction and Maintenance	39	41	39	41	4 7 10	March and July....	40	39½
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	..		–		..	January and July	..	..
37,514	£5	–	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		–		..	–	–	–
41,098	£5	–	Do. Preference (fully paid)	–		–		–	–	–	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	5%	City and South London Railway	27	32	27	32	4 5 11	May and November	..	..
87,500	£10	1%	Liverpool Overhead Railway	5½	5¾	6¼	6½	–	–	–	–

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THE ELECTRICIAN:

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NOTES.

Mr. Arnold Morley's speech at the Association of Chambers of Commerce on Thursday last, although not addressed specifically to the subjects then before the meeting, was useful, perhaps, if only in proving the futility of arguing with people who are given to riding hobbies, and who invent their own statistics wherewith to feed them. Mr. Morley showed that the figures were wrong and the criticisms unwarranted; but directly his back was turned a resolution was adopted reaffirming the complaints, as well as the erroneous calculations on which they were based. The same fate, no doubt, would have awaited anything he might have said on the question of Anglo-French telegraph rates, which, however, he seems to have discreetly passed over in silence. On the other hand, he spoke very openly and sensibly as to a matter which has been broached more than once, although not yet included in the programme of the Association, namely, the adoption in this country of "express telegrams" which prevail on some Continental systems. Mr. Morley's conclusions are so sound that we will not quarrel with his arguments; but we think he could find a better reason for rejecting preferential telegraph rates than the one which describes his customers as a democracy. In the first place it is not true, and in the next it has no more to do with the question than with the prices of top hats. If Mr. Morley wants to be truly democratic he must curtail the privileges enjoyed by the comparatively few who send many telegrams, and extend those privileges to the many who send few telegrams, a task which a democratic Postmaster-General would find rather difficult and extremely unprofitable. The true objection to express telegrams is that they force higher rates upon those who can afford to pay them, and cannot afford to be outstripped by their competitors. This, so far from being democratic, is rather aristocratic; and we may make Mr. Morley a present of it in case he has a mind to recommend it to the Chancellor of the Exchequer by way of making the forthcoming Budget more democratic even than it is expected to be.

With the revival of trade we have the company promoter with us once more, conjuring, as of old, with "that blessed word" Electricity. In our issue of February 16th, after exposing the fallaciousness of sundry comparisons that had been put forward, we so far stretched our charity as to refer to the Livet system of refuse destruction as "a genuine and satisfactory *attempt*." This week the public is invited, on the strength of this attempt, to subscribe £600,000. On this modest sum the Company will work the Livet patents all over the universe—no, in "London and twenty miles round." The estimated annual revenue is on an equally grandiose scale; nothing short of half a million sterling will satisfy the prospectus artist. The basis upon which this magnificent superstructure is reared is the assumption that on "the Livet system three tons of rubbish create the same steam power as a ton of best coal"; ten tons of refuse and one ton of average coal would be more like the truth. No less than £318,000 of the annual total income of £515,000 is to be derived from a portion of the saving effected by metropolitan electric light producers by using the Livet system. How this saving is to be on a coal bill of some £50,000 we do not exactly see, albeit this magic system "has been in operation at Halifax for many months" producing by means of a Parsons steam turbine and a small projector a result said to be equivalent to "250,000 electric candle-power." These are only two out of a sheaf of misleading statements; as to the rest of them, are they not written in the advertisement columns of all the daily papers?

For ten years and more, questions connected with the design and construction of apparatus for generating and measuring electrical energy have occupied the attention of the Institution of Electrical Engineers, almost to the entire exclusion of other matters. That this should have been so was quite natural; there was nothing else of equal importance to discuss. But to-day the centre of interest has shifted. Everyone now admits that anyone's alternators will run in parallel, given a suitable engine with a suitable governor, or better still with no governor at all. With this much debated point settled to the satisfaction of all concerned, the last outstanding question of importance in connection with dynamos has been threshed out; may we now be permitted to follow the good example of the Northern Society of Electrical Engineers, and to pass from dynamos, wattmeters, *et hoc genus omne*, to topics of more general interest, such as the management of central stations and the behaviour of underground mains. Academic papers on "The Ideal Central Station," or "The Perfect System of Mains," are not called for, but contributions only from those who have had actual practical experience of the matters they write about.

The article which we publish this week on a "Workshop Method of Testing Iron" is of some interest in connection

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with the recent discussion at the Institution of Electrical Engineers on this subject. Mr. KAPP, in common with many other engineers, has been using a wattmeter method of determining hysteresis losses, and the value of this simple means of measurement can hardly be overstated, provided certain conditions are observed; one of these conditions being the elimination by calculation of eddy current losses from the total loss. Mr. FELDMANN shows us good reason for believing that the formulæ at present in use for the purpose agree with the results of observation, thus answering to some extent the question put in our leading article of March 2nd.

THERE remains a source of error not alluded to in Mr. FELDMANN's article. Can it with safety be assumed that the reading of a Cardew voltmeter is a measure of the maximum voltage to which it is subjected?—for the induction is calculated on this assumption. In other words, are modern alternators so near a sine function in their electromotive force wave that the Cardew voltmeter reading the square root of the mean square of the volts may be taken always to read the same sub-multiple of the maximum pressure? In the cases dealt with by Mr. FELDMANN this appears to have been so, judging by the results which he obtains when working on this assumption. But it does not seem desirable or safe to assume this in every case without some experimental determination of the shape of the wave itself; and this circumstance, combined with the amount of calculation required, makes a true "Workshop" Method of Testing Iron still an unattained ideal.

FARADAY did not exhaust his subject when he delivered his Christmas lectures on "The History of a Candle." Prof. STOKES described a very pretty experiment some years ago, showing that the flame of a candle is a thin luminous cone. This experiment, which is easy and fascinating to repeat, consists in focussing the sun's rays by a lens on the flame. When the focus is brought to the middle of the flame, two bright discs are seen where the cones of light enter and emerge. The sunlight thus concentrated illuminates the solid particles of carbon to a much higher brilliancy than that due to the heat of the flame, and thus proves that they are solid. In another column will be found some observations by Herr P. GLAN on the dimensions of a candle-flame. He speaks of the volume of the brilliant portion of the flame. This luminous sheath is very thin, as may be shown by Prof. STOKES's test, when the focus of the sun's rays is brought to bear on it. Herr GLAN does not call attention to the fact that a candle flame is of an oval section, due to the curvature of the wick, but, of course, he must have observed it. It is the practice to place the two candles in a photometer with the planes of the wicks at right angles to each other, but the flame is so nearly transparent that this precaution is generally unnecessary. A modification of Prof. STOKES's experiment might be tried with a thin horizontal slice of sunlight, by which the cross-section of the flame at different levels might be examined. The mean projected area of the luminous part of the flame of a standard candle is, as has been already recorded in these columns, about half a square inch, and the brilliance is therefore two candle-power per square inch.

IN the first number, which has recently made its appearance, of *Elektron*, an American monthly magazine devoted to electrical interests, there is an interesting account of the construction and working of the buoy-lighting of the waterway between Chicago and the recent exhibition. The buoys were placed at half-mile lengths, and were connected by means of armoured cable, the armour consisting of galvanised iron wire wound spirally over the insulation. It was originally intended to run the glow lamps from transformers, and each lamp was designed to take 5·2 amperes. It was found, however, that with the normal pressure of 1,450 volts, no more than 1·5 amperes were going through the lamps. On increasing the line pressure to 3,300 volts, the author states, the current was only 1·2 amperes; though it is difficult to see how an actual reduction of the current could occur under these conditions. At any rate, it was found to be impossible to obtain the proper lamp current; so the alternating system was abandoned in favour of the continuous-current series system. The failure of the alternate-current system was attributed by the American engineers to the spiral armoured cable, which "acted as a condenser." It is more probable that it acted like a gigantic choking coil; and on the spot it would have been quite easy to have ascertained if the effect was electrostatic or electromagnetic. The paper does not give us sufficient data to enable us to be dogmatic; but the probability seems largely in favour of the phenomenon having been caused by the magnetic field generated in the armour.

LAST week we discussed at some length the criticism made by the *Journal of Gas Lighting* on our recent comparison of the cost of electric light and of gas. Our attention has been called to four words in this criticism, which fully explains it. Referring to the diagram on page 143 of our present volume, our contemporary observes, "What it does show at the first glance is that in order to make out a fictitious effect," &c. The six times repeated datum of comparison in the body of the preceding article is neglected, and we are judged by what somebody sees "at the first glance." Next time we venture to discuss the common glow lamp, and adorn our remarks with an illustration thereof, some light-hearted critic will mistake it "at the first glance" for a balloon, and will comment severely upon the folly of constructing aeronautical apparatus from a receiver made entirely of glass, from which the air is exhausted, and having leading-in wires, &c.

Telephone Extensions.—Telephone communication between London and Dover and other towns in Kent was established on Saturday by the National Telephone Company.

Cable Interruptions:

	Date of Interruption.
Cayenne-Paramaribo	Oct. 15th, 1893.
Bissao-Bolama	Nov. 24th "
Garachico-Santa Cruz de Palma	Dec. 27th "

The Boat Race.—The Direct United States Cable Company succeeded in transmitting to the United Press of America the announcement of the result of the Oxford and Cambridge boat race, rowed on the Thames on Saturday last, ten seconds after the despatch was filed in London.

British Association.—At the coming meeting of the British Association, at Oxford, Prof. A. W. Rücker will preside in Section A (Mathematics and Physics), and Prof. Kennedy in

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Section G (Mechanical Science). Sir Douglas Galton will be proposed as President for the meeting in 1895, at Ipswich.

Oldham.—The Oldham Corporation on Thursday night last for the first time lighted the principal thoroughfares of the town and the public buildings by electric light. The plant is sufficient for 2,500 glow lamps of 8 c.p. The Corporation obtained power to borrow £27,000 to carry out the scheme, which has been superintended by Professor Kennedy.

Gas v. Electric Cars.—The *Journal für Gasbeleuchtung*, 1893, Nos. 33 and 34, has a detailed Paper by Prof. Baron Gostkowski, of Lemberg Technical High School, on gas cars. The learned professor's dictum is that the gas car is 24 per cent. cheaper to run than the electric car, and that the electric car with overhead wires has a past, while the gas car has a future.

Long-distance Telephony in India.—A successful telephone experiment was tried in Ceylon on February 2nd. Telephones were attached to the telegraph wires, and Colombo was placed in speaking communication with Trincomalee. Almost simultaneously a series of experiments was carried out in Calcutta, direct telephonic communication being established between Calcutta and Nagpur, a distance of 760 miles.

Lyons Exhibition.—At the Lyons Exhibition, which opens next month, an electric tramway connecting the centre of the town with the Exhibition has been laid down. The dynamo used for obtaining electrical energy is driven by a gas engine. The system of transmitting the current to the car has been patented by MM. Claret and Vulleumier, and consists of magnets laid under the ground, and making contact with a conductor rail as the car goes along. A trial of the system has already been made at Clermont, it is said, with success.

India and the Electrical Conference.—When the Committee which arranged the Electrical Conference at the World's Fair was discussing the matter, says the *Madras Times*, it was proposed to put India on the list of invitations, but some member of the Conference asked why "Indiana" should be specially represented and none of the other American States. Those present thinking India was short for "Indiana" accordingly struck it out of the list. That is how it came about that India was not asked to send a representative. Such is fame!

Royal Institution.—The following are some of the lecture arrangements after Easter:—Prof. J. A. Fleming, four lectures on Electric Illumination; Prof. Dewar, three lectures on The Solid and Liquid States of Matter; Capt. Abney, three lectures on Colour Vision (the Tyndall lectures). The Friday evening meetings will be resumed on April 6th, when a discourse will be given by Prof. Victor Horsley, on Destructive Effects of Projectiles. Succeeding discourses will probably be given by Prof. J. J. Thomson, Prof. A. M. Worthington, Prof. Oliver Lodge, Prof. C. V. Boys, and others.

Electrical Engineering at Sheerness.—In the course of a speech in the House of Commons on Monday evening on the question of the wages of dockyard *employés*, in which he stated he was "for uniformity, discipline, good work and trade union hours and wages," Mr. John Burns stated that "at Sheerness the most delicate and complex electrical engineering work was being made by apprentice shipwrights but twelve months out of their time. It was simply absurd to think that these apprentices were competent men to place in charge of electrical machinery on board a large ironclad."

Principal Chemist of the Government Laboratories.—The Government has decided to place the direction of the Customs and Inland Revenue Laboratories under one administrative chief, to be styled the Principal Chemist of the Government Laboratories. The Principal Chemist will also receive references from the Board of Agriculture, the Local Government Board, and other Government departments. The appointment, which is in the gift of the Treasury, has been offered to, and has been accepted by, Prof. Thorpe, F.R.S., who thereby vacates the Chair of Chemistry in the Royal College of Science, which he has held since 1885.

Earth Forward and Return Circuit.—According to a daily contemporary, the Abbé Michel has succeeded in using two separate horizontal geological strata as a telephone circuit. The strata are conducting, and are separated by an intermediate stratum of comparatively insulating material. By coupling the transmitter to the surface stratum and a deep stratum, and similarly coupling the receiver, it was found that speaking could very well be carried on at a distance of 120ft. Very rarely would the geological conditions permit of this arrangement being adopted; while in any case, of course, it would be impossible to have more than one system in the same locality.

Electrical Utilisation of Water Power in Switzerland.—The Commission appointed to examine the tenders for the utilisation of the hydraulic power of the Areuse for the purposes of lighting and transmitting power to Neuchatel, has given its award. The first prize of 5,000 francs has been awarded to M. Alioth, of Basle; the second of 4,000 francs to M. Ramel, of Zurich, and the Zurich Telephone Company; and the third of 3,000 francs to Prof. Palaz, of Lausanne, and M. H. Etienne, of Neuchatel. The members of the Commission were Prof. Weber, of Zurich; M. Picou, of Paris; M. Colombo, of Milan; and M. Hipp, who died during the sitting of the Commission.

Subterranean London.—It gives an impressive idea what subterranean London is fast becoming, says the *Daily News*, to learn that on emerging from the river the new City and Waterloo line will, in its passage up Queen Victoria-street, run for a part of the way underneath the low level main sewer, which in its turn runs along beneath the District Underground Railway. So that at this point in the City we shall have first a busy main thoroughfare, below that a steam railway, then a huge metropolitan sewer, then an electric railway, reaching its terminus at a depth of about 63 feet below the streets, and here it will communicate with another line—the Central London—which will lie at a depth of 80 feet.

Recording Electric Railway Fog Signalling Apparatus.—There is now at work on the bridge over the Boundary-road, close to the Hoe Street Station of the Tottenham and Forest Gate Railway, an invention which should prove useful to railway engineers and engine drivers. The invention consists of a visual, and audible, and permanently-recording electric fog signalling apparatus, and has the following main objects: In the first place, it gives a repeat signal to the locomotive driver of the position of each signal as he passes it, whether the signal be at "danger" or at "line clear." In the second, place, it repeats the signal in the signal cabin. The repeat signalling apparatus on the locomotive consists of an indicating needle or arm on a dial, also two bells or a bell and a gong. There is also a recording index. The system is being brought out by Mr. I. A. Timmis, the inventor of the automatic electric signals on the Liverpool Overhead Railway.

The Brilliance of a Candle Flame.—That the luminosity of a candle can be calculated direct from the dimensions of its flame, is the rather striking theorem of Herr P. Glan, who gives the results of his measurements in the current number of *Wiedemann's Annalen*. The volumes of the bright portions of various candle flames were measured by taking the length by means of a scale placed behind the flame, and the breadth at various points by gauging it with calipers or compasses. These bright portions have approximately the shape of cones, each of these cones being penetrated from below by a truncated cone, consisting of the dark central portion. The difference between the volumes of the two cones gave the volume of the brilliant portion. Stearine and paraffin candles of various thicknesses, and provided with different wicks, were compared by means of a rod photometer. It was soon found that the height of the flame was not the only factor determining the brightness. A stearine candle of 5·88cm. circumference had, on the other hand, a higher luminosity than another 6·49cm. in circumference. But a determination of the ratio of the volume to the illuminating power showed that this ratio is very nearly constant, the difference between the actual luminosity and that calculated from its volume never exceeding 3 per cent. In other words, equal volumes of the bright flame of any two candles give out the same amount of light.

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The Electric Light and the Auer Gas Light.—The following statistics, supplied by the Stockholm central electric station and by the Stockholm Electric Light Company, throw an interesting light upon the effect produced upon electric lighting in Stockholm by the introduction of the Auer gas light in that city. The latter light was introduced in Stockholm in the autumn, 1892, the same time as the electric central station was opened. The immediate effect was the loss of one subscriber for 12 16-c.p. lamps. At the end of the year the station was supplying a total of 4,750 incandescent lamps, which during 1893 increased by 2,750 lamps, making a total of 7,500, the increase on the year being equal to 58 per cent. During the same year the station lost two subscribers, with a total of eight lamps, who adopted the Auer burners. From January 1st to February 22nd this year there was an increase of 102 lamps, from which must be deducted the 21 lamps of one subscriber, who went in for the Auer light. It will thus be seen that during all that time the central station only lost four subscribers, with an aggregate of 41 lamps, or about 0·5 per cent. The Stockholm Electric Light Company had at the beginning of 1893 a total of 5,052 lamps of 16 c.p,, which, at the end of the year, had increared to 5,567 lamps. The Auer burners cannot, therefore, be said to have done the electric lighting establishments much harm, although there is reason to believe, says our Scandinavian correspondent, that the number of people requiring electric light would have been larger had not the Auer burners been in competition.

Thin Metal Partitions in Voltameters.—In a second Paper, "On the Polarisation upon a Thin Metal Partition in a Voltameter" (in the *Philosophical Magazine* for March), Mr. John Daniel discusses the passage of ions through a gold-leaf partition, and also the minimum current strength at which the ions are deposited visibly upon the partition for various electrolytes. In order to investigate the first point two similar voltameters with metallic partitions were set up at the same time, and, without passing the current, quantitative analyses of the solution on the two sides of the partition were made at stated intervals; then the current was passed, the voltameters being in series, quantitative analyses being again made of the solution on the cathode side, and the weight of copper deposited on the kathode determined, and finally the circuit was broken and the analyses again repeated. Curves plotted from these results show no break nor change of slope for the intervals during which the current was passing. Thus it would appear that the current does not sensibly affect the diffusion of copper sulphate and sulphuric acid through a gold-leaf partition. In the experiments on the "critical current" it was found that the concentration of the electrolyte exerted an important influence on the value obtained, and the measurements made indicate that the "critical current" is proportional to the conductivity of the electrolyte. Experiments made to determine whether the variation of the temperature has the same effect upon the "critical current" as upon the conductivity are not yet sufficiently complete to justify conclusions being drawn.

Electrical Communication with the Kentish Knock Lightship.—It is satisfactory to chronicle the fact that the Kentish Knock Lightship was last week placed in electrical connection with the shore. This lightship is 18 miles from the nearest land, and is moored in about 12 fathoms at low water. She is exposed to heavy seas, especially when the wind is easterly. The nearest land is the North Foreland, and it is from the post-office at Kingsgate that the cable is run to the lightship. Owing to the much more exposed position of this vessel than that of the Sunk, it has been necessary to adopt greater precautions in respect of the moorings. Instead of two arms of moorings there are four—*i.e.*, there are four mushrooms placed in relation to the ship's position N.E., S.E., S.W., and N.W. Four chain cables, each about 210 fathoms long, from these mushrooms are brought together at a centre swivel, the patent of Mr. F. Bedwell, of the Telegraph Construction and Maintenance Company, and connected to the four outer loops of the swivel, and from the swivel two chain bridles pass into the ship. The swivel has to be kept about six fathoms above the sea bottom, and thus it will be seen that the vessel has to carry a great weight from her bows. The cable was laid by the Post Office cable ship "Monarch," and at three o'clock on Wednesday afternoon last week a message was sent through from the lightship to the General Post Office, to the effect that the first of the permanent lightship cables had been successfully laid and communication established.

The New Transandine Telegraph Lines.—The direct telegraph lines extending from Buenos Ayres (Argentina) to Valparaiso and Santiago (Chili), which have been established by the Pacific and European Telegraph Company, of which Sir John Pender is Chairman, were opened for traffic on Monday last. From the Atlantic coast to Uspallata on the spur of the Andes, a distance of about 697 miles, the line is aerial on iron poles, and is of the latest type of construction. Thence to Rio Blanco, in Chili, underground cables are laid in about 75 miles of trench through the highest and wildest part of the route, where heavy snow falls in winter would sweep away any telegraphs erected above ground. The lines from Rio Blanco to Valparaiso and the branch to Santiago, consisting together of about 160 miles, are aerial. The total length of the line, which extends from the Atlantic to the Pacific coast, is about 927 miles. Arrangements have been made by which the telegraph lines have been erected adjacent to the railway lines, and exceptional facilities are thus afforded for the efficient maintenance of the wires. There is only one station, which is at Mendoza, but Buenos Ayres and Valparaiso work direct with each other. The opening of this system is of great importance to the West Coast of America Telegraph Company, as it places their cables in direct connection with those of the Western and Brazilian, the Brazilian Submarine, and the Eastern Telegraph Companies, affording a continuous chain of telegraphs in British hands from England and the Continent to the Pacific Coast of South America. The construction of this line was rendered necessary to enable the English Submarine Telegraph Companies to transmit with great rapidity the important traffic to and from the West Coast of South America, where it is dealt with by the cable of the West Coast of America Company.

Electric Light Plant and High Efficiencies.—The following letter has been addressed by Mr. J. S. Raworth to the *Cheltenham Examiner* in regard to the recent tenders for electric light plant for Cheltenham :—

SIR: I observe in your report of the Town Council meeting, published in your issue of the 7th inst., that the Electric Lighting Committee reported on the tenders received for plant, and advised that the tender of Messrs. Siemens Brothers and Co., of Westminster, with "Willans" engines, at £4,610, less £365 for boiler, be accepted. It was afterwards explained that this tender was £745 higher than another tender, the reason adduced for the payment of the extra sum being "greater efficiency." This is an excellent reason; in fact, it is economical to pay even as much as 40 or 50 per cent. additional price for plant of 10 per cent. additional efficiency, and in agreeing to pay for extra efficiency, the Committee have shown their business-like appreciation of a good bargain. As a rule committees are too much inclined to take up with the cheap and nasty article rather than face the trouble of justifying their conduct in paying a high price for one that is first-class. In this instance your Committee appear to have justified their recommendation on the evidence placed before them, that a Willans-Siemens combined engine and dynamo at Glasgow has produced an efficiency of 88 per cent. I need scarcely say that 88 per cent. is a splendid efficiency and is worth paying for, in comparison with the ordinary commercial article, which realises an efficiency of from 64 to 76 per cent. only. The highest recorded efficiency with a "Willans-Siemens" combination for alternate currents is 76 per cent., which was obtained at Bristol, and it is noteworthy that the 88 per cent. case, which the Committee quote, refers to Glasgow, where the dynamos *are not high tension* but *low tension*, and where the current is *not alternating* but *continuous*, and consequently, the case quoted has no bearing on the subject whatever, and it is quite possible that your Committee may find that after parting with £745 of the ratepayers' money on the assumption that they are going to get for it an efficiency of 88 per cent., they have after all only obtained the ordinary commercial article with 76 per cent. efficiency. I should be sorry to write this letter if I could not close by holding out a rayof hope to the Committee that they may yet get their aspirations for high efficiency plant satisfied, and that without paying an extra price for it, and without sacrificing any practical advantages whatsoever. The Brush Electrical Engineering Company guarantees its plant as tendered to have an efficiency of 84 per cent., and will even guarantee 86 per cent., provided the tests be carried out by a careful and independent engineer, such as Prof. Kennedy. Plant of this character may be seen working in London, of an aggregate power of 4,000 h.p., and the efficiency demonstrated beyond a doubt. It is, therefore, just the plant which your Committee desire to obtain and are willing to pay an extra price for, but in this case there is no extra price to pay. The efficiency is proved and guaranteed to be 8 to 10 per cent. better than that of any other existing plant, and your Committee will, I am sure, be pleased to hear that they may obtain these guaranteed advantages and at the same time save £745.

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ON CATHODE RAYS IN GASES UNDER ATMOSPHERIC PRESSURE AND IN EXTREME VACUA.

BY PROF. G. F. FITZGERALD.

Herr P. Lenard has made a most interesting communication to *Wiedemann's Annalen*, No. 2, 1894, upon the above subject. The subject of the investigation is the actions that take place in the so-called dark space surrounding the negative pole in a Geissler's tube. Hittorf seems to have been the first to observe that within this region something of the nature of propagation in rays was taking place, and this has been further studied by innumerable experimenters, of whom Crookes made, perhaps, one of the most important observations that these rays, when falling on a solid, tended to press it away from the cathode.

These rays were supposed to be unable to get through solids until Hertz, in 1892, showed that thin metallic films do not stop them, and Herr Lenard has further shown that thin films of any solid are quite permeable to these rays, thus throwing doubt upon Prof. J. J. Thomson's suggestion ("Recent Researches," p. 126. Note) that the solid acts as an intermediate cathode. This seems also inconsistent with the observation of Herr Lenard that these rays can be propagated into vacua, where an ordinary cathode cannot start rays of its own. Herr Lenard has made such a number of beautiful and most interesting observations that those who wish to study the subject at all fully must refer to his paper, a translation of which is appearing in *The Electrician*. Only the more important experiments and his conclusions therefrom can be noticed in this preliminary account and criticism.

Working upon Hertz's observation that these rays were capable of penetrating thin metallic films, Herr Lenard tried whether they could extend out into the air at ordinary atmospheric pressure. With this end in view he arranged a very small hole 1·7mm. in diam. He cemented a piece of aluminium foil 0·00265mm. thick (7·7 times as thick as common aluminium foil). This thickness of foil is quite opaque to light, and easily stands the pressure of the atmosphere over this small hole. A cathode is arranged so that the cathode rays are discharged normally to this window, and he found that there was a faint glow in the air outside the window when the cathode rays impinged upon its inner surface. This glow extended visible to a distance of 5cm. from the window. Inside it any substance which becomes phosphorescent under the cathode rays in ordinary vacuum tubes glowed brightly, and this phosphorescent effect exists to distances of 8cm. from the window. In air at ordinary pressures this action occurs equally in all directions outside the window, but when the gas in the space outside is at a low pressure the rays are propagated normally to the window and in right lines. The diffusion of the rays by ordinary gases is compared to the diffusion of light by a turbid medium like milk, and Herr Lenard has shown that this apparent turbidity of the gas depends entirely upon its density, Hydrogen being the least turbid, and sulphurous acid, with a density of 32, being the most turbid or ray scattering of the gases he had tried.

Herr Lenard further showed that any solid, if thin, transmitted these rays as well as aluminium foil. Transparency or opacity to light did not seem to affect the question at all. Mica, glass, collodion, soap-bubble films up to 0·02mm. thick: These films consist of thousands of molecules in thickness, and it is impossible to suppose that they contain any holes through which the molecules composing the supposed cathode streams of molecules that Crookes's experiments seem to suggest could penetrate.

Some of the most interesting experiments were those made into vacua, which were so far exhausted that a coil capable of producing sparks of 15cm. in air, could not produce any discharge between terminals sealed through them. Herr Lenard estimates that when he had condensed the mercury vapour in a connected globe by lowering it to a temperature of $-21°$C., the pressure of the remaining gas was about $0·03 \times 10^{-6}$ of an atmosphere, *i.e.*, about 0·03dyne per sq. cm.

In these tubes nothing was visible on the path of the rays, but where they impinged on the glass at the opposite end of a tube 150cm. long, and when there were no magnets near, they were propagated in right lines.

From these and many other interesting observations Herr Lenard concludes that, as was believed by E. Wiedemann, Hertz, and Goldstein, these cathode rays are a phenomenon in the ether and are independent of the presence of matter. If this be so they are a most remarkable addition to the properties of the ether. Phenomena that may all be classed under light propagation are the only known phenomena of propagation in free ether. There is a very essential difference between these cathode rays and ordinary light propagation, and only for this these rays might be very rapid ultra-violet waves, which are known to be rapidly absorbed by air and other gases, but which may be able to run the gauntlet of hundreds of thousands of molecules without being finally absorbed, and might, in accordance with the known transparency of gold leaf, be able to penetrate any solid, even though a conductor, because for their extremely rapid vibrations the molecular motions upon which ordinary conductivity depends may be much too slow to have any sensible effect. The fact that seems conclusive against this view is the deflection of the rays by a magnet. There seems no reason to think that light rays are deflected by a magnet. These rays are deflected in the same way as a conductor carrying a current of electricity away from the cathode. No such action has ever been observed on rays of light. It would be most natural to explain the action by the presence of the matter which is generally required in order to be acted upon by a magnet. There seems very little reason for supposing that a magnet would act upon electric displacement currents in the ether, even if displacement currents of the straight ray kind were possible in the ether without propagating themselves out sideways with the velocity of light. If, however, the action of the magnet be not upon the ray but upon the emitting surface, as has been shown to be the cause of the repulsion of two cathode rays for one another, then there seems to be some reason for thinking that they may be very intense ultraviolet radiations, though their pressure upon matter could then hardly be as great as has been observed. When we recollect that in the vacua described by Herr Lenard there are still 10^{10}, *i.e.*, ten thousand million molecules per cubic mm., there does not seem sufficient reason for looking to an unknown property of the ether when there is so much matter present to explain the phenomenon. Herr Lenard lays great stress on the difficulty of producing electric discharges in these high vacua. This may be due to the difficulty of producing the anode part of the discharge and not of producing the cathode phenomena which are known to be quite secondary to the actual discharge, and Herr Lenard's experiments prove conclusively that this radiant state is a phenomenon independent of the principal part of the discharge. Professor J. J. Thomson mentions a case in which a discharge preferred to pass through a long spiral tube rather than across a distance of 1mm. because there was not room in this short distance for the positive discharge to take place. Herr Lenard also lays stress on the fact that the high vacua did not deteriorate under the action, so that there seemed very little reason to suppose that anything that might be called cathode matter was carried through the window. In this connection it must be remembered that most electric actions in gases and liquids are accompanied by streams of molecules in both directions, and that it may be that as many molecules were carried out of as into the vacuum. Another supposition might be that the cathode property of propelling these molecules from its surface was transferred through it, from molecule to molecule, after the manner of electrolytic conduction, and that no molecules were transferred into the vacuum at all. Suppositions of this kind seem much more probable, and can explain the experiments upon the same basis as other phenomena of electric discharges without supposing that we are dealing with a new etherial property. These very high vacua with their long free paths of their rapidly moving molecules are just the media in which rays such as are observed producing considerable pressures where they impinge might be expected to exist. The dissociated molecules in such a space, with 10^{10} molecules per cubic mm., have a charge of 1,000 electrostatic units per cc., and moving at a moderate

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molecular rate of four or five hundred metres per second would carry a current of a tenth of a milliampere, quite as much as is likely to be going in these streams. In such very high vacua there would not be any large pressures produced by the impacts of these molecular streams, about a thousandth of a dyne per sq. cm. might be expected, not if the velocity of the streams were much greater than that of gases at the temperature of the experiment, as would be likely, they might easily produce pressures in less perfect vacua, such as would account for the mechanical effects observed by Mr. Crookes. Herr Lenard does not seem to have tried whether his filtered cathode rays produced pressures such as Mr. Crookes observed. These pressures may be partly due to the electrification of the surface in the same way as the cathode, or as the molecules in its neighbourhood, in somewhat the same way as a point is repelled by the air in its neighbourhood.

In apparent connection with this whole subject are the interesting observations of Mr. Daniell (*Phil. Mag.*, 1894) upon the transference of electrolytic action in liquids through thin metallic plates. If this be not due to small holes in the plates, view that Mr. Daniell seems not to have fully disproved, and that is confirmed by his statement that the liquid can diffuse through his metallic partitions, these actions, and others that have been noticed, seem to point to electrolytic actions being, in that form, transmitted through small distances in metallic sheets. Mr. Daniell does not seem to have tried other diaphragms than metals, and although their non-conductivity might stop all continuous action through them, it might be worth while trying whether they would transmit electrolytic actions in the same sort of way as he has found thin metallic plates will. Herr Lenard's actions and other discharges in gases, being so abrupt and discontinuous, might easily be transmitted by bodies which could not accommodate themselves to the continuous action of electrolysis in a voltameter.

In conclusion, we may refer to the translation of the original Paper which appears below for further information on this extremely interesting subject, and for a statement of Herr Lenard's views upon his admirable investigations.

ON CATHODE RAYS IN GASES UNDER ATMOSPHERIC PRESSURE AND IN EXTREME VACUA.*

BY PHILIPP LENARD.

1. If a Geissler tube is sufficiently exhausted almost all the phenomena attached to the anode, and those which mark the course of the electric discharge, are eliminated, and the phosphorescence-producing rays proceeding from the cathode—the rays discovered by Hittorf, and studied by Crookes as radiant matter—attain a high development. These rays, although due to the electric discharge, yet show a distribution which is perfectly independent of it. Whilst thus sharply marked off from the discharge itself, they appear by all their properties as a phenomenon analogous to light; but though very similar to the latter in the geometrical character of their propagation, they show decided differences in essential properties. Differing from light as regards their capacity of penetrating solid bodies, the cathode rays in our vacuum tube end where they impinge upon the glass walls. But what would happen if the walls were made transparent for cathode rays? To answer this question experimentally seemed no longer impossible since Hertz had shown that the ordinary metallic films are strongly transparent for cathode rays, even in three or four thicknesses. It is true that these films are very delicate and never free of holes, and thus not directly adapted to my purpose. But the cathode rays do not penetrate through the holes, but through the material of the films.†

It soon appeared that even 15-fold layers of ordinary aluminium foil are strongly traversed, especially by cathode rays suitably produced. Among a number of stronger aluminium films of various thicknesses, which I subsequently obtained, I found one just strong enough to resist the one-sided pressure of the atmosphere on a small surface, free from holes, and only eight times as thick as ordinary aluminium foil. This film was capable of forming a transparent air-tight shutter on a vacuum tube, and of allowing the cathode rays a free exit into the open air. Whether they would avail themselves of it was, of course, not to be predicted. The experiments now to be described will not leave a doubt on that point. Once produced, the cathode rays are propagated into air-filled space, and that to distances of nearly 10 centimetres. The observation of the rays can thus be transferred from the vacuum tube into the open; they can be investigated in any medium. But, in particular, observation and production are made perfectly independent of each other; the conditions of the former may be varied without affecting the latter.

A special interest attaches to the possibility of making the rays enter a perfect vacuum, in which we know they cannot be produced; it means the possibility of performing in this case the same fundamental experiment as that which decided whether light and sound were occurrences in matter or ether. As will be seen, the vacuum offers no impediment to the propagation of the rays. They traverse it with great intensity to distances upwards of a metre; they are thus characterised as occurrences in the ether. Considering how little we know about the ether they can thereby only increase our interest in them.

The Apparatus.

2. After successive modification of almost all the parts of the vacuum tube it was given the form shown in section in Fig. 1, E E. K is the cathode, a circular plate of aluminium, 12mm. in diameter; it is attached to a long handle, which is completely surrounded by the very thick-walled glass tube, K l, and is fused in at l. The glass tube fits well into the neck, h h_1, of the vacuum tube, and is cemented air-tight at h_1. The anode, A A, is a piece of brass tubing which just fits into the vacuum tube, and allows the handle of the cathode to project by 12mm. The platinum wire, *p p p*, maintains the anode in position, and serves as a conductor; it is fused into the tube, R, leading to the pump. Opposite the cathode the vacuum tube is closed air-tight by a strong metal cap, *m m*, and cement. Fig. 2 shows this cap in three-quarter natural size. It is perforated in the centre, at F. Over this perforation 1·7mm. wide, the outer rim of which is carefully rounded off, is laid the thin aluminium plate, A l,* which is attached by cement applied all round.† This shutter, which is transparent to cathode rays, and perfectly opaque to light and air, we will call the *window*, and the space to the left of it in the figure we will call the *observing space* (*Beobachtungsraum*). The window is attached so as to be in good metallic contact with the cap, which is, like the anode, connected to earth. To prevent the window acting as anode, which would lead to corrosion, the inner metallic protecting cover, V, is fixed so as to leave an opening of not more than 3 mm. diameter for the cathode rays. The vacuum tube is surrounded by a tin box, G G, to which is attached in front the large tin screen, S S, which only leaves the window free, and is blackened on the side of the observing space. This box and the screen, which are put to earth, protect the observing space from the light and the electric forces of the discharge.

The most suitable vacuum is that which is obtained when the difference of potential between the electrodes corresponds to a sparking distance of about 3 cm. between spheres in air. To enable the observer to control this sparking distance and vacuum at any time, the adjustable spark-gap, B (Fig. 1), is introduced as a shunt to the vacuum tube. With increasing exhaustion the sparking distance rapidly increases. At lower vacua than that specified cathode rays are produced which penetrate less easily through the window; at higher vacua the discharge tube runs the risk of being injured.‡ The induction coil used, with a mercury interruptor giving about six interruptions per second, and four accumulators gave sparks up to 15cm. in length between spheres. The vacuum tube was permanently attached to the pump, a Geissler mercury pump, for although the vacuum, when not used, remained unim-

* *Wiedemann's Annalen.*

† Hertz, *Wied. Ann.*, 45, p. 28. 1892. E. Wiedemann and Ebert pointed out the transparency of cathode coatings in vacuum tubes about the same time: "Sitz. Ber. Phys. Med. Soc. zu Erlangen," December 14, 1891. I had already long ago tried to construct a tube with transparent shutter, but without success, by using a quartz plate 1mm. thick. Prof. Hertz himself urged me to employ metallic films; for this and many another valuable suggestion I owe him a debt of gratitude.

* 1 sq. cm. of this foil weighs 0·000715 gr., and is therefore 0·00265 mm. thick (7·7 times as thick as common aluminium foil); it may be easily handled and cut with the scissors. It is the "once-beaten aluminium of metal foil makers, and may be had from any of them as an intermediate product. But not every maker produces films sufficiently free from holes. The only suitable kind out of three which I obtained is of unknown origin. Foils of twice this thickness, which may be employed with almost equal success, are more easily obtained reasonably suitable. Holes which transmit air are always visible with a lens in a strong light, and are easily avoided.

† For the window I use marine glue, for the other joints sealing-wax covered with marine glue. Sealing-wax alone shows cracks after a time; marine glue alone would be pressed through the joints by the atmospheric pressure.

‡ The glass covering of the cathode wire is sometimes penetrated, especially between h and h_1. This danger is much diminished in a tube where the glass covering is fused into the vacuum tube, and the window is attached to a platinum tube fused in, thus avoiding any further cementing.

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paired for weeks together, yet the pressure during the working always increased perceptibly, so that from time to time the pumping had to be renewed. The precaution was taken of only setting the interruptor going for the few seconds necessary for an observation; thus the window was protected from heating. The following phenomena were observed :—

Cathode Rays in the Open Air.

3. Cathode rays make the air glow faintly. A halo of bluish light surrounds the window; it is brightest near the window itself, but has no definite external limit; it does not extend further than 5cm. from the window. The light at each discharge appears to shoot in brushes in all directions from the window; it is not bright enough to be investigated by means of the pocket spectroscope. The window itself is dark while it is new. After some use it also begins to glow faintly, irregularly, only at a few points of the small surface; at some points a bluish-grey, at others merging into the green and the yellow. Once started, this glowing appears regularly in the same manner. I shall refer again to this phenomenon, which is, however, an immaterial one.

4. Bodies capable of phosphorescing, if held near the window, glow on the side turned towards it with the light peculiar to them. Compared with the brilliant incandescence of the phosphides of the alkaline earths, of calc spar, and uranium glass, the light due to the air and the window disappears completely. With increasing distance from the window, the phenomenon quickly decreases in intensity, disappearing at a distance of 6cm. or 8cm. The intensity of the incandescence is determined only by distance, direction being

All those bodies also remain dark, which are not capable of phosphorescence, such as metals, mica, gypsum crystals, sulphur crystals. All the specimens of quartz examined glowed blue, but only when held quite close to the window; a piece of rock salt behaved in the same way. It is evident that here we have the faintest cathode glows brought out. I have also noticed a faint blue light in the case of quartz in vacuum tubes.

In connection with the glowing of the window itself, much interest attached to aluminium oxide. An oxide, produced at aluminium cathodes, glowed faintly greyish-green and blue mixed, brightly only in a few points, *i.e.*, like the window. The assumption that this phosphorescence is due to a slight layer of oxide produced under the influence of cathode rays and ozone (*see* 6), is not contradicted by any subsequent observation.

Liquids, which up to the present were not susceptible to cathode rays, were as a rule not illuminated at all, or only feebly. This was seen in solutions of eosin, fluoresceïn, magdala red, sulphate of quinine, chlorophyll, all of which fluoresce well in daylight. These solutions, therefore, behave like eosin-gelatin. A mere drop of petroleum, attached to a wooden rod, showed its blue fluorescent light, and other fluorescent hydrocarbons behaved similarly. In the solid state the above named bodies also remained dark, with the sole exception of sulphate of quinine, which exhibited a brilliant blue colour.

Tubes of tinfoil or glass, introduced between the window and a phosphorescent body so that the line joining the two coincided with the axis of the tube, diminished rather than increased its light.

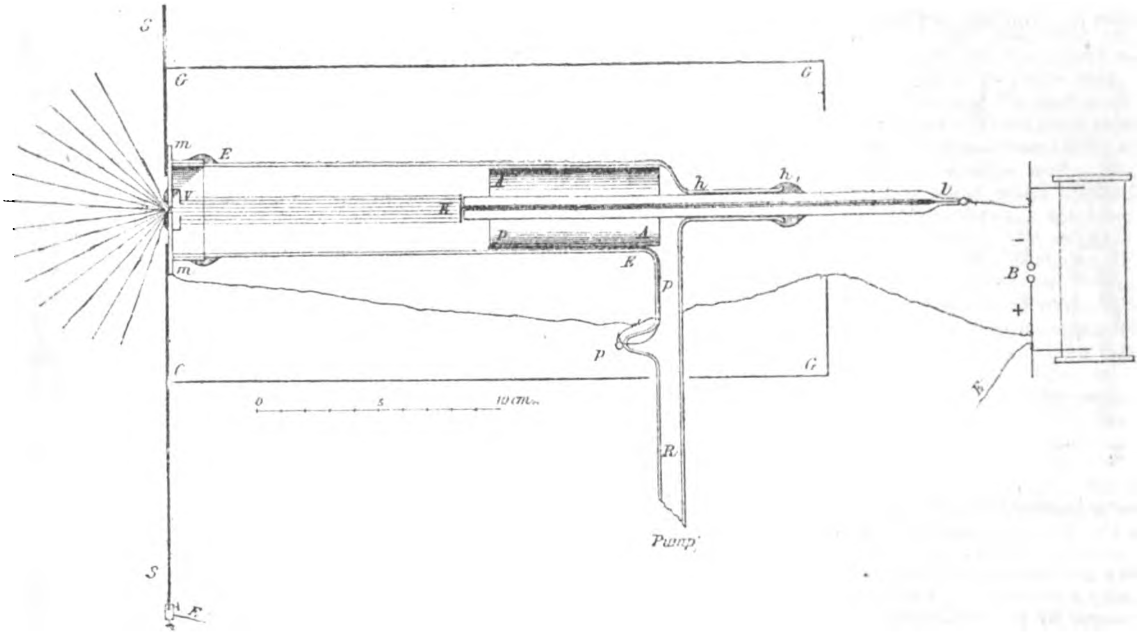

Fig. 1.

without influence. Thus the phosphorescence of a piece of calc spar is equally intense, whether it be placed at Φ (Fig. 2) or at Φ'. If a plane phosphorescent screen* be held perpendicularly against the window wall, so that its margin crosses the window, the brightness, dazzling near the window, decreases uniformly in all directions; equally bright points lie on semicircles whose centre is the window. This isotropic propagation from the window was to be expected from the fact that cathode rays penetrate aluminium diffusively.

The colour and relative brightness of illumination is the same in this case as that observed in vacuum tubes under the influence of cathode rays. Common glass, uranium glass, flint glass, calc spar, chalk, glow in their well-known manner; calc spar after-glows brightly. Very bright, with long after-glow, are the phosphides of the alkaline earths; not less bright, but without perceptible after-glow, pentadecylparatolylketone (green), and asaron (violet). A collection of platino-cyanides gave for the most part brilliant phenomena, the colour and brightness always corresponding to that observed in the ultra-violet solar spectrum; uranium glass yielded its characteristic line spectrum brightly. Eosin-gelatin, strongly phosphorescent in light, remained non-luminous, as in vacuum tubes.

* For this screen tissue paper soaked in pentadecylparatolylketone is specially suitable. The paper is laid upon a cold glass plate, and the melted substance is evenly spread with a brush. Such a screen is translucent, and may, therefore, be examined equally well from both sides; it glows much more brightly than uranium glass, without after-glow. By a phosphorescent screen, *per se*, we shall in future always mean a paper thus prepared; by a phosphorescent body a piece of strontium phospho sulphide attached to a wire and kept in the dark.

5. All phosphorescence phenomena in the observing space cease as soon as a magnet brought near the vacuum tube deflects the cathode rays from the window; the window itself and the air both remain dark.

6. Impinging on the skin, the cathode rays produce no sensation whatever, nor do they affect the eye. The nose perceives a strong smell of ozone, and the peculiar taste produced by the cathode rays upon the tongue may be also ascribed to ozone.

7. A quartz plate ½mm. thick, and not too small, when introduced at any point between the window and the phosphorescent body, extinguishes its glowing; common (genuine or imitation) gold, silver, or aluminium leaf allows it to remain without perceptible weakening. The quartz plate also intercepts the glowing of the air. Looking from above, one can see the air glow between the window and the quartz, but not behind the quartz. The metal films, however, do not cut off the glow of the air; it is very distinctly seen behind them, while the films themselves remain dark. The opacity of the quartz plates used and the transparency of the metal films are characteristic of cathode rays as contrasted with light. But we cannot conclude that quartz is more opaque to cathode rays than metals, considering the differences in thickness; metal plates ½mm. thick are as opaque as the quartz plates. I have altogether failed to find a solid of this thickness or thicker which is transparent. But all substances obtainable in thin films proved to be more or less transparent. Tissue paper placed on a phosphorescent screen only casts a distinct shadow when in a double layer, and it is indifferent whether the paper is coloured white, opaque black, or otherwise. Writing paper is already less trans-

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parent, and a screen overlaid with drawing paper 0·12 mm. thick must be held quite close to the window in order to glow perceptibly. Cardboard 0·3mm. thick intercepted all luminosity. Blown glass films showed perceptible transparency already in thickness of 0·02mm., where they nearly equal the drawing paper mentioned. At a thickness of 0·01mm. they only cast faint shadows, and glass films showing Newton's colours are as transparent as double aluminium foil of equal thickness, or even more so. An essential difference between metals and dielectrics does not therefore exist. Finely split mica and collodion films, produced on a plane surface and drawn off, both about 0·01mm. thick, are very transparent. In the case of glass, and to exclude deception by its own vivid phosphorescence, an aluminium film was introduced between the glass and the phosphorescent body; or, better still, a phosphorescent screen was used, covered with aluminium foil and thus rendered once for all insensible to light. Such an aluminium cover turned towards the window does not diminish the glow of the screen, but increases it by reflection of the phosphorescence. But the water drops which attach the aluminium to the screen show as black spots. However, in sufficiently thin layers even an aqueous liquid is transparent. Soap films mounted in a wire ring only cast perceptible shadows when they exhibit colours of orders higher than the sixth, *i.e.*, when they are thicker than 0·0012 mm. The most surprising case of transparency remains that of metallic films. Starting from aluminium foil and proceeding to thicker plates we reach a highly tenacious rolled aluminium plate of 0·027 mm. thickness, which is just perceptibly transparent; the foil and the phosphorescent screen must, of course, now be held close to the window. In the same manner, *i.e.*, like the above drawing paper, were found to behave, thinnest iron foil and ordinary tinfoil, both 0·02mm. thick.

FIG. 2.

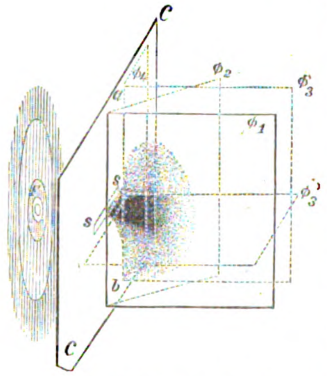

FIG. 3. (Natural Size.)

If two or more transparent screens are introduced between the window and the phosphorescent body—I tried a glass film, aluminium foil, and a gold film—it is immaterial to the glow in what succession they are interposed, provided they are large enough. In cases where only a small piece of the film to be tested was available, it was, for reasons to be presently (8) shown, either held close to the phosphorescent screen or close to the window, or it was stuck across an opening in a larger opaque screen.

A comparison between the above statements shows that no single one of the various bodies tested can be pronounced to be decidedly opaque or transparent in comparison with the others. In the case of light, one solid body a hundredth of a millimetre thick can be more opaque than another one meter thick; such vast differences do not appear to exist for cathode rays. The transparency of glass and collodion appears to contradict the observations of Crookes and Goldstein, according to whom even thin films of these bodies cast black shadows on to the wall of a vacuum tube. But it may be remarked, in the first instance, that the conditions of observations in discharge tubes are very unfavourable. In the flood of light it is impossible to say whether the shadow behind a transparent body is or is not perfectly dark, and this may partly account for the fact that the transparency of opaque metals was the first to be discovered. In the second place, it is not impossible—it is, indeed, probable—that the observers referred to produced under different circumstances different kinds of cathode rays, which are less able to penetrate matter than those here used, which are not only suitably produced, but are filtered by the window.

On replacing the aluminium window by one of glass it was found possible to repeat all the essential experiments with equal success. But the aluminium window remains the more suitable; not that it is more transparent, but because aluminium is opaque to light, and more easily manipulated than glass of equal thickness.

8. The atmosphere is a turbid medium for cathode rays; they are not propagated rectilinearly, but diffused. If a phosphorescent screen is placed parallel to the window wall, say at a distance of 3cm., and an opaque screen, say a quartz plate ½mm. thick, is slowly introduced midway between window and screen, we only see a very indistinct shadow outline on the screen. On fixing the quartz plate in position, and marking on the screen the line in which it is cut by a plane through the window and the edge of the quartz, it is seen that the luminosity overlaps by about 1cm. into the geometrical shadow of the quartz plate thus obtained. If we approach the quartz plate to the screen, this overlapping is diminished, and the shadow is better defined; at 3mm. distance it is still rather indistinct; it only becomes perfectly definite when the plate touches the screen. In the same manner a wire 2mm. thick does not cast an equally large, pretty well marked, and black shadow until it touches the screen. On removing it thence towards the window the shadow is immediately illuminated, and becomes very indefinite; it disappears completely when the wire is 3mm. from the screen. The cathode rays therefrom strongly bend round the edges of opaque bodies. Deception by the illuminated air is excluded, since if we cover the screen with aluminium foil nothing is altered. The quartz plate may be employed to show that our conception of all effects as proceeding from the small window is correct. For if we pass the edge quite close in front of the window, the darkening of the screen begins at the first contact with the window margin, and is just completed at the second contact.

As we have just seen, it is impossible to separate by diaphragms definite rays of even a centimetre's length. If we place a metal plate with a sharp cut hole, 1mm. across, at a distance of about 2cm. from the window, we find a sharp, bright, and equally large image of this hole, only quite close behind the aperture; already at 3mm. the image is magnified about five times and ill-defined, at 8mm. it is magnified ten times, at 12mm. very indefinite and much more magnified.

Fig. 3 shows this distribution at a glance, as produced by a slit, *s s*, 15mm. long and 2mm. broad, cut in the cardboard C C and placed at a distance of 12mm. from the window, F. The ketone screen Φ_1 is held to the slit so as to have the window in its plane. The bushy expansion of the rays is very distinctly shown here, brightness being as faithfully as possible represented by intensity

FIG. 3a.

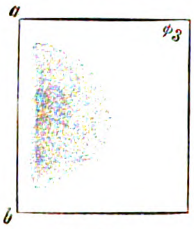

FIG. 3b.

(Natural Size.)

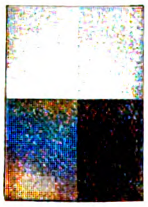

FIG. 4.

of black. On inclining the screen to the position Φ_2, at 45deg. to the plane of the slit, we obtain Fig. 3*a*. We notice here, more distinctly than in the last position, that a fraction of the rays does proceed in straight lines, just as in the case of light through dilute milk, in which we may see diffused light and sharp images. In the first position of the screen the straight rays could not become prominent, since they were propagated tangentially to the screen. When the screen is held on one side of the slit, Φ_3 or Φ_3^1 (Fig. 3), we get an appearance resembling Fig. 3*b* (for the position Φ_3). This is maintained when screen and slit are displaced in the plane of the latter into a position in which rectilinear rays can no longer reach the screen. The bushy expansion shown in Fig. 3 corresponds then to the actual state of things, and is not conditioned or impeded by the presence of the screen Φ_1. Finally, if we turn the screen from the position Φ_3 about its edge *a b* into the position Φ_4, so that it coincides with the slit screen, it remains perfectly dark. Hence no rays bend backwards; again in agreement with Fig. 3.

If parallel rays are allowed to pass through a short vertical slit of 1mm. breadth into a plane parallel trough filled with milk, so that the beam pass through the upper strata of the milk, the beams, as observed from above, are seen to expand from the narrow entrance in exactly the same way as the cathode rays in Fig. 3. Even the trace of rectilinear rays is there. On immersing the slit in the milk the phenomenon remains the same, and the analogy with the cathode ray experiment is more complete.

9. Cathode rays are photographically active. Sensitive printing paper held near the window is blackened at about the same rate as by the subdued sunshine of a foggy day; behind a quartz plate it remains unaffected. Dry plates with development are perfectly blackened at greater distances in a few seconds. The phosphorescent screen may therefore be replaced by the photographic plate. Fig. 4 is the copy of an image thus obtained. In this case the sensitive layer was, as shown in Fig. 4A, half-covered with a quartz plate, Q Q, ⅓mm. thick, across which was laid the double aluminium plate, A L. If light had been the agent, the appearance of the copy must have resembled Fig. 4A. Fig. 4 is very different from this. Not the aluminium plate,

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but the quartz plate has cast the black shadow. In the fourth quadrant this shadow is slightly relieved ; this is due to the light of the air ; the effect is quite absent in the third quadrant, which is covered both with quartz and aluminium. A very much stronger effect than that due to light is produced by the cathode rays, as shown in the upper half of Fig. 4. A shadow of the double aluminium film is only faintly indicated in quadrant II. On the whole, Fig. 4 is nothing but a faithful representation of the phenomena exhibited directly by a phosphorescent screen. But the photographic plate can bring to light effects otherwise imperceptible, provided the exposure be long enough. Thus a pretty strong blackening was obtained behind the cardboard screen 0·3mm. thick, described above (7) as impervious. The cardboard covered the sensitive layer, and strips of different metals were introduced between both. These strips appeared quite in accordance with their degree of transparency lighter (in the negative) on a darker ground, and the film only remained perfectly light where a thick metal frame was laid over all. So cathode rays had actually penetrated through the thick cardboard. Exposure was only two minutes.

Iodine paper turned blue in the observing space ; covered with quartz it remained unaltered. It is doubtful whether this is the direct chemical effect of the ozone developed, or the effect of the ozone generated by them (6). Other chemical effects I have not observed. Electrolytic oxy-hydrogen gas, impinging upon the window or permeated in a thin soap-bubble, did not explode. Carbon bisulphide was not ignited. Even the easily decomposed hydrogen sulphide remained unaffected by a prolonged exposure to the rays in a glass tube attached to the window wall, no sulphur deposit being discernible. A mixture of 3 volumes hydrogen and 1 volume nitrogen, contained in a similar tube containing some water and communicating with a capillary tube with alcohol gauge, showed no decrease in volume, and hence no formation of ammonia. But in this case, as well as in that of air, carbonic acid, or hydrogen, a small increase of volume was observed, which disappeared (somewhat irregularly) after exposure, probably due to the heating of the gases by the absorbed cathode rays. To judge by the amount of expansion this heating would be very slight.* A delicate ther-

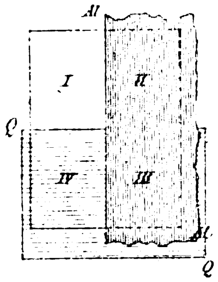

Fig. 4a.

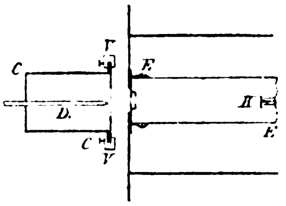

Fig. 5.

mometer and a thermopile placed at the window gave accordingly no definite indications of heat. The effect of a candle flame 50cm. off was easily discovered by means of the thermopile used. The energy of our cathode rays might thus appear to be very feeble, if we lost sight of the fact that the radiation is limited to extremely short time-intervals.

10. Cathode rays penetrate into the interior of spaces closed metallically ; they are perfectly divisible from the electric forces producing them. Up to now we have allowed the cathode rays to enter the observing space through the conducting window wall put to earth ; it was protected from the electric forces of the discharge (2), but, as is seen, not perfectly so. With any conductor in the observing space small sparks may be drawn from the screen (S, Fig. 1), and the same may be done with aluminium foil permeated by the rays. But these sparks remain the same when a magnet (5) applied to the discharge tube deflects the cathode rays from the observing space. This shows that the electric forces producing the sparks have no immediate connection with the cathode rays. It might be expected that the sparks would disappear, and the cathode rays remain, if the whole discharge apparatus were enclosed in a conducting envelope adjoining the window wall. It is easier in practice to reverse the process, and to exclude the whole generating apparatus by means of a perfectly closed conducting envelope. The well-soldered tin box, C C, Fig. 5, is placed as such an envelope at the window. The removable front partition, V V, is a metal frame with an opening 4cm. square, covered with aluminium foil 0·0045 thick (double the thickness of the window). Into this box the cathode rays enter quite as easily as if only its front wall were present. This may best be shown by enclosing a photographic plate in it. The negative of Fig. 4 was actually obtained in this box, and was indistinguishable from others taken in the open observing space. Fig. 4 shows especially that the luminosity of the air also exists in the box, that it therefore does not appertain to the electric forces, but to the cathode rays. If we now replace a portion of the wall of the box by fine wire gauze soldered to it, this luminosity and the phosphorescence of bodies inside may be directly observed. But it is quite impossible to draw with a pointed wire, D (Fig. 5), even the smallest spark out of the front wall inside the box, whether the wire is connected with the back wall or not. Only when in the latter case the wire is prolonged outward a few centimetres, does it give sparks with the front wall ; but in this case the electric forces are introduced from behind into the box by the insulation of the wire.

It is, therefore, possible to completely separate the cathode rays from the electric forces (in the narrower sense). This excludes the assumption that the window or other surfaces, which we have designated as pervaded by the rays, act as cathodes in the ordinary sense. Again, the back of such a surface only sends out rays from those places which correspond to those illuminated from the front, as shown by the shadows of wires and quartz plates propagated through aluminium foil (8). To make cathode rays of the observed lengths proceed in all directions from the back of a plate in air, or, generally, to make cathode rays in a perfect vacuum (see below) proceed in that way, can only be done in the known way, viz., by allowing cathode rays to fall upon the front of the plate.

11. Electrified bodies lose their charge in the observing space. An insulated metal plate placed near the window, say an aluminium disc 17mm. in diameter, does not, when exposed to the rays, acquire any charge which might be discovered by a sensitive Exner electroscope. But if the plate, to begin with, was given a positive or negative charge, the leaves of the electroscope collapsed immediately when exposure took place. The state of things was unaltered when plate and electroscope were surrounded by a cage of very fine wire gauze in contact with the window wall. The much used ½mm. quartz plate intercepts this effect when applied to the window, but not till it just completely covers the window. Aluminium foil transmits the effect. Intercepting the cathode rays by a sufficiently strong magnet applied to the discharge tube stops the effect. On removing the aluminium disc to 8cm. from the window, that is to the limit of perceptible displays of phosphorescence, the effect is not much diminished ; it is shown very distinctly even at a distance of 30cm. from the window. The introduction of the hand midway between window and plate intercepts them. The sudden discharge of the plate near the window may be slightly retarded by the addition of a Leyden jar of medium size. I have also noticed the discharging effect in rarified air. It is not decided whether this was an influence of the cathode rays upon the surface of the window, or upon the air, or upon the irradiated plate itself. The latter supposition seems hardly probable considering the great distances.

(To be continued.)

* The tube, centrally attached to the window wall, was 6cm. long and 4·5cm. wide inside, so that the chief portion of the cathode rays was absorbed in the enclosed gas and only little at the walls. The tube contained 95·4 cubic cm. of gas ; the increase of volume attained 25 cubic mm., which would only mean a heating through 0·08°C.

THE BOARD OF TRADE ELECTRIC TRACTION REGULATIONS.

Various Acts of Parliament and Provisional Orders granted last Session, authorising the use of electric traction on tramways, impose on the Board of Trade the duty of prescribing regulations to be observed by the tramway companies for the prevention of injury to gas and water pipes, and for minimising interference with other electric circuits. After hearing the various parties interested the Board of Trade have decided to prescribe regulations in the accompanying form. The regulations as originally drafted will be found in *The Electrician* of November 24, 1893, p. 96.

Definitions.

In the following regulations—

The expression "energy" means electrical energy.

The expression "generator" means the dynamo or dynamos or other electrical apparatus used for the generation of energy.

The expression "motor" means any electric motor carried on a car and used for the conversion of energy.

The expression "pipe" means any gas or water pipe or other metallic pipe, structure or substance.

The expression "wire" means any wire or apparatus used for telegraphic, telephonic, electrical signalling, or other similar purposes.

The expression "current" means an electric current exceeding one thousandth part of one ampere.

The expression "the Company" has the same meaning as in the Tramways Act.

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Regulations.

1. Any dynamo used as a generator shall be of such pattern and construction as to be capable of producing a continuous current without appreciable pulsation.*

2.—One of the two conductors used for transmitting energy from the generator to the motors shall be in every case insulated from earth, and is herein-after referred to as the "line"; the other may be insulated throughout, or may be uninsulated in such parts and to such extent as is provided in the following regulations, and is herein-after referred to as the "return."

3. Where any rails on which cars run or any conductors laid between or within 3ft. of such rails form any part of a return, such part may be uninsulated. All other returns or parts of a return shall be insulated, unless of such sectional area as will reduce the difference of potential between the ends of the uninsulated portion of the return below the limit laid down in Regulation 7.

4. When any uninsulated conductor laid between or within 3ft. of the rails forms any part of a return, it shall be electrically connected to the rails at distances apart not exceeding 100ft. by means of copper strips having a sectional area of at least one-sixteenth of a square inch, or by other means of equal conductivity.

5. When any part of a return is uninsulated it shall be connected with the negative terminal of the generator, and in such case the negative terminal of the generator shall also be directly connected, through the current-indicator herein-after mentioned, to two separate earth connections which shall be placed not less than 20 yards apart.

Provided that in place of such two earth connections the Company may make one connection to a main for water supply of not less than 3in. internal diameter, with the consent of the owner thereof and of the person supplying the water, and provided that where, from the nature of the soil or for other reasons, the Company can show to the satisfaction of an inspecting officer of the Board of Trade that the earth connections herein specified cannot be constructed and maintained without undue expense the provisions of this regulation shall not apply.

The earth connections referred to in this regulation shall be constructed, laid, and maintained so as to secure electrical contact with the general mass of earth, and so that an electro-motive force, not exceeding four volts, shall suffice to produce a current of at least two amperes from one earth connection to the other through the earth, and a test shall be made at least once in every month to ascertain whether this requirement is complied with.

No portion of either earth connection shall be placed within 6ft. of any pipe except a main for water supply of not less than 3in. internal diameter which is metallically connected to the earth connections with the consents herein-before specified.

6. When the return is partly or entirely uninsulated the Company shall in the construction and maintenance of the tramway (*a*) so separate the uninsulated return from the general mass of earth, and from any pipe in the vicinity; (*b*) so connect together the several lengths by the rails; (*c*) adopt such means for reducing the difference produced by the current between the potential of the uninsulated return at any one point and the potential of the uninsulated return at any other point; and (*d*) so maintain the efficiency of the earth connections specified in the preceding regulations as to fulfil the following conditions, viz.:—

(i.) That the current passing from the earth connections through the indicator to the generator shall not at any time exceed either two amperes per mile of single tramway line or five per cent. of the total current output of the station.

(ii.) That if at any time and at any place a test be made by connecting a galvanometer or other current-indicator to the uninsulated return and to any pipe in the vicinity, it shall always be possible to reverse the direction of any current indicated by interposing a battery of three Leclanché cells connected in series if the direction of the current is from the return to the pipe, or by interposing one Leclanché cell if the direction of the current is from the pipe to the return.

In order to provide a continuous indication that the condition (i.) is complied with, the Company shall place in a conspicuous position a suitable, properly connected, and correctly marked current-indicator, and shall keep it connected during the whole time that the line is charged.

The owner of any such pipe may require the Company to permit him at reasonable times and intervals to ascertain by test that the conditions specified in (ii.) are complied with as regards his pipe.

7. When the return is partly or entirely uninsulated a continuous record shall be kept by the Company of the difference of potential during the working of the tramway between the points of the uninsulated return furthest from and nearest to the generating station. If at any time such difference of potential exceeds the limit of seven volts, the Company shall take immediate steps to reduce it below that limit.

8. Every electrical connection with any pipe shall be so arranged as to admit of easy examination, and shall be tested by the Company at least once in every three months.

9. Every line and every insulated return or part of a return except any feeder shall be constructed in sections not exceeding one-half of a mile in length, and means shall be provided for isolating each such section for purposes of testing.

10. The insulation of the line and of the return when insulated, and of all feeders and other conductors, shall be so maintained that the leakage current shall not exceed one-hundredth of an ampere per mile of tramway. The leakage current shall be ascertained daily before or after the hours of running, when the line is fully charged. If at any time it should be found that the leakage current exceeds one-half of an ampere per mile of tramway the leak shall be localised and removed as soon as practicable, and the running of the cars shall be stopped unless the leak is localised and removed within 24 hours. Provided that where both line and return are placed within a conduit this regulation shall not apply.

11. The insulation resistance of all continuously-insulated cables used for lines, for insulated returns, for feeders, or for other purposes, and laid below the surface of the ground, shall not be permitted to fall below the equivalent of 10 megohms for a length of one mile. A test of the insulation resistance of all such cables shall be made at least once in each month.

12. Where in any case in any part of the tramway the line is erected overhead and the return is laid on or under the ground, and where any wires have been erected or laid before the construction of the tramway in the same or nearly the same direction as such part of the tramway, the Company shall, if required so to do by the owners of such wires or any of them, permit such owners to insert and maintain in the Company's line one or more induction coils or other apparatus approved by the Company for the purpose of preventing disturbance by electric induction. In any case in which the Company withhold their approval of any such apparatus the owners may appeal to the Board of Trade, who may, if they think fit, dispense with such approval.

13. Any insulated return shall be placed parallel to and at a distance not exceeding three feet from the line when the line and return are both erected overhead, or 18 inches when they are both laid underground.

14. In the disposition, connections, and working of feeders the Company shall take all reasonable precautions to avoid injurious interference with any existing wires.

15. The Company shall so construct and maintain their system as to secure good contact between the motors and the line and return respectively.

16. The Company shall adopt the best means available to prevent the occurrence of undue sparking at the rubbing or rolling contacts in any place and in the construction and use of their generator and motors.

17. In working the cars the current shall be varied as required by means of a rheostat containing at least 2) sections, or by some other equally efficient method of gradually varying resistance.

18. Where the line or return or both are laid in a conduit the following conditions shall be complied with in the construction and maintenance of such conduit:—

(*a.*) The conduit shall be so constructed as to admit of easy examination of and access to the conductors contained therein and their insulators and supports.

(*b.*) It shall be so constructed as to be readily cleared of accumulation of dust or other *débris*, and no such accumulation shall be permitted to remain.

(*c.*) It shall be laid to such falls and so connected to sumps or other means of drainage, as to automatically clear itself of water without danger of the water reaching the level of the conductors.

(*d.*) If the conduit is formed of metal, all separate lengths shall be so jointed as to secure metallic continuity for the passage of electric currents. Where the rails are used to form any part of the return they shall be electrically connected to the conduit by means of copper strips having a sectional area of at least one-sixteenth of a square inch, or other means of equal conductivity, of distances apart not exceeding 100 feet. Where the return is wholly insulated and contained within the conduit, the latter shall be connected to earth at the generating station through a high resistance galvanometer suitable for the indication of any contact or partial contact of either the line or the return with the conduit.

(*e.*) If the conduit is formed of any non-metallic material not being of high insulating quality, and impervious to moisture throughout, and is placed within 6ft. of any pipe, a non-conducting screen shall be interposed between the conduit and the pipe, of such material and dimensions as shall provide that no current can pass between them without traversing at least 6ft. of earth, or the circuit [conduit ?] itself shall in such case be lined with bitumen or other non-conducting damp-resisting material in all cases where it is placed within 6ft. of any pipe.

(*f.*) The leakage current shall be ascertained daily, before or after the hours of running, when the line is fully charged, and if at any time it shall be found to exceed half an ampere per mile of tramway the leak shall be localised, and removed as soon as practicable, and the running of the cars shall be stopped unless the leak is localised and removed within 24 hours.

19. The Company shall, so far as may be applicable to their system of working, keep records as specified below. These records shall, if and when required, be forwarded for the information of the Board of Trade.

Daily Records.

Number of cars running.
Maximum working current.
Maximum working pressure.
Maximum current from the earth connections (*vide* Regulation 6 (i.)).
Leakage current (*vide* Regulations 10 and 18 (*f.*)).
Fall of potential in return (*vide* Regulation 7).

Monthly Records.

Condition of earth connections (*vide* Regulation 5).
Insulation resistance of insulated cables (*vide* Regulation 11).

Quarterly Records.

Conductance of joints to pipes (*vide* Regulation 8).

Occasional Records.

Any tests made under provisions of Regulation 6 (ii.).
Localisation and removal of leakage, stating time occupied.
Particulars of any abnormal occurrence affecting the electric working of the tramway.

March 6, 1894. Board of Trade, 7, Whitehall-gardens, S.W.

* The Board of Trade will be prepared to consider the issue of regulations for the use of alternating currents for electrical traction on application.

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BOARD OF TRADE (DRAFT) REGULATIONS FOR UNDERGROUND ELECTRIC RAILWAYS.

Certain Acts of Parliament granted last Session, authorising the use of electric traction on railways to be constructed underground in metal-lined tunnels, impose on the Board of Trade the duty of prescribing regulations for the prevention of injury to gas and water pipes, and for minimising interference with other electric circuits. The following draft regulations have been prepared, and submitted for the consideration of the Board of Trade:—

Definitions.

In the following regulations—

The expression "energy" means electrical energy.

The expression "generator" means the dynamo, or dynamos, or other electrical apparatus used for the generation of energy.

The expression "motor" means any electric motor carried on a train and used for the conversion of energy.

The expression "pipe" means any gas or water pipe, or other metallic pipe, structure, or substance.

The expression "the Company" has the same meaning as in the Railway Act.

Regulations.

1. Any dynamo used as a generator shall be of such pattern and construction as to be capable of producing a continuous current without appreciable pulsation.*

2. One of the two conductors used for transmitting energy from the generator to the motors shall be in every case insulated from earth by means of insulators of a strong and durable material, so shaped as to offer great resistance to surface leakage, and is hereinafter referred to as the "line"; the other may be similarly insulated throughout, or may be uninsulated in such parts and to such extent as is provided in the following regulations, and is hereinafter referred to as the "return."

3. Where any rails on which trains run or any conductors laid within the metal-lined tunnels in which the railway is constructed form any part of a return, such part may be uninsulated. All other returns or parts of a return shall be insulated.

4. When any uninsulated conductor forms any part of a return, it shall be electrically connected to the rails at distances apart not exceeding 100 feet by means of copper strips having a sectional area of at least one-sixteenth of a square inch, or by other means of equal conductivity.

5. When any part of a return is uninsulated it shall be connected with the negative terminal of the generator and in such case the negative terminal of the generator shall also be directly connected to the iron or other metal plates forming the lining of the tunnels. In each case the connection shall be made through a suitable current indicator.

6. The iron or other metal plates forming the lining of the tunnels shall be so made and connected together as to form a continuous metal tube.

7. Where any pipe is brought into the tunnel from outside, means shall be provided to secure that no portion of the pipe outside the metal tube shall be in metallic connection with the tube or with any conductor of electricity within the tube.

8. When the rails form any part of the return they shall either be electrically connected, at intervals not exceeding 100ft., to the metal tube by metallic conductors which will not be appreciably heated by a current of 100 amperes, or they shall not be in any metallic connection with the metal tube except by means of the connections to the negative terminal of the generator. In the latter case the rails shall be supported by cross sleepers of wood specially prepared to resist the penetration of moisture and the growth of any mould or fungus, and they shall be of such sectional area and so connected at joints and from one line of rails to another, and where necessary to supplementary conductors or feeders, that the difference of potential between the rails and the metal tube shall not in any part and under any working conditions exceed 10 volts. A test of this shall be made at least once in each month.

9. When the return is partly or entirely uninsulated a continuous record shall be kept by the Company of the difference of potential during the working of the railway between the points of the uninsulated return furthest from and nearest to the generating station. If at any time such difference of potential exceeds the limit of seven volts, the Company shall take immediate steps to reduce it below that limit.

10. Every line and every insulated return shall be constructed in sections, and means shall be provided at or near each station for breaking the connection between sections for the rapid localisation of faults.

11. The insulation resistance of any conductor laid outside the metal tube shall not be permitted to fall below the equivalent of 10 megohms for a length of one mile. A test of this shall be made at least once in each month

12. The leakage current shall be tested daily before and after the hours of running with the working pressure, and duly recorded. Should the amount of this at any time appear to indicate a fault of insulation, steps shall at once be taken to localise and remove it.

13. The Company shall, so far as may be applicable to their system of working, keep records as specified below. These records shall, if and when required, be forwarded for the information of the Board of Trade.

Daily Records.

No. of trains running.
Maximum working current.
Maximum working pressure.
Maximum current from the rails to generator.
Maximum current from the metal tube to generator.
Leakage current (*vide* Regulation 12).
Fall of potential in return (*vide* Regulation 9).

Monthly Records.

Maximum difference of potential between rails and metal tube (*vide* Regulation 8).
Insulation resistance of conductors laid outside metal tube (*vide* Regulation 11).

Occasional Records.

Localisation and removal of leakage, stating time occupied.
Particulars of any abnormal occurrence affecting the electric working of the railway.

* The Board of Trade will be prepared to consider the issue of regulations for the use of alternating currents for electrical traction on application.

Note.—Those regulations only apply to railways constructed underground in metal-lined tunnels.

REVIEWS.

The Book of the Fair. Parts 10 and 11. (The Bancroft Company, Chicago and San Francisco.)

To commemorate and to record the wonders of the Chicago Exhibition an elaborately-illustrated book is being published in parts. Lest words should fail us in singing its praises, 17 ready-made suggestions for reviews accompany the two parts which we have received. We search in vain for any useful information, statistics, scientific tests of machinery or apparatus, or anything which we can commend to our readers, but are only met by columns of extracts from exhibitors' catalogues, interspersed with this sort of thing: "Let us imagine ourselves standing at eventide in the central court, now almost a solitude, haunted by the shadows of deserted temples cast athwart the plaza." This reminds us, by the way, that the innumerable photographs which we have seen of the grounds and buildings of this Exhibition are remarkable for the small number of visitors; perhaps, for the sake of quiet, they were taken on Sundays. The electrical section of this book contains only one reproduction of an out-door photograph, and in this not a single human being is visible. In the agricultural section, a portion of which is to be found in Part 10, a view of the administration plaza on "Chicago Day" amply makes amends for this deficiency. The illustrations of the exhibitors' stalls are remarkably fine specimens of photographic reproduction, and do as great credit to the printers as did, at the time, the woodcuts in the similar volumes recording the London Exhibition of 1851.

Standard Tables for Electric Wiremen. By C. M. Davis. Fourth edition; revised and edited by W. D. Weaver. (New York: W. J. Johnston Co.)

In this compact little work we have a collection of tables, rules and diagrams, which may be considered likely to be of use to a wireman. The data are based upon American practice, however, which differs in many respects from English practice; and the tables are all referred to the B and S wire gauge, quite unknown over here.

Induction Coils and Coil-Making. By F. C. Allsop. (London: E. and F. N. Spon. New York: Spon and Chamberlain. 1894.)

The scope of this little book is restricted to the construction and action of shocking, medical and spark induction coils, and their accessories. Those who are desirous of learning how to make or use a coil will find full particulars in this little treatise, which is copiously illustrated with not very superior cuts. A portion of the book has already appeared as a series of articles in the *English Mechanic*. Not a word is to be found about the very simple oil coils, with which the brilliant experiments of Tesla, Elihu Thomson, Swinton, and others can be so easily carried out.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

THURSDAY, March 29th.

Institution of Electrical Engineers.

8 p.m. General Meeting at 25, Great George-st. Presentation of balance-sheet. The following Paper will be further discussed: "Parallel Working through Long Lines," by W. M. Mordey, Member; to be followed by the reading of the following Papers: (1) "A Universal Shunt Box for Galvanometers." (2) "Transparent Conducting Screens for Electric and other apparatus." (3) "An Astatic Station Voltmeter," by Prof. W. E. Ayrton, F.R.S., and T. Mather. (4) "The Best Resistance for the Receiving Instrument with a leaky telegraph line," by Prof. W. E. Ayrton and C. S. Whitehead, M.A.

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ELECTRIC TRAMWAY REGULATIONS.

The amended regulations by the Board of Trade for the employment of insulated or uninsulated returns of electric tramways have been issued and will be at once incorporated in the various Acts of last session. In order to save our readers the trouble of referring to the draft form of these regulations, we print them in full in their final form in another column. We have compared the two copies, word by word, and in scarcely a single instance can the interests of electric traction be said to have suffered by the amendments made after and in consequence of the Conference at which the matter was so fully discussed. We have also received a draft copy of the regulations which are intended to apply to railways constructed underground in metal-lined tunnels. These are also printed in full in another column. The fact that such a line is surrounded by a cast-iron tube which may be made electrically continuous throughout its length, rather than that it is a railway as distinguished from a tramway, makes further regulations necessary, but at the same time this fact considerably simplifies the matter.

The general effect of the regulations is to compel the use of feeders, and although the use of such conductors has been the exception rather than the rule in this country, it must be remembered that most of our lines have been experimental, or of limited length. Considerations of economy of power, quite as much as possibility of electrolytic corrosion, will be sufficient in most cases to induce traction engineers to use feeders, and the tapping of the return which, whether insulated or uninsulated, is really a feeder, at distances not exceeding 100 feet

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apart, will not be a very expensive matter. The most important electric line in this country, and no mere tramway, but perhaps the most important electrical railway in the world, namely the Liverpool Overhead Railway, has no feeders, nor has it, indeed, copper conductors. The conductor is of steel and the return is by the rails and perhaps also by the iron structure. The specific resistance of iron is greater than that of copper, approximately in the inverse ratio of the cost, and the fact that the sectional area in this case is four square inches does not imply that the conductor is so large that no feeders are required; the chief reason in this case is that the generating station being at the middle of its length, the line must for this purpose be considered as one of only about three miles.

In the first regulation the word "steady" has been omitted, and the words "without appreciable pulsation" have been introduced, the object being, of course, to avoid the use of such dynamos which give a fluctuating current. Prof. AYRTON has suggested the use of a "discontinuity meter," and it has been found that the fluctuations of current of a Brush machine amount to about 1½ per cent. Whether the current is found to present "appreciable pulsation" as specified in this regulation, will probably be settled merely by the presence or absence of any appreciable continuous hum in neighbouring telephone wires. There is, fortunately, no difficulty in avoiding this defect in ordinary dynamos, and the regulation is likely to be felt only where feeders supply the line by means of dynamotors, for here, there is a temptation to reduce the number of sections on the low-pressure commutator. The non-conducting screen mentioned in Regulation 5 was the subject of much discussion at the Conference. A layer of bitumen or coatings of bituminous paint will probably suffice; but it is to be hoped that the owners of gas and water pipes will soon recognise the simple scientific fact that their greatest security lies in ample connection with the earthed negative pole of the circuit. The alteration of Regulation 6 (i.) is of no little importance; the maximum earth current is increased from two amperes to ten per mile of single line, and a current equal to five per cent. of the total current output of the station is permitted, as an alternative. The specification of the direction of the current in 6 (ii.) is important. One of the main purposes of these regulations is to ensure that if any leakage or return current passes through the earth it shall *enter* gas and water pipes, and not leave them except through proper metallic conductors, thus avoiding corrosion. The allowance of fifteen per cent. increase in the fall of potential in regulation, instead of five volts as a limit, in Regulation 7, is one of the important concessions made at the Conference; and the localising and removal of leaks "as soon as practicable" in Regulation 10, and the taking "all reasonable precautions" in Regulation 14, are evidences of the liberal treatment which this matter has received at the hands of the Board of Trade.

Care has been taken to avoid the easy but unsatisfactory course of ordering that this, that, and the other, are to be done to the satisfaction of the Board of Trade. It is better to make a rather stringent rule and relax or qualify its enforcement, than to leave it in such a vague condition. At the same time, it must, of course, be acknowledged that the details of electric traction may be greatly developed, and that the rules must not tie down the practice to that of the present day, but must leave room for improvements. The sixteenth regulation affords an example. "The best means available" must be used to prevent "undue sparking at the rubbing or rolling contacts." When better means than the present ones are invented, this regulation will only entail a new kind of trolley wheel or head, or new brushes, or perhaps brush-holders. For such details as these we may look for assistance to America, although the general principles of our electric traction may be governed by the general conditions of this country. Considering that we have but one conduit line in this country, and one which is in many respects exceptional, and that the Buda-Pesth line, though successful, would not be tolerated here; the explicit terms of Regulation 18 may be said to refer to an ideal system rather than to any which is in actual use. Such a conduit has, indeed, to be invented, or, if invented but unknown, to be tried and worked on a practical scale. Some people look upon all regulations as hindrances, and regard them as Government interference with the liberty of individuals. That such rules are vexatious to some people cannot be denied, but investigation shows that the unrestricted doings of these people would be highly vexatious to the general public.

TESTING IRON OF TRANSFORMERS BY A WORKSHOP METHOD.

BY CLARENCE P. FELDMANN.

In 1886 Titus Otto Bláthy, of Budapest, wrote a letter to the Editor of *The Electrician*, telling him that he had succeeded in separating the hysteresis and eddy-current losses, and promising some further details in the near future. The letter was reproduced, but the promised details did not appear. The method consisted in observing for different voltages and different frequencies the total losses, and in putting the hysteresis losses proportional to the first, the eddy-current losses proportional to the second power of the frequency. Besides, the latter were taken proportional to the square of the induction, which Bláthy at that time called "magnetic current," and the power of B for the hysteresis losses was worked out by a method of trial and error. In the meantime Mr. Gisbert Kapp has taught us how to separate these losses for continuous-current dynamos, Dobrowolsky has employed this method for transformers, Steinmetz has given his empirical law, Evershed and Fleming have worked out the formulæ for the eddy-current losses occurring in the iron of transformers, and J. J. Thomson and Ewing have shown the mathematics of it. I have tried to find sufficiently exact formulæ for the eddy-current losses in iron sheets and iron wires, if thickness or diameter is measured in millimetres. Having found (from Fleming's values) the eddy-current loss per cubic centimetre, for sheets,

$$\left(\frac{b \cdot p \cdot \mathbf{B}_{max}}{2{\cdot}5 \times 10^6}\right)^2 \text{ watts,}$$

and for wires,

$$\left(\frac{b \cdot p \cdot \mathbf{B}_{max}}{2 \cdot \times 10^6}\right)^2 \text{ watts,}$$

where b = thickness or diameter in millimetres,

p = frequency, ∿ per second,

$\mathbf{B}_{max}$ = maximum induction.

I tried to verify these data by means of some of my own and Neustadt's and Bláthy's tests, the latter carried out in 1885 and 1886. The reasoning was the following:—The total losses had in both been measured by the Ganz wattmeter, the effective values of current and potential difference by means of an electro dynamometer and a cardew voltmeter. If I calculated the maximum induction $\mathbf{B}_{max}$ from the effective value of the potential difference $\mathbf{B}_{max} = 0{\cdot}9\ E/4\ p.f.$ where E = effective potential difference, and f = sectional area, I could find the eddy-current loss per unit, and for the total volumes. Subtracting this loss, and the small loss due to the total magnetising current from the total loss measured by the wattmeter, I would obtain the hysteresis loss for the total and the unit volume. If this loss, divided by the 1·6th power of $\mathbf{B}_{max}$, gave a constant

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number, the separation of eddy current and hysteresis losses was completed in the right way.

To make the calculation easier and less disagreeable I plotted the result in a curve, and picked out the values of the total losses for the following values of B_{max}:—

—	Total losses after subtraction of copper losses due to magnetising current.	Eddy-current losses calculated.	Consequently: Hysteresis losses observed.	Hysteresis losses calculated.	Difference in per cent.
B_{max} =	Watts.	Watts.	Watts.		
3,000	53·3	9·7	$45·6 = 1{,}245\ B_{max}^{1·6} \times 10^{-7}$ =	46·2	1·3
4,000	86·1	16·1	72·3 = 1,245 " × " =	73·0	1·0
5,000	124·8	25·0	103·3 = 1,245 " × " =	104·6	1·3
6,000	169·6	36·4	138·6 = 2,248 " × " =	140	1·0
7,000	221·7	50·3	179·5 = 1,262 " × " =	179	0·3
7,500	249·6	58·0	201·2 = 1,269 " × " =	200	0·6
			Mean value $1{,}255 \times 10^{-7} B_{max}^{1·6}$		1·0%§

§ Mean value.

The mean value of the difference between "observed" and "calculated" hysteresis losses—if those calculated from the observations as described may be called "observed" at all—is within the errors of observation. The observations were rather exact, as a very large number of them was made. The data refer to a transformer built up of iron sheets or strips 0·5mm. thick, 10mm. wide, and coiled up in the usual way of the old Ganz transformer to form plates whose magnetic length was 94cm. These iron plates were piled up so as to form a core of rectangular section, and the layers of the thin iron sheets or strips were separated by means of thin paper sheets. The other data were:—Sectional area of iron core, 129 sq. cm.; volume of core, 12,200 cubic cm.; number of windings, 30; resistance, 0·013 ohm; frequency, 42.

The calculated hysteresis losses were obtained from the relation $1255 \times 10^{-7} \times B_{max}^{1·6}$, which is equal to $42 \times 11200 \times 0·00245 \times 10^{-7} \times B_{max}^{1·6}$ watts.

Another series of observations, dated November 25, 1885, relates to a smaller transformer built of oxidised iron wire, one millimetre in diameter. The sectional area of the iron core was 30 sq. cm., the volume of the core was 1,320 cubic cm., the number of windings was 45, the resistance was 0·1 ohms, the frequency 54, and the length of the magnetic circuit was 42 cm.

Total indicated.	Total watts.	Calculated eddy current loss.	Observed hysteresis loss.	Calculated hysteresis loss.	Difference in %	a
B_{max} =						
7,000	36·5	11·8	24·7	24·7	0·0	0·00245
8,000	46·0	15·4	30·6	30·6	0·0	0·00244
9,000	56·0	19·5	36·5	36·9	1·1	0·00239
10,000	67·5	24·1	43·4	43·7	0·7	0·00240
11,000	80·0	29·2	50·8	50·7	0·2	0·00244
12,000	93·8	34·7	59·1	58·6	1·9	0·00248
				Mean value ...	0·5%	0·00244

The calculated hysteresis losses were in this case obtained from the relation $0·00244 \times 1320 \times 54 \times 10^{-7} \times B_{max}^{1·6}$ watts.

Having obtained these satisfactory results, I tried to push the thing a little further, and to find from the readings of the wattmeter, dynamometer, and Cardew voltmeter a magnetic characteristic of the transformers tested. To do this, I divided the total watts by the potential difference; this gave the one component of the total current as measured by the dynamometer. The second component was easily found by taking $\sqrt{(\text{total current})^2 - \left(\frac{\text{watts}}{\text{potential difference}}\right)^2}$. This second "wattless" component was the magnetising current, which gave the magnetomotive force, the magnetising force, and the permeability.

For the second transformer with iron wire core, the calculations gave:—

—	—	Watts : volts = amps.	$\sqrt{J^2_{tot} - J^2_{eff}}$	$H = \frac{45}{42} \cdot \frac{4\pi}{10} \cdot 0.9 J_0$	$\mu = \frac{B}{H}$
B_{max} =	J_{tot} =	J_{eff} =	J_0 = Amp.		
7,000	3·0	36·5 : 22·7 = 1·61	2·53	3·68	2,270
8,000	3·5	46·0 : 25·9 = 1·78	3·00	3·76	2,130
9,000	3·9	56·0 : 29·2 = 1·92	3·40	4·14	2,180
10,000	4·5	67·5 : 32·4 = 2·08	4·00	4·87	2,050
11,000	5·0	80·0 : 35·6 = 2·25	4·45	5·42	2,030
12,000	5·9	93·8 : 38·9 = 2·42	5·40	6·58	1,820

While, for the first transformer, a similar table contains the following numbers:—

—	—	Watts : volts = amps.	$\sqrt{J^2_{tot} - J^2_{eff}}$	$H = \frac{30}{91} \cdot \frac{4\pi}{10} \cdot 0.9 J_0$	$\mu = \frac{B}{H}$
B_{max} =	J_{tot} =	J_{eff} =	J_0 =		
3,000	4·70	53·3 : 21·6 = 2·47	4·0	1·49	2,010
4,000	5·67	86·1 : 28 8 = 2·99	4·82	1·79	2,230
5,000	6·58	124·8 : 36·1 = 3·45	5·60	2·08	2,400
6,000	7·50	169·6 : 43·3 = 3·92	6·39	2·38	2,520
7,000	8·41	221·7 : 50·6 = 4·38	7·17	2·67	2,620
7,500	8·90	249·6 : 54·1 = 4·62	7·63	2·84	2,640

Obviously, these results are not as trustworthy as those due to the wattmeter readings alone. This is due to the fact that the dynamometer was not sufficiently sensitive, and that the errors of the three observations enter in full into these results. But perhaps the method is worth mentioning for workshop use, as it gives the actual working data of the transformer, and for the frequency in question. If it is reversed it shows how to calculate the eddy current and hysteresis losses, and how to find from them the "wattless" component of the total current, the angle of lag between current and potential difference, and so on, as, among others, Dobrowlsky showed at his Frankfort lecture.

This is only one series of observations taken from Bláthy's exhaustive tests, which he carried out, together with L. Neustadt, in the autumn of 1885 and in the first months of 1886. Transformer cores of every description, with iron plates, wires, and strips of various sizes, were thoroughly tested; and, as has been said in another place, "it is a pity that this lot of useful material has been buried in the professional bosom."

ON PARALLEL WORKING, WITH SPECIAL REFERENCE TO LONG LINES.*

BY W. M. MORDEY.

(Concluded from page 557.)

SOME TESTS OF A 25-KILOWATT ALTERNATOR USED AS A MOTOR.

The motor in this case was arranged to drive a direct-current dynamo by means of which a load could be put on it that would be quite constant so long as speed was constant. It was desired—(*a*) To find the effect of placing in the alternator circuit various amounts of resistance; (*b*) to find the effect on the steadiness. The 25-kilowatt alternator motor was driven by a 50-kilowatt alternator as generator.

Test F.—Motor was run with no load except its own direct-coupled exciter, and the direct-current dynamo, which in this case was run unexcited.

EFFECT OF REDUCING MOTOR EXCITATION AS RESISTANCE IN EXTERNAL CIRCUIT WAS INCREASED.

A. Generator. Volts.	A. Motor. Volts.	Amperes.	Line Resistance.	Remarks.
2,000	2,000	2·23	0	Current varying a little.
1,980	1,900	3·7	0	Current very steady.
2,040	1,900	3·5	65	"
1,960	1,840	2·0	65	"
1,950	1,820	2·23	75	"
1,960	1,800	2·0	85	"
1,960	1,780	2·23	95	"
1,960	1,760	2·23	105	"

* Paper read before the Institution of Electrical Engineers, March 8.

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We thus see a confirmation of what has been said about steady running being obtained, even with a very large resistance in the circuit, if there is a sufficient difference between volts of generator and motor. This is very common sense, and an experiment to prove it may seem superfluous. The experiment was not carried further, as the resistance used was the greatest available at the moment. This light load test should be read in connection with the full load test A.

Test G.—A test was then made with a load on the direct-current dynamo. This load was 8 kilowatts, and was constant. Allowing for friction, and various losses outside of itself, the alternator motor was doing between 14 h.p. and 15 h.p.

A. G'nerat'r Volts.	A. Motor. Volts.	Amperes.	Power dev'lop'd	Resist-ance.	Remarks.
2,040	2,040	7·0	14·5	0	Current fairly steady.
2,040	1,980	7·3	„	6	„ „
2,060	2,000	7·45	„	10	„ „
2,040	1,900	8·2	„	25	Current steadier.
2,040	1,740	9·8	„	35	Current steady.
2,120	1,540	11·0	„	45	„ „

In this is seen the gradual increase of motor current as the motor volts get lower, while steadiness rather improves with the addition of length (or resistance) of line. The test is incomplete, because it was not convenient to put a larger load on, and therefore the motor was not worked up to full power; but it is confirmatory of Test A. It is interesting to observe, with regard to this test, that the idle current was very small. For example, the first reading of 7 amperes may be divided into 2·25 amperes needed to drive the motor and its exciter, and for friction of the direct-current dynamo (see *Test F*); and into 4·75 amperes for the added load of 8 kilowatts. The dynamo gave 8 kilowatts, and the motor received about 4·75 amperes × 2,040 volts = 9,690 watts. Allowing for the losses in the two machines, it will be recognised that the transformation was not only very fairly efficient, but that the power-factor was evidently high.

The relative lowering of the E.M.F. of a synchronous motor is a necessity in order to obtain good results in power transmission over long distances. In this way the necessity for self-adjustment by the motor of the phase relation is avoided, the motor being enabled to work (other qualities permitting) at its most advantageous phase relation. And the other advantages are retained of high power-factor (that is, a small idle current) and a high efficiency of generator, motor, and line. By this means it will be found possible to work such motors over very long lines, and with almost any desired line loss. It, of course, has its counterpart in direct-current power transmission, but there is a difference. In one case the speed varies and the field remains constant, in the other the speed remains constant and the field must be varied. It is not necessary to alter the excitation of a direct-current motor—its speed simply drops or rises until it has got the right E.M.F. With an alternate-current synchronous motor the speed cannot drop. The excitation must be lowered in this case to give the right E.M.F. Failing this, the motor will shift its phase in an endeavour to attain the same result. Of course, in the direct-current machine, the speed may be kept up by lowering the field.

Some Tests of Two 100-Kilowatt Alternators.

Test H.—By the kindness of the City of London Company, I was enabled to make a trial with two of their 100-kilowatt alternators at Bankside, with the object of finding if, under the ordinary conditions of the station, these machines would work parallel with a considerable resistance between them and their load. For this purpose a load of about 100 kilowatts was put on, and the two alternators were made to supply it through a resistance of 7·5 ohms in the external circuit of each. As this resistance corresponds to 37·5 per cent. line drop at full load, and 18·75 per cent. drop at half load, it is a fairly severe test. It was found that some lamps and a voltmeter placed across the load (a wire resistance) kept perfectly steady. This, of course, was only a half-load test.

Test J.—When full load, or nearly full load, was on both machines, with 8 ohms in the circuit of each, there was a quite noticeable, but not at all violent, slow pulsation in the synchroniser lamp direct across the terminals of the alternators; but at the load the pulsation was very slight—barely noticeable. My impression was that with suitable adjustments this would have been quite a practicable arrangement—that is, to feed a lighting system from two alternators parallel, each having a 20 per cent. line loss between it and the load—a condition that is not likely to present itself very often.

Test K.—An attempt was then made to run the two machines parallel, with a load close to one of them, but separated from the other by a line of 16 ohms, corresponding to a line loss of about 40 per cent. The machines did not show any inclination to get out of step, but there was a pulsation of the E.M.F. at the lamps (at the load) of about 4 or 5 per cent. The result of this test, as carried out, was not good enough for lighting; although, if time and facilities had allowed, I think it quite likely that it could have been made satisfactory; but there was no pulsation or unsteadiness of a kind that would have interfered in any way with power transmission work.

It is a pleasure to me to make my acknowledgments to two assistants, Mr. Stobart and Mr. Foyster, who have ably aided me in connection with the recent tests and experiments, and to Mr. Watson in connection with the tests in 1891.

Some Analogies.

Probably I am not alone in having often found a difficulty in conveying, to persons not specially familiar with alternate-current matters, any very clear idea of the kind of action that takes place in parallel working. I would like, therefore, to be allowed to conclude by describing an analogy which I have often found useful in such cases.

Everybody knows something of toothed wheels. To explain the relations of two alternators, separately driven, working parallel, imagine two engines driving by spur gearing on to a common shaft. The shaft represents the circuit from which power may be taken; the spurs, or teeth, represent the successive waves of current. The operation of getting into synchronism is understood when one engine is imagined as running at its proper speed geared with the countershaft. To get the second engine to help, it will readily be understood that before being geared with the shaft it must be brought up to such a speed that the spurs of its toothed wheel synchronise with those on the shaft. A synchroniser, or phase-indicator, is the equivalent of a device for showing when the teeth of one wheel are exactly opposite the spaces between the teeth of the other wheel—that is, when they are synchronous. The mechanical process of slipping the two spur wheels together is the equivalent of electrically connecting the alternator and the circuit, and all the effects of doing this switching at the wrong time are easily illustrated by the sudden strain that would be imposed on the teeth. It will now be easy to follow the process of increasing the supply of steam to the engine until it transmits its proper proportion of power to the shaft; as well as the reduction of steam to such a point that the connection of either engine with the shaft (or of alternator with the circuit) can be interrupted at a time when no power is being transmitted from it or to it, and when, in consequence, its withdrawal makes no difference to the remaining engine (or alternator) or to the countershaft (or circuit). The changing of load from one engine to the other is readily understood.

Then the difficulties of parallel running may be made clear. Imagine one engine to get an insufficient supply of steam: it will be seen how the other must not only keep the countershaft (and any load) going, but must also drive the other engine. And note that this driven engine (receiving its power from the countershaft) is the analogue of the synchronous motor, and that the fact that the pressure is now not on the front side, but on the rear side, of the teeth, corresponds to the pull on the poles and armature coils being in the opposite direction to what it was as a generator; and that the difference of phase, or angle, between a generator and a motor, is illustrated by this change in the relative position of the teeth on spur wheel and shaft. If the teeth of one wheel are exactly midway between those of the other, corresponding to exact cophasal synchronism, a line drawn through the tip of one bisects the hollow of the other; and driving is possible either way, in this position, only if there is absolute fit—that is, no lag or lead—no clearance either side. As this is not possible in practice, there is always a lead or a lag, corresponding to similar changes in the relative positions of field and armature in an alternator, as generator and as motor; this change of angle being also conveniently expressed or measured in terms of the space occupied by a pair of teeth or a complete period.

Then it is possible, by this analogy, to get an engine builder to see what happens when an engine runs at different speeds during parts of each revolution. He will see that, if two engines are in use, and one is slowing a little as it goes over its dead centres, while the other is getting steam and quickening a little, the teeth of the former will be bearing with diminished pressure on the teeth of the countershaft, while the latter will be exerting increased pressure. And he will see that, if this difference is considerable, the power may all have to be supplied by one engine, which may even have to drive the other engine as well—that, in short, each engine may in each revolution be alternately a generator and a motor, twice or oftener (according to the number and setting of the cranks).

It will not be difficult to explain the pulsations of synchronising current transmitted through the circuit between the two alternators by the analogy of the impulses transmitted from one engine to another through the countershaft. He will also understand why, if the engines have this defect, this interchange of

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power will not take place, and will not be required, if he so arranges matters that the connection is made at a time when the engines (supposing them arranged to run at the same speed) are in the same part of their stroke; but in this case, as the engines cannot correct each other's irregularities, the speed of the countershaft may have an objectionable want of evenness of running, affecting any machinery driven from the countershaft—that this difference will be less on the driven machinery if it is driven by belting, and therefore not necessarily synchronous, than if it is driven by spur gearing, and so forced to run at the same speed.

I will not stop to do more than suggest the comparisons that may usefully be drawn between weight of fly-wheel and of electromagnetic inertia or self-induction as illustrating the effects in steadying the running of all shafts or circuits. But I cannot resist the temptation to show that, as with alternators in parallel, the very rapid interchanges of power take place with scarcely perceptible resistance (that is, frictional) losses, it is conceivable that two such machines and engines will take less steam to drive them than if they are dividing the same load between them on separate circuits. That this increase in efficiency is a fact has been shown by actual tests, which I hope later on will be placed before you.

Then the analogy may be carried further, and an understanding may be imparted of the difference in the synchronising abilities of various alternators. To do this it is necessary to add to the analogy of spur gearing the idea of that gearing having teeth of various degrees of stiffness or rigidity, varying all the way from phosphor-bronze to yielding elastic material such as soft rubber. The former may be compared to the alternators having unyielding fields and small armature reaction; the latter to machines having poles the magnetism of which gives way, more or less, under pressure. It will, no doubt, be difficult to get the uninitiated to grasp the idea of a tuft of lines of magnetic force from a pole-piece acting, through air, on a copper wire carrying a current, as corresponding to the material teeth of spur wheels geared together; but it is at least worth the attempt, and the result is usually better than the antecedent chaos.

Having conveyed this idea of various degrees of rigidity of teeth, as the equivalent of the various degrees of synchronising efforts of which different alternators are capable, the next step is to explain why with alternators having magnetic teeth of the gelatinous variety it is possible to put them into parallel (or to gear them) when they are unsynchronous, without anything happening except a more or less complete temporary flattening of the teeth (or alternations) of both machines, corresponding to a temporary cessation of useful effort, until they have gradually worked themselves into phase. And it will be understood why with such machines any sudden alterations or strains should be avoided as likely to result in the bending down of the teeth and loss of synchronism. On the other hand, it will be seen that, if the machines have strong and unyielding teeth (or powerful synchronising qualities), they will make a prodigious effort to keep in step whatever happens. This analogy affords an explanation of the difference in the way in which the synchronising current circulates between alternators of the two kinds. With spur wheels of the strong type it will be seen that any transfer of power will be immediate and prompt, the correcting impulses being transmitted with decision and sharpness, the lagging or yielding permitted being only that due to the space between the teeth. This corresponds with the short, sharp impulses of synchronising current between two alternators of one type; while the slow and sluggish impulses of current between two alternators of the weak field type is understood by imagining what would happen with an attempted interchange of power between the two engines geared to a shaft by teeth of some yielding material.

A further analogy, and I have done, to show those who are at all familiar with the mechanics of spur gearing how unnecessary it ought to be, so far as the machines are concerned, to reduce the number of magnetic teeth, or periods, in order to get satisfactory and smooth driving, either singly or parallel. It is only in cases where the electrical spur wheels are so designed that the teeth cannot get in, that a small number of periods can be of any service (so far as the machinery is concerned). Steady and smooth driving is rather to be sought in the other direction.

DISCUSSION.

The following is an abstract of the discussion on Mr. Mordey's Paper. Speakers whose remarks are prefaced by an asterisk have returned their proofs revised:—

*Mr. RAWORTH said that the Brush Company had not by any means taken a very serious view of Prof. Forbes's statements. They were perfectly well aware that the dynamos they manufactured were not steam rollers or anything of that sort. They were manufactured to work under certain conditions, and they *did* work under those conditions remarkably well. The only thing that Prof. Forbes said was that they did not work in synchronism when coupled together with a number of incandescent lamps in series. The Brush Company were not at all afraid of that allegation. But he wished to point out that, in the first instance, Prof. Forbes had found a mare's nest, and that Mr. Mordey had taken a great deal of trouble to explain away that mare's nest without dropping on the actual bottom of it, although he had got very close to it. The peculiar phenomenon Prof. Forbes had observed was not an alternating current effect at all, and no question of alternating currents was needed to explain it, nor for that matter did they want any electricity in the question whatever. They had on the occasion to which Prof. Forbes had alluded two dynamos working in parallel driven by two similarly governed engines without load. What could happen under those circumstances but hunting? There was no such thing in the world as a governor that did not hunt, and there would not be until they got no friction; the centrifugal force must be enough to overcome the friction of the governor. This was what happened on that historic occasion at Messrs. Willans' works. One of the governors was hunting; the steam came on and carried the engine away a little faster, then the governor shut down and the speed dropped. Of course, the variations were small, but still quite sufficient for the purpose. That was repeated backwards and forwards. The same thing exactly would have happened if there had been two continuous current dynamos there, or if there had been no dynamos at all there. It would have been just the same if they had put one engine in front of the other and connected the two fly-wheels by a thin india-rubber band, when they would have found the top of the belt slack and the bottom tight, and the bottom slack and the top tight in regular pulsations. The mare's nest which Prof. Forbes had got hold of was nothing but a common mechanical effect, and had nothing whatever to do with the alternators, excepting as they rendered the effect visible.

Mr. SPARKES said the principal difficulty in the parallel running of alternators in parallel was to secure steam engines that would give them an equal turning moment. The synchronising current wholly depended upon the inertia of the moving parts, and if the change of speed varied very much during the revolution they found a very large current necessary. That was aggravated very often, as mentioned by Mr. Raworth, by governors. All governors hunted, and even when they had a governor with a very small amount of friction they still required a sensible amount of synchronising current. The difficulty was got over by having more than one cylinder. When they took a compound engine they certainly got better results than by having a single cylinder. In coupling large cylinders together he thought it advisable that there should be at least two high-pressure, if not three high-pressure cylinders, working on the same crank, so as to get a very equal turning moment. If they put a very heavy fly-wheel on the machine, of course they modified the amount of work done by the armature, but it was impossible in many cases to put on a sufficiently heavy fly-wheel to obviate the strain put on the armature.

*Mr. KAPP said it was an exceedingly happy simile to compare alternators worked in parallel with spur-wheels running in gear. There was only one restriction he would like to make on Mr. Mordey's method of representation, and that was where he contrasted flexible-teeth spur-wheels with those having stiff teeth, to the disadvantage of the former. As the paragraph read, they might be inclined to think that the idea of flexibility carried with it the idea of a weaker tangential force acting between the two wheels. If that were so, then undoubtedly the stiff-toothed wheel would be better. But there was no reason to suppose that the flexible tooth was not equally strong. It yielded a little, but the more it yielded the greater force it exerted, therefore it was perfectly compatible with the simile to imagine the two wheels having teeth of equal strength, only one wheel would yield through a certain distance before it attained that tangential force, whereas the other did not yield at all, and attained that tangential force at a blow, and for that reason he had always been an advocate of having machines with a certain amount of self-induction. The experiments in the Paper were, of course, undertaken and brought to their notice with a definite object, namely, to show that Prof. Forbes's objection was not one which would occur in practice; moreover, that it was not so detrimental to the working of the machine as he made out. But he (the speaker) thought Mr. Mordey had not done himself justice. Most of the experiments were made on motors running light. In one or two cases there was a load mentioned, but it was a small load for the size of the machine. Had Mr. Mordey really treated the machines as they would be treated in a power transmission, that is to say, had he put on a 50-kilowatt alternator a mechanical load of 50 kilowatts he would have found that it would have dropped out of step very much sooner than it did. He would like to say something about the V curves, which were exceedingly useful if one drew the whole of them. The curve, so far as it went, showed exactly the point at which the machine would drop out of step. There was this interesting fact about it, that if they had a transmission plant where the resistance in circuit was small and the self-induction was large, they would find that the left branch of the V became vertical, and then turned over, whereas the right branch of the V sloped out to a very great distance, in fact, so far that the machine could not take the great current which this branch would indicate as possible. The machine would not take it because it would get too hot. In a transmission plant it would be best to excite a little above the point which Mr. Mordey rightly considered theoretically the best point, that was, the bottom of the V. The curves were taken whilst the machine was running idle, and did not represent the true shape; the true shape would be more rounded at the bottom, and the arms would be more curved. If they had a transmission where the resistance was small, and for some reason or other had chosen motors with fairly large self-induction, it would be advisable to excite the motors higher than the generator in order that they might work on that branch of the curve which sloped indefinitely. With the bad conditions which Mr. Mordey artificially produced in order to test this point, namely, where they had a large resistance in circuit and little self-induction in the machines, the shape of the curve was different. The left branch began to slope very much more to the left; it was, in fact, a concave line to the horizontal, whereas the right-hand branch would very quickly turn over. The point

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where the branch turned over showed the point where the machine dropped out of step. If they had large resistance in their line, that was to say, long lines, and could not afford to put in plenty of copper, they would then have, as Mr. Mordey rightly said, to work their motor at a lower excitation than the generator. But in general, when they used alternating currents for power transmission they were not under the necessity of wasting much power in their line, because they had the alternative to raise the voltage to such an amount that they could work with very small line loss, and that was no doubt the right way to work; but in that case the motor should be excited to at least the same electromotive force as the generator, preferably a little more, to give them a margin of power. It was all very nice to say that a 100-kilowatt motor was loaded to 100 kilowatts: it might be so if they averaged the load for the whole day, but under certain conditions, in fact, under most conditions, the load might often be considerably increased. His own machines were used in a power transmission in Switzerland. The machine was a 60-kilowatt alternator, and drove a factory, and when it was necessary to put on a heavy tool, or a whole row of tools, an enormous sudden strain was put on the machine, and instead of 60 kilowatts the machine did perhaps 100 kilowatts for the moment. They must have a margin of power, and they could get that by exciting the motor rather more strongly than the generator was excited—always supposing the line resistance was low. If it were high the machine could not deliver the power at all. As regards parallel running of alternators, he thought they had heard enough of the contention that certain alternators would run in parallel and others would not. It was not a question of the alternator, it was a question of the engine, and he could illustrate this best by his experience in Bristol. When Mr. Preece and himself designed the Bristol station they were perfectly well aware that an even turning moment was the only and necessary condition for working, and, in order to meet that condition, they specified engines with three cranks to work with alternators made by Messrs. Siemens, and when the engines were properly adjusted they could not read the synchronising current between the 80-kilowatt alternators and the 200-kilowatt alternators, and were quite sure the synchronising current did not reach five amperes. The following was interesting:—The expansion of each cylinder was adjusted separately. As a man had not three hands the expansions could not all be adjusted at the same moment. Therefore they got a slightly uneven turning moment, and the consequence was immediately visible on the ampere meters. As soon as they touched the expansion of one cylinder there was a slight jerk of the needle. As soon as they had adjusted all three the synchronising current became again negligibly small.

*Prof. SILVANUS THOMPSON said he hoped they might have had some further information and experience from those who had been manufacturing alternators and running them on a large scale. They certainly desired to have further data to discuss, particularly as to the question of the transmission of power from one alternator to another through a line of very considerable resistance, a line which of itself absorbed any considerable fraction of the power. There might well be cases where the generator and motor would not be similar, especially at the end of the line, where there was a measurable drop in voltage, and in that case it was probably advisable not to have the same degree of saturation of the magnets in the motors as would be the case if the machines were absolutely similar. With respect to Mr. Kapp's argument as to the flexible teeth being capable of driving as well as the rigid teeth, he (Prof. Thompson) might point out the reason why the flexible teeth, in the electrical case, were not so good for driving as the stiff teeth. It was that the very property of flexibility was not that there was a yielding, but that the yielding made the teeth less strong. There were some other ways of synchronising than those adopted in this country, and he would like some information about the American acoustic synchronisers. He would also ask whether anybody had had experience of a purely optical synchroniser? It was quite possible some optical synchroniser would be found more suitable and convenient than the electric forms. Lastly, he would ask whether anybody had had experience of the use of a common steam supply to the engines that were driving the machines which were running in parallel. It seemed to him that a good deal of the easy working of two engines working together might depend upon the question whether the steam supply was in common. It was desirable that they should have an expression of opinion, and a statement of actual experience gained in different stations with different types of governors and alternators.

The further discussion of the Paper was adjourned to the next meeting of the Institution on March 29th.

UNDERGROUND MAINS.

The following is an abstract of the discussion on the Papers on "Underground Mains," read before the Northern Society of Electrical Engineers by Mr. J. H. Rider and Mr. S. V. Clirehugh, and published in our last issue:—

Mr. WORDINGHAM said that, as regards the general questions of mains, the most important thing was durability. Take the case of vulcanised rubber cables. In Whitehaven they had a resistance of 1870 megohms—not per mile, but for the whole system as laid. Put on 1,000 consumers, each of one megohm, then the insulation resistance would only be 1,000 ohms; it was no use putting in thousands of megohms if the general resistance was only a few thousands of ohms. There could be very little doubt that copper was durable. Now, in Manchester they had partly bare copper in culverts and partly rubber. The resistance of bare copper was low; as to actual figures, he should not care to give any without having considered the matter first, but the figures which had got about were simply absurd; the resistance was said to be only a few ohms, instead of that it was certainly hundreds of ohms. As to rubber cables, he believed if the joints were properly vulcanised they could get perfect insulation. With regard to the question of vulcanising joints, the difficulty had been a little exaggerated. No doubt there was a large amount of difficulty in ascertaining the right duration of time for different mixtures and temperatures, but once the manufacturers gained this experience for them, and supplied them with vulcanising material that was ascertained to be good, there was very little difficulty in vulcanising joints. The great convenience of bare copper was the ease of getting on consumers. They simply had to sweat on a pair of thimbles and clamp them on to the bare mains.

Mr. A. B. MOUNTAIN thought that the difficulties of vulcanising were to be overcome by ordinary care, and considered the system of drawing vulcanised cables through cast-iron pipes in every way satisfactory for feeders or high-tension mains. Cables insulated with bitumen, paper, or fibre might be very good for low-tension mains, but were, he thought, unsuitable for high-tension work, unless laid with great care and at very considerable expense. With regard to the insulation resistance of the Manchester mains, there, of course, they had the continuous-current system with probably all the consumers connected on to one network. In the case of a town supplied by an alternating current the network would be divided, and the risks arising from leaks very considerably reduced, because the number of consumers connected on to any one section would be a small proportion of the total. The system of splitting up into small sections was a strong point with an alternating-current supply. In laying lead-covered cable underground, such as that proposed for Bolton, there were many points to be noticed. If the cables were laid in ground where there were traces of ashes they got serious trouble. Then the cables might be easily damaged by a blow from a pick or spade. If the cable was stranded into three, twisted in a spiral form, in the centre of the three circles of insulating material there would be a space not properly filled in, along which he should anticipate moisture creeping, and also when connecting consumers to the three-wire mains some difficulty might be anticipated in ascertaining to which pair of cables the consumer should be connected. He should like to know how the cables were distinguished.

Mr. BOURNE thought that Mr. Clirehugh in many ways under-estimated the capacity of paper as an insulator. At one time he had the problem set before him to make a paper cable for an alternating high-pressure current. Mr. Clirehugh said the insulation on the samples shown was very thin—it seemed to be about $\frac{1}{16}$ of an inch. The cables he (Mr. Bourne) made were successful, and the paper insulation had a thickness of about 17½ mils. There were seven thicknesses of the very finest paper. The cables worked at a pressure of 2,000 volts. They might get enormously high dielectric strength in paper; whether they could get the requisite strength combined with durability was a matter about which he had not had sufficient experience.

Mr. JAS. TAYLOR said that the only thing that struck him was that the difficulty of making rubber joints was over estimated. As regards paper and fibrous insulation, rubber had had ten years' experience and paper had not, and in another seven or eight years they would know more about it.

Mr. CONNOLLY said that it had often struck him that electric light work was more and more falling in line with the old telegraph work—that was to say, they were going back from the lower class of insulation to the higher class, and at the same time they were also going in a great deal more for the drawing-in system which was copied from the Post Office system for telegraph wires. The only thing they did not follow the practice of the telegraph world in was in the use of gutta percha. The reason for that was obvious. He could not conceive any permanent system of underground mains which did not consist of cables that were not only insulated but were also insulated with waterproof material, because sooner or later there was bound to be trouble with the insulation unless they could rely upon the insulating material being impervious to water. With lead-covered cables, with cables depending upon the lead for protection, they had the constant danger of a break in the lead or trouble at the extremities, and so long as they were dependent upon anything outside the insulating material for protection they could never feel safe. He heard on all hands of troubles with the underground copper mains, not so much in Manchester—things were new in Manchester—but in London, Paris, and elsewhere, even in places where there were supposed to be no troubles at all, and it had constantly been forced upon his mind that they could not rely in a permanent way on anything which did not consist of conductors insulated throughout. He did not know that indiarubber was the only material that could be used for the purpose, but it seemed to be the only one that had been used so far that answered its purpose in any way.

Mr. CLIREHUGH remarked that he withdrew his remarks about making indiarubber joints.

Mr. COWAN did not agree with Mr. Clirehugh's figures comparing the cost of laying armoured conductors direct in the ground with the same laid in cast iron pipes. He had tried Brook's oil insulation on a short line, and found it on the whole very satisfactory. The pressure was 2,000 volts.

Mr. BOURNE: Mr. Clirehugh seemed to think ten times a very severe test to subject a cable to. If Mr. Clirehugh would take any reasonably good cable—say for 100 volts—it would stand from 10,000 to 25,000 volts; that was his (Mr. Bourne's) experience. For instance, there was a cable he took out of the Crystal Palace—he did not know whose make it was—there was nothing extraordinary about it: but it took about 62,000 volts to break it down. It was only a short piece and was being used for a 100-volt circuit.

Mr. R. TAYLOR said he should like to state his experience as regarding vulcanised rubber. He had been engaged for the last 20 to 25 years in indiarubber cable making at W. T. Henley's and other places. A little had been said as to jointing. He did not think this should be treated lightly. His experience was that in vulcanised joints with care there was no fear of the joint going bad: but the greatest care should be exercised, and the workman should be thoroughly trained.

The discussion was then adjourned until April 9th.

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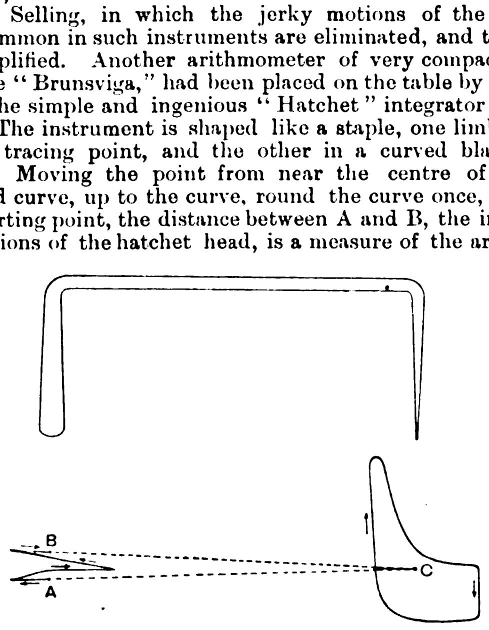
PHYSICAL SOCIETY.

At the meeting of the Physical Society held on March 9th, 1894, Professor A. W. Rücker, F.R.S., President, in the chair, Professor O. Henrici, F.R.S., made a communication on

"Mathematical Calculating Machines, especially a New Harmonic Analyser."

After mentioning the general principles on which such machines are based, the author showed a new arithmometer devised by Professor Selling, in which the jerky motions of the numeral wheels common in such instruments are eliminated, and the operations simplified. Another arithmometer of very compact design, named the "Brunsviga," had been placed on the table by Professor Boys. The simple and ingenious "Hatchet" integrator was then shown. The instrument is shaped like a staple, one limb terminating in a tracing point, and the other in a curved blade like a hatchet. Moving the point from near the centre of mass of any closed curve, up to the curve, round the curve once, and back to the starting point, the distance between A and B, the initial and final positions of the hatchet head, is a measure of the area of the



curve. The instrument has been found very useful for indicator diagrams. A Hine and Robertson's planimeter* lent by Professor Perry, an Amsler planimeter, combined with a pantograph for measuring small areas, an Amsler integrator to give areas and first moments, and a beautiful sphere and cylinder rolling-integrator of great accuracy by Coradi, of Zurich, were shown, as well as an ingenious integraph devised by Abdank Abakanowitcz.

Passing on to harmonic analysers, Professor Henrici explained the object of such instruments, viz., to determine the coefficients in Fourier's expansion for any periodic curve,

$$y = A_0 + A_1 \cos\theta + A_2 \cos 2\theta + \dots\dots$$
$$+ B_1 \sin\theta + B_2 \sin 2\theta + \dots\dots$$

and briefly described Lord Kelvin's instrument now in use at the meteorological office. This machine gives the first term and three pairs of coefficients A and B, but is large and expensive. The author had endeavoured to devise a simple and more portable instrument, and now described the various stages in the evolution of his new analyser. Using Clifford's method of wrapping the curve round a cylinder, he saw that by imparting a simple harmonic motion to a plane tangential to the cylinder, which plane carried an Amsler planimeter, whose tracing point followed the intersection of the plane with the curve as the cylinder rotated, any coefficient A_n or B_n could be determined. This arrangement had considerable friction, and only gave one coefficient at a time; it also necessitated readjustment of the period of the harmonic motion for each pair of terms. Another machine founded on integration by parts was then constructed, in which the relative periods of cylinder and registering wheels were adjusted by a disc and roller, the motion being transmitted to the wheels by bands driven from the disc spindle. This gave A_n and B_n at one operation. Mr. A. Sharp used this machine for some time, and then designed an inversion of it, in which the curve was laid out flat and the machine rolled over it. This arrangement greatly facilitated the multiplication of registering wheels, and thereby enabled several pairs of coefficients to be determined at once. The first machine of this kind showed several small errors, which were avoided in a second instrument, a specimen of which, made by Coradi, was exhibited and described. A rectangular frame, carried on three rollers (two being fixed to the ends of a long axis), traverses the paper in the direction of *y*, and the tracing point is fixed to a carriage which moves on the frame in a direction perpendicular to *y*, *i.e.*, in the direction of θ. A band is attached to this carriage and imparts a motion proportional to θ to two horizontal axes (one for the A coefficient and one for the $B^1 p$), placed above and parallel to the long roller axis above mentioned. Each of the two axes carries five pinions, having teeth in the ratios 1, 2, 3, 4, 5 respectively, which gear with crown wheels fixed to vertical spindles. The latter, therefore, rotate through angles proportional to θ, 2θ, 3θ, 4θ, and 5θ. To the lower ends of these spindles horizontal rings are attached, in which the bearings of a registering wheel are formed. Each wheel rests on a cylinder carried by the long axis, and rolls or slides thereon according as its axis is parallel or perpendicular to that of the cylinder. Moving the tracing point once round the curve gives five pairs of coefficients. By changing the driving band to other pulleys, so as to turn the pinions at different rates relative to the θ movement, the sixth, eighth, tenth, and seventh and ninth pairs can be determined.

The chief drawback of the instrument is that the registering wheels are not easy to read, whilst the backlash of the crown wheels and pinions introduces small errors. In the latest form of instrument toothed wheels are dispensed with, and glass spheres carried in frames on the vertical spindles roll on the horizontal cylinders. Each sphere actuates two registering wheels on fixed axes at right angles to each other, and these give respectively the sine and cosine coefficients. The number of vertical spindles is therefore halved, and the instrument greatly simplified. These details have been introduced by Coradi. A working drawing of another analyser, designed by Mr. Sharp, which gives the amplitude and epoch of the curve resulting from each pair of terms in Fourier's expansion, was exhibited.

The discussion on Professor Henrici's communication was postponed until next meeting.

Mr. H. Wilde, F.R.S., then exhibited and described his "*Magnetarium*." This consists of a hollow geographical globe wound all over the inner surface with insulated wire in planes parallel to the equator. Within this globe is a sphere wound with wire on its surface, and having its axis inclined at 23½deg. to that of the outer globe. By means of epicyclic gearing the spheres can be made to rotate at slightly different rates. When electric currents of suitable strength are passed through the two windings, the magnetic condition of the earth can be imitated, both as regards distribution at any epoch, and the secular variations. A better result was obtained by putting sheet iron over the land areas, and a still closer approximation by using thin iron over the water areas. A magnetic chart and tables giving the magnetic elements at various places for different epochs were shown. The author mentioned that recent observations by the United States Survey at Ascension Island, and by Professor Thorpe in Senegambia, had confirmed results obtained by the magnetarium.

The PRESIDENT said he had tried the apparatus, and found the Siberian oval closely imitated. The secular variations at Greenwich were also well shown. In South America the approximation was not so good.

In reply to a question by Mr. BLAKESLEY, Mr. WILDE said the present position of the pole of the inner sphere was 84deg. W., 67deg. N.

* Described in *The Electrician*, Vol. XXVI., p. 432.

ELECTRIC CONDUCTORS FOR FIERY MINES.*

BY JOSEPH LIBERT.

A Belgian royal decree of 1884 provided that safety lamps fed with pure vegetable oil should alone be used for lighting fiery mines, thus introducing an insurmountable obstacle to electric lighting in such collieries, which are the most numerous and generally the most important in Belgium. The progress made in electric lighting, however, and the great advantage of obtaining, in underground workings, better light than that afforded by ordinary safety lamps, brought about a modification, contained in the royal decree of February 12, 1893, which provided that owners of fiery mines might be authorised by the Minister of Agriculture, Industry and Public Works, to adopt electric lighting in their underground workings, subject to such conditions as may be judged necessary.

These conditions will chiefly bear upon means for obviating the danger of igniting firedamp by the production of sparks, and even voltaic arcs, caused by the interruption of a circuit, through any cause, either in the conductors or in the commutators and interrupters, while the incandescent filaments of the lamps would also be protected from any accidental contact with an inflammable mixture. Means should also be taken to prevent the heating of the conductors traversed normally or exceptionally by an excessive current, which might set fire to combustible substances, such as the timbering and coaldust, especially in dry collieries. Deficient insulation may occasion danger of the same kind, and also give rise to the production of sparks, if the tension be high, while it would expose the men to shocks, the consequences of which might be serious.

Most of these difficulties are now easily overcome. Heating of the conductors is avoided by giving them a sufficiently large sectional area; while the efficient ventilation of mine workings contributes to keep the conductors cool. The leads, which may be

* From a communication to the *Annales des Travaux Publics de Belgique*.

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insulated as completely as desired, should be obtained from firms of repute; and this is a most important point, especially underground, where working is almost, if not entirely continuous, and the detection of defects is more difficult than in surface installations. The commutators and interrupters may be so arranged that any sparks are completely isolated from explosive atmospheres. The incandescent lamps, which can alone be used, will be protected by thick glass globes with absolutely tight joints.

The Belgian mine regulations do not oppose the use of electric motors in the underground workings of fiery mines, although such motors entail greater danger than electric lighting plant, on account of the higher tension of the currents employed, the production of sparks at the brushes of the dynamos, the heating of the armatures, and their accidental deterioration.

The author avows that in the present communication he has no intention of discussing the applications of electricity to mining, but will only deal with the subject of conductors, and especially those of recent invention for ensuring safety, and the chief object of which is to suppress danger from sparks, caused by an interruption of the circuit, owing to a movement of the measures, whether merely the fall of a stone or the falling-in of the roof. The experiments made by Profs. Wullner and Lehman, published in the report of the Prussian Firedamp Commission, do not appear to the author sufficiently complete or conclusive to warrant the belief that a spark, however small, is not dangerous in an inflammable mixture. Though it would be interesting, from a scientific standpoint, to establish the limits within which sparks may be regarded as free from danger, the question is very complex, and results favourable to security would scarcely be conclusive, if vitiated by a single adverse case owing to circumstances which it is often impossible to foresee, as was found in the official experiments with safety lamps and so-called safe explosives.

It would appear more logical to look for a solution of the problem as to the use of electricity in mines, in means for avoiding the production of sparks, or, at any rate, for keeping them out of contact with a dangerous medium. As regards electrical conductors, a maximum of protection may be obtained; and it may be asserted that conductors, properly made and laid by those accustomed to mine workings, will only break in very rare instances. On the other hand, it should be borne in mind that electric conductors exclusively laid in the main trolley-ways, in the neighbourhood of landings and in underground engine-rooms—in fact, wherever falls are least likely to occur, and where inspection is easy and the existence of explosive mixtures exceptional, except in the case of mines subject to sudden outbursts of firedamp, in which the mechanical effects may cause the breaking of the conductor, and so constitute a very present danger. It may, indeed, be concluded, on the whole, that electrical conductors, as now manufactured, afford a sufficient degree of safety in nearly all cases.

Concentric conductors, especially when well insulated and covered with a strong armour of galvanised steel wire, are very convenient for the transmission of electric current in wires, and may suffice, as regards safety, for most cases, being especially valuable when alternate currents are employed. As the forward and return conductors are enclosed in the same covering, the danger of shock due to contact with one of the conductors is avoided.

By arranging the conductors with plenty of slack against the sides of the workings, the movement of the measures will only have the effect of causing them to slide upon their fastenings; and an accidental crushing may have the effect of bringing the two conductors into contact, thus causing a short-circuiting, which would interrupt the line at its commencement by means of a fusible plug or interrupter. The degree of safety might be further increased by inserting the conductors in drawn iron pipes, so as to avoid crushing or accidental injury by tools or vehicles. It has also been proposed to lay them in the drains at the sides of the headings; but this practice is not advisable, as they would soon be deteriorated by the dampness, besides being out of sight, while the making of connections and the finding of defects would be more difficult.

Efforts have lately taken a new direction. Instead of endeavouring to ensure safety by the simple protection of the conductors, an arrangement is being devised by which the extra-current sparks shall be produced in a closed chamber, whatever accidents may overtake the conductors. It was in England that the first practical solution of the problem was obtained, a fact explained by the rapid increase in the employment of electricity in mines, thanks to the industrial liberty enjoyed. The author then goes on to describe the safety conductor invented by Messrs. Atkinson*, and determines by calculation the intensity of the current in the two branches of the shunt circuit, in the event of contact between the auxiliary and the main conductor, with the object of proving Messrs. Atkinson's assertion that the disengaging apparatus is by no means paralysed, but may still work. As the result of purely electrical calculations, the author concludes that the current will be capable of melting the fusible wire intercalated in the shunt-circuit, and of thus interrupting the main circuit, as in the case of a simple breakage of the external conductor only.

The author then says a few words as to the Charleton conductor, also containing a shunt-circuit, in which the induced current has the same direction as the main current. The subsidiary conductor, however, does not consist of a ribbon which may stretch if the conductor break, but of a single wire, so arranged that in all probability it would break before the main conductor, although not necessarily so. When this eventuality occurs, an interrupter cuts off the current of the main circuit—this interrupter being an electro-magnet, the coil of which is traversed in different directions by the main current and the induced current, so that they neutralise one another. If the auxiliary wire should break, owing to a movement of the measures causing a pull upon the conductor, the induced current would be interrupted by the breaking of the auxiliary wire, and the electro-magnet, influenced only by the main current, would interrupt it by attracting its armature. A slight spark would be produced inside the conductor through the breaking of the auxiliary circuit, the spark of the main current being produced at the electro-magnetic interrupter, placed out of danger, or suitably insulated, if contact be formed between the conductors by crushing. Equilibrium may also be upset, provided that supplementary resistance be introduced into the auxiliary circuit, in which case a phenomenon will occur similar to that with the Atkinson conductor.

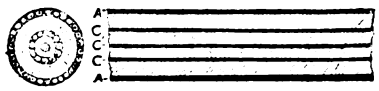

Fig. 1.

The author observes that, for doing any necessary repairs, it is necessary to remove from their attachments, and take up to the surface, both the cables or conductors above mentioned, because no soldering can be done in the underground workings. He then describes, as being free from this objection, a new safety cable or conductor invented by M. Noblet, engineer to the Cockerill Company, Seraing, when devising a system for permanently lighting by electricity some roads and landings in the collieries of that Company, the practical details having been worked out by M. Jaspar of Liège. The Noblet cable, while resembling the two above-mentioned in having a central auxiliary wire, differs totally from them in all other respects. Its essential characteristic is that the auxiliary conductor is traversed by a current of different direction from that of the main conductor, the diameter of the auxiliary wire being independent of the section of the main cable which surrounds it. The latter is suitably insulated from the auxiliary wire and from all external contact, being also protected by a strong armour of galvanised steel wire.

The system comprises two similar conductors, marked C C in Fig. 1, C′ being the auxiliary conductor, and A A the armature, while the insulator is represented by hatching. Each cable is, moreover, divided into sections, which also constitutes an innovation, the length of each section being determined by local circumstances. If the measures are solid, long sections may be adopted; but, in a district where there is reason to fear falls of the roof, their length would naturally be reduced. At each end of a section the cable is provided with a brass ring or coupling, both for the main and for the auxiliary conductor (as shown by Fig. 2, in which the same letters refer to the same parts as in Fig. 1), the rings of the

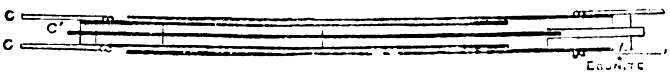

Fig. 2.

two adjoining sections fitting with easy friction. The small internal ring serves for coupling the auxiliary wire, while the outer rings connect the sections of the main conductor. These couplings are, however, so arranged that, if a sufficient effort be exerted to give them a sliding movement, a very slight displacement—about 5mm. or less than ¼in.—is sufficient to interrupt the circuit of the subsidiary conductor, while to entirely disconnect two sections of the cable the displacement must be considerable. Each ring is covered with india-rubber tubing, for insulating the cable at the joint, the tubing being firmly tied at both ends, so that there must be a little stretching before any displacement of the ring can occur, and this displacement cannot be effected without a certain amount of effort. Instead of rings, the two ends of adjoining sections may be connected by a wire wound round them like a spiral spring, the auxiliary wire being thinner and continuous at the joint, in which case, if strain be exerted on the cable, the fine auxiliary wire would break while the cable would stretch. The author, however, prefers the ring coupling, because, in case of a section becoming deteriorated, another may be substituted without the necessity of soldering or taking up the cable, an important point for ensuring the regular working of electrical appliances.

* This safety conductor was described in these columns, September 11, 1891, p. 527 (Vol. XXVII.)

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The author then passes in review the various accidents which may occur to the cables, and the manner in which the Nolet system is calculated to prevent the formation of sparks.

There may be a pull upon the cable, through a movement of the measures, or any other cause, when the section upon which the strain is exerted will be immediately disconnected; and, as it is the auxiliary wire which will be disconnected first, the current in the circuit of the electro-commutators will be interrupted long before the rings conducting the main current become uncoupled.

So soon, however, as the auxiliary circuit, or that of the electro-magnets, is broken, the circuit of the two cables is immediately cut at its commencement. If, therefore, the couplings of two adjoining sections should happen to become completely uncoupled, no spark will be possible at the moment of separation, since the current will have already been interrupted.

As regards the small spark produced between the two ends of the interrupted auxiliary circuit, it is completely shut off from all communication with the atmosphere, since the two rings of the main conductor rub one against the other, and the surface of contact is considerable. If the rings be not injured by the accident they may again be coupled up, and, if necessary, the india-rubber renewed; and, to re-establish the current, the two armatures of the electro-commutators must be once more worked by hand.

The cables are also liable to still greater injury; they may be crushed under a fall of the roof, or cut by the shock of a vehicle or a blow from an axe, in which cases the main and auxiliary conductors come into contact, as in the Atkinson system. If such an accident occur to the positive cable only, a short circuit will be set up between the auxiliary wire and the positive cable; and a current nearly double the normal will pass through one of the electro-magnets, because, if the comparatively minute resistance of the conductors be ignored, the total resistance of the auxiliary circuit will be diminished by one-half, the other electro-magnet being out of the circuit, and the main current will immediately be interrupted. If, however, the crushing should occur to the negative cable, the same phenomenon will take place, but in a contrary direction. Normally, the current of the electro-commutators has an intensity of 0·06 ampere; and the shunt circuit has a resistance of about 2,000 ohms when the distribution tension is 120 volts.

Both cables may also break at the same time, although this is very unlikely to occur; and, even in the event of a very serious accident, it is probable that one of the cables will break first, if only a fraction of a second before the other. In the event, however, of both cables being crushed absolutely at the same time, both the electro-magnets will be traversed by a current double the normal, and neither of the commutators will be brought into action; but, thanks to the arrangement, the shunt-circuit will not be interrupted, while the fusible plug above mentioned offers further protection. If any considerable leakage should occur in either of the cables, through the accidental removing of its covering, for instance, the corresponding electro-magnet would let go its armature, and the distribution current would be interrupted before acquiring dangerous intensity.

The Nolet system lends itself admirably to the lighting of a headway in which the lamps are spaced out, instead of being grouped together, as in the neighbourhood of a landing or in an underground engine-room; and it is for this that it was devised. The author has repeated the experiments made at M. Jaspar's works, Liége, in the presence of a large number of engineers and mineowners, being impressed with the simplicity and practicability of the arrangement. All the various accidents were reproduced by which electric cables might be injured in mine workings, the effort of drawing asunder, crushing and contact with earth through denudation or other cause; and the results proved most satisfactory. One main fact in favour of safety is that the current cannot pass unless absolutely perfect. The cable experimented upon was calculated for a current of 8 amperes, at 120 volts capable of supplying 20 10-c. incandescent lamps, the electric energy consumed in the secondary circuit being 7·2 watts, or less than 1 per cent. of the total available energy. The ring couplings might serve for taking off the current for the lamps, so that the connections would thus be rendered as simple as possible.

M. Libert concludes his Paper by giving the principal conditions which an electrical system for mines ought to fulfil. The intensity of the current per square centimetre of sectional area should not exceed the figure obtained by the application of the formula deduced from Kennedy's experiments, from which it results that the heating caused by the normal current cannot exceed 10·4deg. centigrade above the surrounding temperature and 41·7deg. cent. when the intensity attains a value double that of the normal current. The diameter of the conductor satisfying this condition is deduced from the formula :—

$$d = 0{\cdot}374\, I^{\frac{2}{3}} \text{ ampere.}$$

in which d represents the diameter in millimetres, and I the intensity of the current in amperes.

All return of current by the earth should be strictly prevented. The insulation of the conductors should be sufficient for the tension of the current traversing them; and an earth indicator should be intercalated for giving warning if any leakage should occur. The main circuit and the various important branches should be protected by cut-outs or electro-magnetic interrupters, which should be put in action by a current exceeding from 50 to 100 per cent. the normal intensity. The commutators, interrupters, and cut-outs should be so constructed that no permanent voltaic arc can be produced between the metallic parts composing them. The appliances must be completely enclosed, their stands and covers being incombustible; and the lamp must be rendered harmless by being enclosed in an hermetically tight lantern provided with a thick glass globe.

The roads and places in which the electric appliances are placed should be well lined and provided with sufficient ventilation by a current of pure air; and in the event of an inflammable mixture being detected, the working of the electrical appliances is to be immediately suppressed, the protection of the cables forming the subject of special instructions in each individual case.

A CHEAP RECORDING VOLTMETER.*

The waste of energy in a recording voltmeter, due to the amount of force necessary to overcome friction, has caused the photographic method of obtaining records to be the one at which many inventors have grasped, and the present instrument is one of

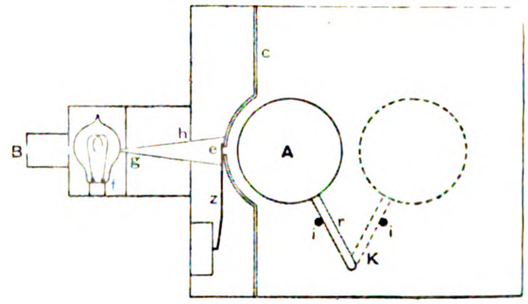

Fig. 1.

this class, and is of very simple construction, all systems of lenses or special darkened chambers being done away with; and, of course, the same principle is applicable to all registering instruments.

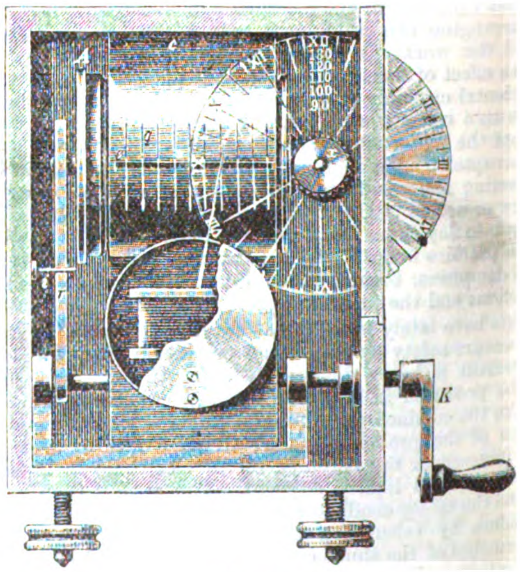

Fig. 2.

Fig. 1 is a diagrammatic representation of the working parts, in which A is the usual revolving drum, driven by clockwork, and

* From an article by Dr. A. Raps, *Zeitschrift für Instrumentenkunde*, January, 1894.

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making one revolution in 24 hours, and carrying the sensitive paper. It is carried on a lever, *r*, and lies when in action against the stop *i*. Close in front of it, when in this position, is the metal plate *c*, having a fine horizontal slit *e* (which must be protected from

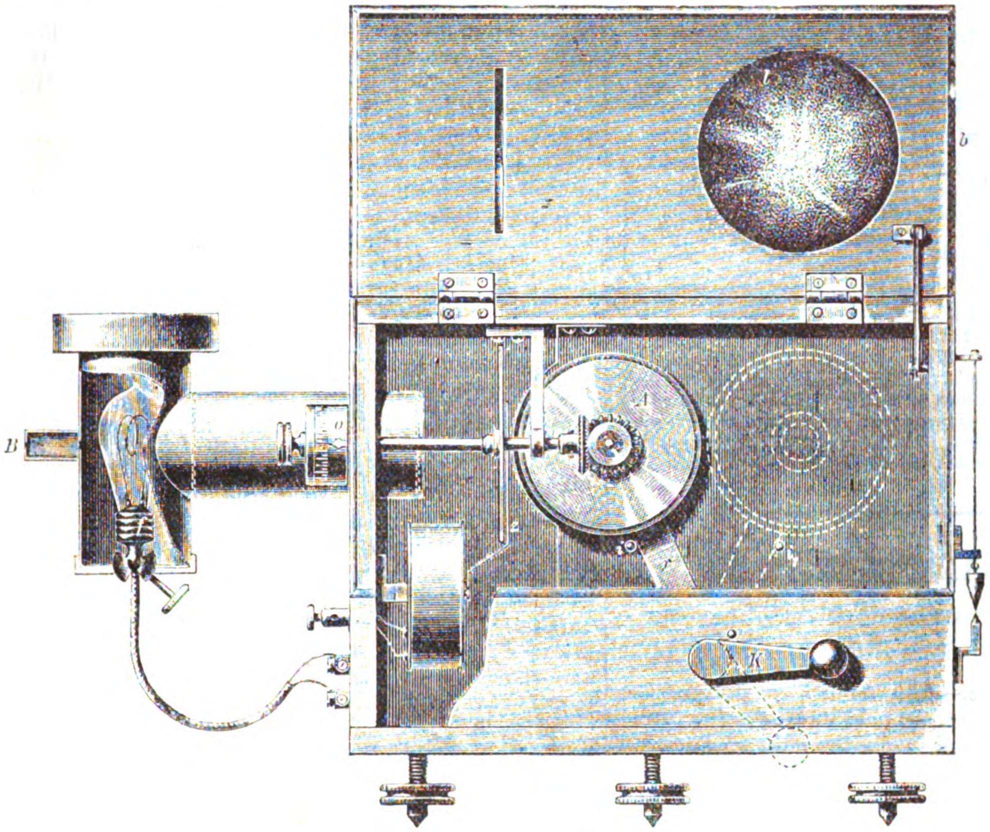

FIG. 3

dust), immediately in front of which the needle, *z*, of the indicating mechanism works; and in front of this again is the lamp. The result of this arrangement is, that when developed the paper shows the movement of the needle as a white line on a dark background, owing to the protection from light caused by the shadows of the needle. Fig. 2 shows the ingenious arrangement by which horizontal lines, corresponding to volts on the particular indicating mechanism used, are described on the paper by the shadows of the wires *g* stretched across the slit; while the shadow of figures

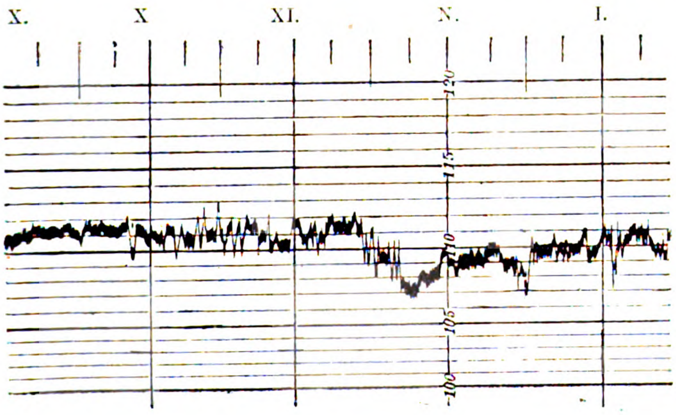

FIG. 4.

and radial lines on a rotating glass plate geared to the drum, mark the hours and quarters.

Suitable arrangements are made outside the case (*see* O, Fig. 3) for putting this plate in the correct position. The advantages of this method are great and obvious, since no special care is required in the setting of the paper, and no stretching can affect the results, and any indicating mechanism desired can be utilised. The method of introducing the sensitive paper in full light is described, and the same arrangements permit of its development and fixation in the same manner in open daylight; the exposure being always the same, no skill is required for these operations. It will be noticed that any violent depression in the volts, such as would not be taken account of by an ordinary registering voltmeter, owing to its very rapid movement, is plainly shown on this voltmeter by a white line on the paper, due to the momentary extinction of the lamp.

Fig. 4 shows a diagram of the pressure on the Berlin mains, and shows the figure and scale as marked by the instrument itself. The makers are the Allgemeine Electricitäts Gesellschaft.

LEGAL INTELLIGENCE.

Edison-Bell Phonograph Company v. The London Phonograph Company.

This was an action before Mr. Justice North, to restrain the infringement of a patent for improvements in the phonograph. The defendant trades at 62, Old Broad-street, under the name of the London Phonograph Company. The original claim in this country for a patent for Edison's phonograph was contained in his telephone patent, and was held bad as being an invention not covered by the provisional specification. The patent now sued upon is principally for a single diaphragm connected with both a recording and a reproducing point, so that the instrument can be used for recording and speaking by employing the diaphragm itself as a switch. The plaintiffs had established their patent in an action before Mr. Justice Wright, and now moved for an interim injunction.

The DEFENDANT admitted that to a small extent he had been in possession of instruments which to some extent infringed; but he said he had altered his instruments by removing the recording point, and that the instruments in his possession did not now practically infringe the plaintiff's rights.

Mr. Justice NORTH said that there having been an admitted infringement, and the plaintiffs having obtained a judgment in one action, they were entitled to an interim injunction in general terms, but directed against the particular instruments in possession of the defendant.

Winnipeg (Canada) Street Railway Company v. The Winnipeg Electric Street Railway Company, &c.

This was an appeal before the Judicial Committee of the Privy Council from a judgment of the Court of Queen's Bench of Manitoba, and the principal question raised was whether the City of Winnipeg could validly grant to the Winnipeg Electric Street Railway Company a right to lay down street railways and to run cars within the city in streets already worked by street railways of the appellant Company and in streets not yet worked by the appellants, but in which the latter were willing to work. The appellants contend that the city of Winnipeg was precluded from

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granting competing rights to the respondent Company in either case, both by the terms of their statutory powers and also by an agreement made with them (the appellants). The respondents assert that no exclusive right was conferred on the appellants in the matter, and that any contract purporting to have that effect was not binding.

After hearing the arguments for the appellants, the LORD CHANCELLOR said their lordships would not require to hear counsel on the other side. They would deliver judgment on a future occasion.

Alley and Maclellan v. Latimer Clark, Muirhead and Co. (Limited).

This action, in which the record has been closed, was brought in the Courts of Session, Glasgow, at the instance of Messrs. Alley and Maclellan against Messrs. Latimer Clark, Muirhead and Co. (Limited), for payment of £726. 8s. 2d., the price of goods supplied by the pursuers to the defenders between August, 1892, and December, 1893. The pursuers state that the defenders have no domicile in Scotland, but they have been rendered subject to the jurisdiction of the Scotch Supreme Court by arrestments. The defenders explain that they are in liquidation, and that this action cannot proceed without the leave of the High Court of Justice (Chancery Division), England. They also state that the debt due by the Corporation of Glasgow to the defenders, which the pursuers had arrested, is claimed by Dr. A. Muirhead, London, as having been duly assigned by the defenders to him, conform to assignation in his favour, dated November 29, 1892, and bearing to have been duly intimated to the Corporation on January 12th last, more than a week before this arrestment was used.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, Saturday, *March* 3, 1894.

The Rating of Arc Lamps.—The annual meeting of the National Electric Light Association, held in Washington from February 27th to March 2nd, was one of the most successful in its history. Most of the Papers were largely of a trade nature, and, as is usual, the discussions by the station managers and others, though excessive in length were of little or no value. The subject of the rating of arc lamps was referred to a special commission consisting of Profs. Mendenhall, Anthony and Forbes and Messrs. Weston and Hammer, who reported that what is ordinarily known as a 2,000-c.p. arc should be defined as one requiring on the average 450 watts for its maintenance, the measurements being made at the lamp terminals with no sensible resistance in series with the arc. The report was adopted, and a question is thus settled that has been the cause of much friction between arc light companies and municipalities. A discussion on the most economical size of arc dynamos developed an almost unanimous opinion in favour of machines of 100 lights, and even more, for large stations.

The Scott Alternate-Current System.—The event of the Convention was the surprise sprung by the Westinghouse Company through the disclosure of a new alternating current system in a Paper read by its electrician, Mr. C. F. Scott. Mr. Scott began by pointing out the advantage possessed by the three-phased system in requiring much less copper and having much less self-induction than the two-phased system, while, on the other hand, the latter possessed a great advantage in regulation and required only two transformers where three were necessary in the three-phased system. He then introduced his new system, which is a combination of the two systems. By means of specially designed converters the currents generated by a two-phase generator are distributed as three-phased currents, and then either applied directly or transformed again to two-phased currents. Similarly two-phase apparatus may be used on a three-phase system. In the first instance, if one of the circuits be overloaded the action will only affect its own generator circuit and not interfere with the balance. The Paper was discussed by Profs. Rowland, George Forbes, and others. Prof. Forbes stated that the system was an extremely beautiful one, and on the face perfectly feasible and practicable. Prof. Rowland said that he considered that this work of Mr. Scott marked a new era in polyphase transmission; he was working along a similar line himself, and while he had succeeded in finding a way to transform the frequency as well as the phase, his method lacked the practical merits of the one under consideration. Profs. Forbes, Rowland and Scott all took occasion during the discussion to pay a tribute to the splendid work of Mr. Kennelly in simplifying alternating current calculations.

The Niagara Transmission.—The Niagara controversy cropped up several times in the discussion, and Prof. Forbes stated that no particular system had been adopted by the Cataract Construction Company, which was disputed by Mr. Stillwell, of the Westinghouse Company, who was sustained by Prof. Rowland. Mr. Stillwell claimed that the plans adopted at Niagara were substantially those developed by the technical staff of the Westinghouse Company, and were simply the Tesla polyphase system.

CORRESPONDENCE.

THE PARALLEL RUNNING OF COMPOUND-WOUND THOMSON-HOUSTON ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your number of March 9th, Mr. Snell, in his series of articles, makes a statement in the part devoted to the "Compensating for the Drop of Pressure in Conductors," referring to the Thomson-Houston alternators, that alternators compounded as done by the Thomson-Houston Company will not work in parallel. I beg to correct this statement, and to give the result of experience and of different experiments made, which go to show how easy it is to run compound-wound alternators of this type in parallel.

At St. Brieuc, France, the Thomson-Houston Company installed in March, 1891 (see *The Electrician*, Vol. XXVI., April 24, 1891, p. 757) two 70-kilowatt alternators of 2,000 volts at no load, and over-compounded for 25 per cent. loss in the line. (The distance between station and centre of distribution is 13 kilometres.) These alternators are compounded precisely as described by Mr. Snell in his article, and have been running continuously in parallel in the most satisfactory manner. The dynamos are driven from the same line of shafting, operated by water wheels, care having, of course, been taken to adjust the pullies so that the dynamos run at exactly the same speeds under similar conditions of load, &c. A reactive coil was installed to facilitate throwing the dynamos in multiple. An instance which, however, goes to show the tendency of these machines to fall into step, even under most adverse circumstances, is that at one time, due to an accident, a part of the switchboard was torn down and the reactive coil short circuited, and when the switchboard was repaired the connections to one of the phase lamps were crossed, with the result that the operators at the station threw the machines in parallel every night when they were 180deg. out of phase, and this during a period of three months. They immediately came into phase with only a slight flicker in the lights. The effects were so slight that the operators did not call even the attention of the superintendent to the matter.

It is the regular practice at this station, before throwing machines in parallel, to place the rheostats in their field circuits in similar positions, so that the dynamos will have the same potentials when carrying the same load. On account of the heavy line loss in this particular case, when one alternator is running alone on the line at full load, its potential is about 2,300 volts, and the one to be thrown into circuit at that time has a potential of about 2,000 volts. The effect of the compoundage is such as to bring the two machines to the same potential when once in multiple. The rheostats in the exciting circuits of these alternators are such as to permit the variation of the potential of these machines from 1,800 to 2,700 volts on no load.

The following experiments were tried on these two alternators. They were put in multiple on a line load of but 15 amperes, which is about half-load for one machine alone. The load was fairly equally divided between them, and the line potential was 2,120 volts. Under these conditions half the resistance of each field rheostat was in circuit with its

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particular dynamo. Progressively the exciting current of one dynamo was diminished to the minimum, and that of the other increased to the maximum, by means of these rheostats. The potential of the line current remained constantly 2,120 volts.

First one machine and then the other was excited to its maximum value, while the excitation of the other was reduced to its minimum. In each case it was the machine having the least excitation which carried the smallest current. The sum of the currents from the two dynamos was a maximum when the greatest difference of excitation existed. There was not the slightest tendency for the machines to get out of phase. By varying the compoundage of one or the other alternator, by means of the rheostat in shunt to compound winding, practically the same results were produced.

The fact that alternators of this type have been running in multiple at St. Brieuc for the last three years, overcompounded 25 per cent. and driven from the same countershaft, that they run and stay perfectly in parallel when one is excited fully 50 per cent. more than the other, and can be thrown in multiple without danger, even when they are 180deg. out of phase, surely shows that compound alternators built on the principle described by Mr. Snell can be satisfactorily operated in parallel.—Yours, &c., E. M. Mix.

11, Rue Vezelay, Paris, March 15, 1894.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I beg to thank Mr. E. M. Mix for kindly calling my attention to a mis-statement on my part in "Electric Motive Power." I am much interested by his account of the parallel working at St. Brieuc, which leaves no doubt of the suitability of Thomson-Houston alternators for running parallel.—Yours, &c., Albion T. Snell.

EDDY CURRENTS IN AN INDUCTOR ALTERNATOR.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The description of a new alternator by the Compagnie de l'Industrie Électrique in your last issue does not give any particulars of the eddy current losses which must occur in the inner ring of the fixed magnet.

This is apparently a solid casting of steel, and is subject to the same varying magnetic flux as are the armature coils. A statement of the power absorbed by this machine on open circuit would be interesting.—Yours, &c., John H. Rider.

Town Hall, Bolton, March 12, 1894.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: As might have been supposed, the internal ring of the magnet in this alternator is not a solid casting of steel. It is built up of sheet iron. This was not shown in the drawing, which was intended as a diagrammatic sketch, and not as an exact representation of the actual machine.

On open circuit, the machine producing the full voltage at the normal speed, and apart from excitation, 10,200 watts were absorbed. At normal speed, without excitation, the power absorbed amounted to 4,200 watts, thus leaving 6,000 watts for the loss by hysteresis and Foucault's currents. This refers to a 275 kilowatts alternator, and shows that the metal has been carefully laminated.—Yours, &c.,

Pro Cie. de l'Industrie Electrique,

Geneva, March 16, 1894. L. Goichot.

ARC LAMPS ON ALTERNATE CURRENT CIRCUITS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to the description of the Scarborough electric lighting in your last week's issue, it appears to me that the sub-stations with single transformers may under certain conditions be most unsatisfactory. Suppose that 20 per cent. of the load of one of these transformers consists of arc lamps with choking coils for regulation, the effect of switching on these lamps will be to so reduce the volts at the transformer as to spoil the incandescent lighting. The inductive resistance in the circuit reduces the volts in a very marked way, and I could point to cases where (the transformer being of ample size for the load) the presence of a single arc lamp lowers the voltage so much as to make the incandescent circuits quite dim and useless. I have never seen this question brought forward, but it is of considerable importance, and perhaps some of your readers have had the same experience and found how to get over the difficulty.

Of course, if ordinary resistances are used for the arc lamps instead of choking coils, and lamps are selected with small induction, there would be no trouble, but one uses choking coils because of the small amount of energy wasted in them. The saving, however, is effected by reducing the volts, and as most electricity meters are current meters only, the consumer does not reap much advantage. It is the custom with some supply companies to put in a separate transformer for arc lamps, but this would be hardly possible in the case of distributing from sub-transformer stations.—Yours, &c.,

J. O. Girdlestone.

16, Davies-street, Berkeley-square,
London, March 19, 1894.

IRON TESTING.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: If Messrs. Parsons and Co. would explain how they obtain equal induction in the two samples they are comparing for hysteresis loss it would be easier to estimate whether their method has any advantage over others. As we understand their explanation, a core of laminated brass would appear by the test to be excellent material for a transformer. We are also not clear how the induction can be varied appreciably by increasing the weight or cross section of the core.

We may say that some time ago we carefully considered testing for hysteresis loss by means of a comparison of temperature rise; but abandoned the idea in favour of a modification of Prof. Ewing's method for obtaining the complete hysteresis curve.—Yours, &c.,

The Manchester Edison Swan Company (Limited),
March 20, 1894. Per E. W. C.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1894 Edition of "The Electrician" Electrical Trades' Directory and Handbook is now ready. This valuable book contains 1,000 closely-printed pages, and several new and useful features have been added. The price of the Directory and Handbook is 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

"Electrical Engineering Formulæ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.) A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). prospectus on application to the Publisher.

"Electromagnetic Theory," by Oliver Heaviside, is now ready, price 12s. 6d. (abroad 13s.). Prospectus on application.

"The Incandescent Lamp and its Manufacture."—This book, written by Mr. Gilbert S. Ram, is now ready; price 7s. 6d. (abroad 8s.). Prospectus on application to the Publisher.

"Drum Armatures and Commutators."—This book, written by Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

Tenders Accepted.—Messrs. Verity and Sons have obtained the contract for the electric lighting of the Blackpool Tower, and have arranged with Messrs. Siemens Bros. and Co. for the supply of the necessary dynamos for the installation, which is on a large scale.

——— The tender of the Fowler-Waring Cables Company (Limited) has been accepted by the Brighton Corporation for the supply and laying of armoured and lead-covered electric cables. Tenders were also received from W. T. Henley's Telegraph Works Company (Limited), the British Insulated Wire Company (Limited), the Callender Company, the India Rubber Company, Messrs. Siemens Bros. and Co. (Limited), and Messrs. W. T. Glover and Co.

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APPOINTMENT VACANT.—The Guardians of the Dewsbury Union require a "competent man to act as consulting engineer," and to superintend the erection of the electric lighting installation plant at the workhouse. Candidates must have had experience in similar work, but must not be contractors, nor in any way interested in contract work. Applications must be sent in by the 28th inst.

LIQUIDATIONS.—It is notified by Mr. F. S. Lucey, the official liquidator to the International Cable Company (Limited), that, by an order dated February 15 last, the chief clerk directed a dividend of 20s. in the £ to be paid to the creditors of the Company.

——— Meetings were held on Friday last before Mr. Warley, Assistant Official Receiver, of the creditors and shareholders of Newington, Priddle and Co. (Limited). An abstract of the Official Receiver's statement appeared in our issue of the 9th inst. At the meetings the Chairman reported that shortly after the winding-up order was made the whole of the property and the goodwill were sold for £330. With the exception of the collection of the book debts, there remained very little to be done under the liquidation proceedings. Resolutions were passed for the Official Receiver to act as liquidator and wind up the Company, assisted by a committee of inspection to be subsequently elected.

——— Mr. J. H. H. Duncan, of 39, Coleman-street, E.C., has been appointed liquidator of Elmore's French Patent Copper Depositing Company (Limited).

——— A meeting of the Thorneburry Miners' Safety Lamp Company (Limited) is to be held at 18, St. Swithin's-lane, E.C., on April 18th, at 11 a.m., to receive an account of the winding up.

INCANDESCENT LAMPS.—Messrs. Laing, Wharton and Down announce that they are prepared to supply a new incandescent lamp, called the "L. W. D.," at low prices.

——— Messrs. Barclay and Son send us particulars and price list of incandescent lamps manufactured by Messrs. Pulsford, Triquet and Co., for which they have been appointed sole agents.

MESSRS. JOSEPH BOURNE AND SON.—This old-established firm of makers of vitreous Denby stoneware insulators, battery jars, cable tubes, &c., send us a copy of their newly-prepared illustrated list of insulators and other manufactures for which the firm are well known.

ELECTRO-HARMONIC SOCIETY.—The last concert of the season of this society will be given on Friday evening, the 30th inst., at the St. James' Hall Restaurant, Regent-street, London, W., at eight o'clock. An excellent programme is provided, under the musical direction of Mr. T. E. Gatehouse and Mr. A. E. Izard.

EMPLOYERS' LIABILITY.—In the Westminster (London) County Court, on Monday last, an action was brought against Messrs. Verity and Sons by a workman lately in their employ, named Taylor, to recover damages for personal injuries alleged to have been sustained through the negligence of the defendants' foreman. For the defence, Edward Bowen, the defendants' foreman, stated that they were fitting electric call bells to the lift at Whitehall-court, and that it was through the plaintiff's own fault that the accident happened. After hearing the evidence, the jury found for the plaintiff for £60 and costs.

MESSRS. WOODHOUSE AND RAWSON UNITED (LIMITED).—Some misapprehension exists as to the sale of the premises of the Cadby Hall Works at Hammersmith, formerly occupied by this firm in the manufacture of their electrical and general specialities. We are asked to state that the whole of the work previously carried out at Hammersmith has now been transferred to the extensive Cornbrook Works at Manchester, where all the plant and apparatus of Messrs. Woodhouse and Rawson's make is now manufactured.

MESSRS. BULLERS (LIMITED).—It is stated that this Company have in contemplation the removal of their works from Dudley to Tipton. A portion of the Company's workshops at Dudley were destroyed in a gale about two months ago.

MESSRS. HODGES AND TODD.—Increase of business has necessitated the taking of additional works premises at Hampstead-road, N.W., where the additional plant will be driven by electricity supplied from the St. Pancras mains. The firm's offices remain at Turnmill-street, E.C.

MESSRS. BENNETT AND DRUCE.—This firm have received instructions from Messrs. Horrockses, Crewdson and Co., cotton spinners, of Preston, Lancs., to put down three 500-light dynamos in their cotton mill now in course of erection. An interchangeable system of wiring has been devised by Mr. Druce, rendering complete failure of the light an impossibility. It is estimated that about 900 lamps will be required.

MESSRS. BAXENDALE AND CO.—The electrical department of this firm are supplying and equipping complete search-light plants for the night navigation of the Manchester Canal, including the necessary staff for working the same. From a testimonial received by the firm from the master of the s.s. "Grampus," it appears that the search lights have proved of great service in the navigation of the Canal at night, the passage having been made by this vessel, on the night of Friday, the 2nd inst., in a little over five hours.

MESSRS. MAUNSELL, MERCIER AND CO.—This firm have secured the contract for wiring, fittings, and complete plant for the installation of about 600 16-c.p. incandescents at the Deansgate Hotel, Manchester, the generating plant including two 30-b.h.p. gas-engines and two dynamos.

MESSRS. O. BEREND AND CO.—This well-known firm send us particulars and prices of the Hambruch patent positive feed pneumatic and automatic oil lubricating system. The particulars issued give an illustration of an installation of this system applied to shafting, for which economy in oil, wages, attendance, &c., are claimed. The system consists of an air compresser for forcing air through a network of tubing on to the surface of the lubricating oil contained in specially-constructed patent lubricators, causing the oil to be fed on to the bearings in proportion to the pressure, and shows at a glance the rate of feed and contents of all the lubricators. Instructions for using are included in the list. Messrs. Berend and Co. also issue List F, devoted to description and prices of Gülcher's Patent Thermopiles, manufactured by Julius Pintsch, of Berlin, for whom Messrs. Berend and Co. are the agents in this country.

AYR.—The Town Council recently decided to consult Sir William Arrol as to the advisability of appointing an electrical engineer to arrange for a survey to be made of the borough for electric lighting purposes. On Sir William's advice it has been decided to ascertain first of all the arc lamps likely to be required, and also the probable amount of support householders in the district are likely to accord the electric lighting scheme. The surveyor to the Council has been authorised to visit towns of a similar size to Ayr for the purpose of obtaining information on the electric lighting subject, and to lay the same before the Electric Light Committee.

BATH.—An application made to the Corporation by the City of Bath Electric Lighting Company for power to extend their mains beyond the present area has been declined by the Lighting Sub-Committee.

BOMBAY.—The Municipal Corporation recently held a meeting, at which, in order to recover rates and taxes due from the late Eastern Electric Light and Power Company, it was decided that an application should be made to the High Court for an order authorising the sale of the Company's deposit of 5,000 rupees lodged in connection with the agreement between the Company and the Municipal Corporation in 1883.

BRECHIN.—Mr. Jamieson, a member of the Town Council, has given notice that, at the next meeting of that body, he will move that application be made to the Board of Trade for a Provisional Electric Lighting Order.

CASTLEFORD.—Having received Mr. R. Hammond's report on electric lighting, the Chairman of the Local Board said that he had gone carefully through the documents, but had come to the conclusion they were not in accordance with the requirements of the town. Mr. Hammond has been requested to forward plans and all necessary particulars.

CHURCH LIGHTING.—The restoration of Bristol Cathedral, which has been in progress for some time, is approaching completion, and the electric light fittings are shortly to be added.

CARDIFF.—Mr. W. H. Massey, the electrical engineer to the Cardiff Corporation, stated at the last meeting that nearly 14,500 yards of pipes had been laid, leaving about 2,500 yards to be completed, and that the electric current would be ready for public lighting in about three months. There is some talk of Mr. Massey being proceeded against for libel by a Company associated with certain patents for utilising dust in the generation of steam. It appears that Mr. Massey has, in connection with the glowing accounts recently appearing in the Press as to what is likely to be done in the near future by the use of dust destructors, fallen foul of the Company referred to, who threaten to take proceedings. At a meeting of the Electric Light Committee of the Cardiff Corporation on Tuesday last Mr. Massey stated that he had intended to ask permission to make an explanatory statement as to the answer he gave at the last meeting of the committee, but as legal proceedings were threatened he would offer no explanation now. It would be in the recollection of the committee that he declined to express any opinion on the particular system of refuse destructor, to which attention had been called, and the remarks he made had reference only to a press show, about which he had read reports.

COMMISSIONERS OF SEWERS (LONDON).—At their meeting on the 20th, the Commissioners were invited to sign a petition against the Central London Railway Extension of Time Bill, but on an undertaking by the Central London Company to reduce the time

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for the completion of their work to the year 1899, it was agreed that no opposition be made to the Bill. Colonel Haywood, the engineer to the Commission, has for some time past been suffering from ill-health, and it has now been decided to retain his services as Consulting-Engineer at the present salary. The question of appointing another engineer remains in abeyance. It has been decided by the Commissioners to appoint a valuer, whose services will be first required in the preparation of a report as to the City of London Electric Lighting Company's works, and their liability to assessment. Mr. Walter Barnett, of Winchester House, E.C., was appointed. The Committee, in recommending Mr. Barnett's appointment, express great confidence in his skill and judgment.

Country House Lighting.—Kylemore Castle, the seat of Mr. Mitchell Henry, in the West of Ireland, has been lighted throughout by electricity from designs made and carried out by Messrs. J. C. Howell (Limited), of Queen Victoria-street, E.C., under the superintendence of their engineer, Mr. Furniss. Water from a number of small mountain streams is collected in a natural lake, situated at about 400ft. above the level of the house, which is situated in a very isolated position. The presence of this water power has enabled Messrs. Howell to utilise a "Girard" high-pressure turbine coupled to a Crompton dynamo, from which the supply of current has given every satisfaction. Interior lighting is effected by 270 incandescents, and the terrace is lighted by two 500-c.p. arcs, mounted on wrought-iron standards. The current is also used to heat a hot closet for kitchen use. The installation includes the outlying buildings, stables, &c., and is ultimately to be extended to the memorial church, post office, dairy, and farm buildings. Special difficulties were met with in carrying out the work, all of which were satisfactorily overcome.

Dartford.—Mr. W. Greig, a member of the Local Board, is preparing an electric lighting scheme for Dartford, and the fact that the Local Board have refused to renew the contract with the local gas company for more than one year indicates a disposition on the part of the majority on the Board to give Mr. Greig's scheme every opportunity.

Derry.—The town of Derry was on Saturday last *en fête*, the citizens coming out to witness the turning on of the electric light. From the descriptions of the ceremony attending the public inauguration which appear in the local press, the ratepayers appear to be immensely pleased with the installation. The streets of the town were brilliantly lighted from seven o'clock to 10:30. The contract is not yet quite completed, and the city will not be lighted by electricity permanently for a week or two, as there are still some lamps to be put up in two or three of the principal thoroughfares.

Dundee.—The electric light has now been established twelve months at Dundee, and Mr. D. Urquhart has completed his inspection of the installation. Everything is certified as satisfactory.

Grange.—The Chairman of the Local Board had a notice on the paper for the last meeting, recommending the application for a Provisional Order by the Local Board, but the cost of the application, which was estimated at £250, induced him to withdraw his proposal. At the same time he thought that no time should be lost before going into the question of the cost of the lighting of the district by electricity, which he considered would be much cheaper and better than their present costly system.

Guildford.—A long discussion took place at the last meeting of the Town Council upon the electric lighting question. The General Purposes Committee have reported that they have considered the question, and, after an interview with the promoters of the electric lighting Provisional Order, they recommend the Council to oppose the granting of such an Order to the present applicants, and to resolve that, at the close of the present year, they will themselves take the necessary steps to apply for an Order. A report was also presented from Mr. A. F. Phillips on the water supply and pumping machinery, which is identified with the general scheme of electric lighting. Mr. Phillips's report contains some elaborate suggestions with regard to the electric lighting scheme, and, after a full discussion, it was decided to adjourn the meeting to allow the General Purposes Committee to bring up a further report.

Killarney.—The Town Commissioners have discussed a resolution instructing the clerk to ask Mr. Santry to continue the lighting of the town by electricity until all questions concerning the contract are decided, and that, as some doubt seems to have arisen as to the contract for public lighting, tenders be again advertised for on the same terms as in August last. This proposal was agreed to, and came again before the Commissioners at their last meeting.

Lambeth.—The Vestry of this parish have given their consent to an application of the Crystal Palace District Electric Supply Company for a Provisional Order under the Electric Lighting Acts. The Order, however, only refers to a small portion of the Lambeth parish situate at Gipsy Hill.

Liverpool.—The Palace, a popular pleasure resort at New Brighton, has recently undergone considerable alterations, and the whole of the premises, both inside and out, are now lighted by electricity. The plant includes a 32-h.p. Campbell gas engine and a 300-light Phœnix dynamo, the installation being carried out by Messrs. A. Hall and Co., of South John-street, Liverpool.

Llandrindod Wells.—The chairman of the Local Board has reported that, from inquiries he has made, and after an inspection of the electric lighting installations at Morecambe and Blackpool, he is convinced that an installation worked by gas power will be found most suitable for their district.

Maidstone.—The Local Board have disposed of the question of electric lighting, which has been under discussion for some considerable time. The Committee appointed to discuss the matter have met several times, but have come to no final decision in the matter. At the last meeting of the Board it was proposed by Mr. Barker that the Board should themselves carry out the Provisional Order for lighting the borough by electricity, the time for the Board taking the matter in hand themselves having nearly elapsed; but, after a lengthy discussion, it was decided, on the motion of Alderman Ellis, to transfer the Provisional Order to a company.

Plymouth.—Tradesmen and other large consumers of light are complaining that the "metropolis of the west" is lagging behind on the question of electric lighting. Whereas quite a number of western towns (both small and large) either have the benefits of the electric light, or are contemplating their early introduction, Plymouth still keeps behind in this important matter. The only move at present made is that the gas company has given notice to apply for Parliamentary powers.

Ruthin.—Col. Cornwallis West, a large landowner and resident, has written to the Town Council asking for information regarding the electric lighting scheme, which was some time ago under consideration, and expressing his intention of adopting the light, should it be introduced.

Stirling.—From reports to hand of the discussion at the Town Council's meeting on the resolution that the local authority should at once apply to the Board of Trade for a Provisional Order for electric lighting purposes, it is clear that everything was done to induce the members of the Council to support their original decision that the Council should themselves undertake the electric lighting of the district. Notwithstanding this, by a majority of two in a council of twenty, it was decided that the Caledonian Electric Supply Company should be allowed to proceed with their application. The Council instructed the Town Clerk, however, to inform the Company that the Council wished to have an opportunity of making terms with them, and a special committee was appointed to take the matter in hand.

Walsall.—The Board of Trade have provisionally approved of the Town Council's electric lighting scheme, and the Town Clerk has applied to the Local Government Board for borrowing powers to carry the scheme into effect.

West Ham.—A motion was recently carried at the Town Council to adjourn the consideration of the electric lighting question for six months. At the last meeting it was agreed to refer the matter to a committee.

Weston-super-Mare.—A memorial has been presented to the Town Commissioners, calling attention to the present inefficient system of public lighting, and asking the Commissioners to take into consideration the practicability of installing the electric light throughout the district.

Works and Office Lighting.—At the meeting of Spratts Patent (Limited), the Chairman informed the shareholders that at the extensive works at Bermondsey, where the Company are engaged in the making of their well-known specialities, the electric light has been installed throughout.

Worcester.—Mr. Preece anticipates that the public supply of electric current will be ready by October next. This installation will constitute by far the largest water-driven electric lighting works in the country. For many years the Worcester Corporation has discussed the advisability of purchasing the gas undertaking. When the subject of electric lighting came up for discussion recently many members of the Corporation considered the time had come when, failing the purchase of the gas works, they might enter the lists as a healthy competitor to the gas company. The fact that Worcester is well served by the Severn, and that therefore water power would be at the Corporation's command, lent increased force to the arguments in favour of the Corporation's undertaking the supply of electric current throughout the district. Some initial difficulties and objections from the Severn Navigation Commissioners had to be overcome, but these were at no time a serious matter, and finally everything was settled satisfactorily by

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an offer from Mr. Willis Bund to sell the old water mills on the Teme at Powick. Mr. W. H. Preece was then called in, and with Mr. Purchas, the late city surveyor, and Mr. Thomas Caink, who has succeeded Mr. Purchas in that office, proceeded to prepare a scheme involving an expenditure of over £42,000, of which £23,500 represents plant, machinery and apparatus, and £15,000 the cost of the erection of the central station building. During the progress of the work everything has run smoothly but for for one mishap—the temporary dam gave way, and for some days the whole of the work was submerged. On the water having been pumped out the heavy masonry work was proved to have sustained no damage. The works are not likely to suffer through any scarcity of water power, as there is much more than sufficient for the purpose, although it is not continuous. On this account powerful steam engines have been provided for emergencies. The Brush Company have supplied the electrical plant. The water power is to be developed by four inward-flow Victor turbines, two of 54in., one of 38in., and one of 30in., providing nearly 350 h.p., and capable of developing up to 800. The work is being superintended by Mr. Leonard Wigan, as clerk to the works, who has under his care what will doubtless prove one of the most important installations in the country.

YORK.—The Streets and Buildings Committee of the Corporation have decided to defer coming to any resolution on the subject of electric lighting until they are furnished with further information on the subject, and have been able to visit Oxford to inspect the installation works there put down by the Electric Construction Company.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

February 24, 1894.

3,986. W. P. THOMPSON. Liverpool. Improvements in electric motors. (The Ries Electric Specialty Company, United States.)*

3,994. A. J. BOULT. London. An improved electrolytic process for covering or coating threads, fabrics, feathers, or other articles or materials with metal. (A. Soret, France.)

4,005. K. BEHRENS. London. Dynamometer for mechanical musical instruments.

4,010. W. B. ESSON. London. Improvements in winding the armatures of dynamo machines of the drum type.

4,021. A. C. BROWN. London. Improvements in telephone transmitters and arrangements for same.

February 26, 1894.

4,055. P. E. E. RAVEROT and G. A. HESS. Paris. Improved telephone exchange system. (Date applied for under Patents, &c., Act, 1883, sec. 103, August 8, 1893, being date of application in France.)

4,083. K. SCHLEYDER. London. Improvements in electric arc lamps.*

4,091. F. JEHL and M. VON HARDTMUTH. London. Appliances for the carbons of electric arc lamps for increasing the duration thereof.*

4,096. J. L. COPPING. London. Improvements in cable traction operated by electricity as a motive power.

4,102. H. A. C. SAUNDERS and A. C. BROWN. Improvements in street fire alarms and telephonic combinations for same.

February 27, 1894.

4,113. H. T. BARNETT. London. Improvements in electric batteries.

4,142. A. R. UPWARD. London. Improvements in construction of electrical letters and signs.

4,144. E. O. CLARK. London. Improvements in electrodes for arc lamps.*

4,168. A. W. HUSSEY. London. Improved construction of electric battery.

4,170. W. P. THOMPSON. Liverpool. Improvements in alternating-current electric motors. (C. S. Bradley, United States.)

4,171. W. P. THOMPSON. Liverpool. Improvements in alternating-current electric motors. (C. S. Bradley, United States.)

4,177. W. P. THOMPSON. Liverpool. A new or improved reel device for fire hose, electric cables, suspending cords, and the like. (P. Schneider, Germany.)

4,182. L. HIGGINBOTTOM, T. MANNOCK, and E. HOPKINSON. Manchester. Improvements in overhead electric travelling cranes.

4,190. E. L. BERRY and F. HARRISON. London. Improvements in apparatus for use with electrically-illuminated signs or advertisements, or in other cases where frequent changes of electric circuits are to be made.

4,197. F. W. BUSCH. London. Improvements in or connected with bases or covers for electric switches and fuses.*

February 28, 1894.

4,214. W. L. SPENCE. Manchester. Improvements in or in connection with electricity and other meters.

4,226. R. H. JAHR and C. F. SCHOELLER. London. Improvements in electric arc lamps.

4,235. J. W. EWART. London. A new electric fitting for piano.

4,244. A. DICKINSON. Birmingham. Improvements in and relating to the overhead system of electric tramways.*

4,254. J. C. B. ANDREWS. London. Improvements in electric arc lamps.

March 1, 1894.

4,325. A. H. HARRIS. Birmingham. Improvements in the electro-deposition of aluminium.

4,326. T. BAMBER and O. BAMBER. Accrington. Lamp, answering the purpose for cap and loop lamp (for incandescent lamps).

4,333. W. H. JOHNSON. Bournemouth. Improvements in and relating to apparatus for supporting and suspending electric light and other like fittings.*

4,366. A. J. BOULT. London. Improvements in dynamo-electric machines. (Compagnie de l'Industrie Electrique, Switzerland.)

March 2, 1894.

4,402. H. G. REA. Richmond. An electricity meter.

4,429. A. METZGER. London. Improvements in and in the manufacture of electrical switches.*

March 3, 1894.

4,472. T. PARKER. Wolverhampton. Improvement in electrolytic processes in the manufacture of chlorine alkali and derived products.

4,477. J. HESKETH and T. HESKETH. Blackpool. An improved automatic regulator for electric generators.

4,484. G. MICHAELSON. Berlin. Electro-magnetic switching.

4,485. G. MICHAELSON. Berlin. Correction of an electric bell.

4,522. A. J. BOULT. London. Improvements in electrically-operated clocks. (H. Campiche, Switzerland.)*

4,539. W. DIESELHORST and SIEMENS BROTHERS AND CO. (LIMITED). London. A joint for wires and electrical conductors.*

4,540. SIEMENS BROTHERS AND CO. (LIMITED). London. Improvements in contact bars for the overhead conductors of electrical railways and tramways. (Messrs. Siemens and Halske, Germany.)

4,554. C. ADAMS-RANDALL. London. Improvements in telephony.

March 5, 1894.

4,572. C. ADAMS-RANDALL. London. Improvements in telephonic transmitters.

4,575. E. A. VAUGHTON. Birmingham. Improvements in connection with electrical tramways.

4,610. E. F. MOY. London. An improved temperature regulating device for electricity meters.

4,635. H. WEHMANN. London. Improvements in galvanic batteries.

March 6, 1894.

4,647. T. R. BURRELL and F. FOWKES. Ambleside. Improvements in electric lighting by incandescence lamps arranged in series.

4,691. A. P. LUNDBERG, G. C. LUNDBERG, and G. PEGG. London. Improvements in apparatus for connecting and disconnecting electrical circuits.

4,724. O. MARCH. London. Improvements in and relating to secondary batteries.

March 7, 1894.

4,788. F. H. NALDER, C. W. S. CRAWLEY, and A. SOAMES. London. Improvements in standard resistance boxes.

4,805. J. M. KLINGELSMITH. London. A new or improved method of lighting cycle lamps by means of electricity.

4,828. E. BÜTIKOFER. London. A combined tachometer and telemeter.

4,849. G. ST. J. DAY and S. ALLMARK. Manchester. Improvements in casings, culverts, or means for supporting and protecting electrical conductors.

4,904. R. HACKING, G. BRAND, A. G. HOWITT, and J. JOHNSTONE. London. Improvements relating to electric lamps.

4,909. G. H. COLLINS and C. S. JONES. London. Improvements in or relating to combined targets and electrical indicating apparatus.*

4,910. W. L. WISE. London. Improvements in or relating to the distribution and utilisation of electricity. (E. Modesse, Belgium.)

4,911. W. M. MORDEY. London. Improvements in or relating to electric supply apparatus such as alternators and transformers, applicable also to other purposes.

March 9, 1894.

4,945. E. G. PINK. Dublin. A combined electricity meter and automatic switch, with apparatus for registering the position of an index or pointer.

4,969. S. F. GOUGH-CALTHORPE. London. Improved device for converting and making oil lamps suitable for electric light.

4,987. E. C. DE SEGUNDO. London. An improvement in arc electric lamps.*

4,993. W. WHITEHOUSE and H. PINNELL. London. An improvement or improvements in joints for suspending electroliers.

5,001. A. ESSINGER and T. HARDEN. London. Improvements in connection with electric fuses and switches.

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5,002. H. G. NICHOLS. London. Electric lamps.
5,003. J. G. W. ALDRIDGE. London. Improvements in regulating electric motors.

March 10, 1894.

5,014. W. S. RICHMOND. Suffolk. Using oil engines, gas engines, and electric engines or motors for working of capstans on fishing or other boats and cranes, &c.
5,025. M. H. SMITH London. Improvements in electric rail or tramway systems.*
5,026. R. H. BEST Birmingham. Improvements connected with the apparatus for raising and lowering the centre lights of chandeliers and electroliers, also applicable to brackets and like fittings.
5,072. G. H. Ricke London. Improvements in hangers for trolley wires.

March 12, 1894.

5,102. G. GILLMORE. Manchester. A new or improved telephonic relay.
5,118. W. E. HEYS. Manchester. Improvements in and connected with electro-locomotion on railways. (J. J. Heilmann, France.)
5,157. M. MAWSON and A. STUART. London. Improvements in apparatus for indicating the height of fluids in tanks or reservoirs by electricity.
5,158. T. J. DAWSON. London. Improvements in splice coverings for electric wires.*
5,164. A. HOFFMANN. London. Improvements relating to fittings for suspended electric lamps.

March 13, 1894.

5,194. T. R. ANDREWS and T. PREECE. Bradford. Improvements in the method of, and apparatus for, starting and stopping electric motors.
5,203. M. H. GALSWORTHY and S. S. GALSWORTHY. London. Improved electric-lit sights for night shooting on sporting rifles and other guns.
5,217. A. C. BROWN and G. R. NEILSON. London. Improvements in phonographs and appliances connected therewith.
5,226. C. P. SHREWSBURY, F. L. MARSHALL, J. COOPER, and J. L. DOBELL. London. Improvements in, or connected with, electric batteries.
5,243. A. D. LEWIS. London. Improvements in electric perforating pens.*
5,253. W. L. WISE. London. Apparatus for electric lighting, ventilating, &c., by means of storage batteries and dynamos driven from car axles or other power of varying speed. (J. N. Lewis, United States.)*
5,254. W. L. WISE. London. Apparatus for electric lighting, ventilating, &c., by means of storage batteries and dynamos driven from car axles or other power of varying speed. (J. N. Lewis, United States.)*
5,271. E. H. BROWN. London. Improvements in or connected with electric railways.*
5,273. R. W. BARKER. London. Improvements in closed conduits for electric railways. (The Lawrence Electric Company, United States).*
5,276. J. F. CUMMINGS and E. M. ENGELMAN. London. Improvements in electric railways.

March 14, 1894.

5,299. W. ROCKLIFFE, A. BEST and A. SUTHERLAND. Newcastle-on-Tyne. Improvements in the construction of brushes for preparing metals for electro-plating and for other like cleansing purposes.
5,340. J. A. FLEMING. London. Improvements in the construction of electrical resistance coils.
5,359. C. BALBIANI. London. Improvements in electrical signalling and in apparatus therefor.
5,363. T. B. GRANT. London. An improved form of alternating-current dynamo.
5,375. J. G. STATTER. London. A new or improved method of regulating or varying the speed and of twisting moment of electro motors and apparatus therefor.

March 15, 1894.

5,417. T. J. COCKERILL and W. E. BENNETT. Rochdale. A method of, and apparatus for, electrically signalling or transmitting a communication in the event of a fire or conflagration.
5,433. H. EDMUNDS. London. Improvements connected with the insulation of electric conductors of armatures or other encased, enclosed, or insulated electric conductors from which it is desirable to allow of the transmission of heat.
5,439. H. JOHNSON. London. Improvements in globes or shades for gas, electric, and other lamps.
5,442. E. P. OKEDEN, of the firm of R. Waygood and Co. London. Improvements in lifts actuated or controlled by electricity.
5,449. G. C. FRICKER. London. Improvements in connection with alternating-current dynamos working in parallel.
5,474. W. J. DAVY. London. Improvements in electric arc lamps.

March 16th, 1894.

5,508. A. MUIRHEAD. London. Improvements relating to the transmission of signals through submarine telegraph cables.
5,509. A MUIRHEAD. London. Improvements in the manufacture of submarine cables.
5,531. F. J. BURRELL. London. Improvements in dynamo supports for portable and traction engines with locomotive-type boilers.
5,537. R. HEATHFIELD and W. J. RAWSON. London. Electrical deposition of zinc and alloys of zinc and apparatus therefor.

March 17th, 1894.

5,572. F. FEARNLEY. Leeds. Elastic ear cushion for use on telephone receivers.
5,579. J. KIRKWOOD. Glasgow. Improved solutions for the electrica deposition, separation, and refinement of aluminium.
5,592. J. GRUBB and W. H. STURGE. Birmingham. Improvements in counterweights for electric light pendants and other similar purposes.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d. each.

1893.

3,477. NEHMER. Galvanic elements.
3,573. TAUSSIG. Extracting metals by electricity.
3,666. LOWRIE. Distributing electrical energy.
4,144. ARMSTRONG. Electrodes.
5,064. CAUDERAY. Electric clocks.
5,470. SIBERY. Electric signalling on railways.
5,638. DAVY. Electric arc lamps.
6,254. SHEPARD. Electric arc lamps.
6,470. MILLS (Kennelly). Electrical measuring instruments.
7,190. NEW. Magnetic parts of electrical apparatus.
7,407. JONES. Electric meters.
7,935. BUCHET. Arc electric lamps.
7,714. WYATT. Electric targets.
7,782. HARDINGHAM (Felten and Guilleaume). Electric cables.
8,004. DE PASS (Johannet and another). Electro-motors.
8,087. BROCKIE. Arc electric lamps.
8,315. NEW and MAYNE. Electric switches.
8,331. TYER. Electrical lock and block apparatus for railway points and signals.
9,805. SIEMENS BROS. AND CO. (Limited), and JACOB. Electric contacts.
19,146. O'BRIEN. Telephone book holders, &c.
22,765. MCCRAITH. Multiple telegraphy.
23,186. THOMPSON (Coffin). Welding pipes and tubes.
23,633. PARKIN. Electric motor.
23,744. URQUHART (Ysasmendi). Lighting railway trains by electricity.
24,392. WINKLER. Electric motors for vehicles.
24,871. JOHNSON. Dry batteries.
24,926. BRIERLEY (Weber and another). Arranging wires for electric bell, &c., circuits.
25,016. LAKE (Rand). Rosette for electric wires.

1894.

57. JOHNSTON and others. Electric motor apparatus.
95. ECKERT. Telephonic transmission.
135. PUPIN. Transmitting electric currents.
495. THOMPSON (Coffin). Transformers for electric currents.
1,003. LAKE (Johnson and another). Electric railways.
1,417. WHITTINGHAM. Starting electric motors.
1,473. LAKE (Dieckmann). Dynamo-electric machines.

COMPANIES' MEETINGS AND REPORTS.

Direct Spanish Telegraph Company (Limited).

The forty-first ordinary general meeting of the Company was held at the offices, Winchester House, Old Broad-street, on Tuesday, under the presidency of Sir John Pender, G.C.M.G., M.P.

The MANAGER (Mr. Charles Gerhardi) read the notice calling the meeting, and the minutes of the last ordinary general meeting and of the extraordinary general meeting of September 1st. These minutes having been approved as correct, the report of the Directors was taken as read.

The CHAIRMAN: I will go over the different heads of the reports and make any remarks that I consider desirable. The accounts for the half-year ended December 31st, 1893, show, after providing for debenture interest, a balance to the credit of profit and loss of £4,996 7s. 1d. The traffic receipts show a decrease of £509. 15s. 4d. as compared with the corresponding period of 1892. The decrease in traffic during the last half-year was not only due to falling off in Stock Exchange business, but also to a general depression of Spanish trade. This stagnation in Spanish business was particularly referred to at the general meeting of a bank doing a large business with Spain. I think that all who have anything to do with business, whether in Spain or in any other part of the world, must have felt that we have been passing through very severe commercial times during the past three years. They will not, however, continue for ever. I believe that the old energy, pluck and enterprise of the race still exist, but there has been such serious loss in one way and another, and such great over-production, that everything has become disorganised for the time. When,

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however, you remember the enormous amount of money that is invested, and the return of interest on that money, you will see that it will only take a very short period, comparatively, to bring us back into the old state of things again. I think there is a little evidence now of an improvement in this direction, and when a better state of things does come about, you may be quite sure that telegraphy will benefit by it. Submarine telegraphy suffers less than most other businesses in a period of depression. When times are bad people require help and facilities, and they have very often to use the telegraph with a view to securing those objects. I am speaking after long years of experience, and I express my own earnest belief that we shall see good times come round again. I believe there is now some evidence of the sun beginning to shine again through the black cloud which has hung over us for so long a period. The working expenses are £35 less than those for the corresponding period of last year. It is a small sum, and is one of those changes which are incidental to this as to other companies. The greatest possible care and attention are given to keeping down the expenses in every way we can. The Company's cables, and the land-lines in connection with them, have, with one exception, continued in good working order throughout the half-year. The Falmouth-Bilbao cable became interrupted on August 16, 1893; it was, however, promptly and effectually repaired by the Eastern Company's cable ship "Electra." The cost of these repairs, amounting to £1,453. 18s. 9d., has been taken from the reserve fund. The total duration of the interruption of the Bilbao cable was only eight days, which is the shortest interruption on record as far as this Company is concerned, and the cost of the repairs is also the smallest amount incurred in restoring any of our cables. The break was occasioned by a submarine landslip or subsidence of ground. The cable, except at the place where it was severed, was found in very good condition. That is, upon the whole, satisfactory, and I may further add that the ships of the Eastern Company—which holds a very large stake in this Company—are very convenient for us in the event of any interruption taking place. A ship is always available and can be used promptly for making any repairs this Company requires; but, as I have said before, the less we are dependent on the Eastern Company or any one else for effecting repairs, the better for our interests. For the last two years efforts have been made to secure an office inside Covent Garden Market, but there was no available place. Last October, however, an opportunity was found to secure a small space in the gallery of the Foreign Fruit Auction Mart. This branch office has proved of great use, not only in securing the traffic with Spain and other places from the market, and insuring prompt delivery of the telegrams for the fruit merchants, but also as a delivery station for general messages for the West End of London. It is a very remarkable fact how the telegraph teaches people to save time when a small office is opened where there is any amount of trade carried on, more particularly with the parts which our submarine system touches; and we find that all small stations generally pick up something extra than was contemplated when establishing them. Such offices afford wonderful facilities to those who use the telegraph, and the public appreciate these facilities which encourage them to send two telegrams when otherwise they might send only one. After adding the usual sum of £2,500 to the reserve fund, the balance of profit and loss amounts to £2,496. 7s. 1d. Out of this amount the Directors recommend the payment of the dividend at the rate of 10 per cent. per annum on the Preference shares, and a dividend at the rate of 4 per cent. per annum (free of Income-tax) on the Ordinary shares, and to carry forward the balance. The reserve fund will then amount to £37,551. 11s. 10d. The rate of dividend on the Ordinary shares is the same as has been paid since July, 1891. The dividend warrants will be issued on March 31st, being payable on April 2nd, the 1st being a Sunday. Out of the reserve fund as it now stands—namely, £37,551. 11s. 10d.—the sum of £33,997. 2s. 2d. is invested in superior securities, yielding an average interest of 3½ per cent. after payment of income-tax. I think I have said nearly all that it is necessary for me to state. I have drawn attention to the leading features in the report, and I can only repeat what I have said elsewhere — that submarine telegraphy has become one of the great features in our life and one of the factors of progress, and I feel quite sure regarding the position of this Company. Although Spain is not as active as she used to be, still she occupies a very prominent and important part in Europe, and I hope that we shall see, with the revival of trade there, a considerable increase in our telegraphic communications with that country. I beg to move—

"*That the report and accounts now presented be and are hereby received and adopted.*"

Mr. EDMUND ETLINGER seconded the motion, which was carried unanimously.

The CHAIRMAN then moved that a dividend at the rate of 10 per cent. per annum (less income-tax) on the Preference shares, and a dividend at the rate of 4 per cent. per annum (free of income-tax) on the Ordinary shares, be declared, which was seconded by Mr. ETLINGER, and carried unanimously.

Mr. J. D. PENDER proposed, and Mr. DYETT seconded, the re-election of Sir John Pender, G.C.M.G., M.P., and Mr. Edmund Etlinger as Directors, and the motion was carried unanimously.

Mr. HIBBERDINE proposed the re-election of Messrs. Deloitte, Dever, Griffiths and Co. as auditors, with a remuneration of twenty guineas, which was seconded by Mr. COCHRAN, and carried.

Mr. COCHRAN proposed a vote of thanks to the Chairman and Directors, which was seconded by Mr. LOWE, and unanimously adopted.

The CHAIRMAN: I thank you on behalf of my colleagues and myself. You may rest assured that whatever we do in a financial direction for the Company we shall act with a view of improving it as much as we possibly can. I thank you very much for the confidence you repose in us.

The meeting then separated.

Eastbourne Electric Light Company (Limited).

The annual general meeting of this Company was held on Monday, at the Clifton Hotel, Eastbourne, under the presidency of Mr. Alderman George Boulton.

In moving the adoption of the Directors' report (which will be found below) the CHAIRMAN congratulated the shareholders on its very satisfactory character. For years past, he said, they had been working under great disadvantages—against apathy and powerful opposition—but these difficulties had been overcome, and he thought great credit was due to their officials for this year's report. He briefly sketched the history of the Company, and reminded the meeting of the first installation put down in 1882, under the high-tension system. It extended for only three miles, and was laid on the Parade, Devonshire-place, and Terminus-road. Now the circuit measured 7¼ miles of double cable, and 3¼ miles of single cable, or close on 18 miles of cable, with eight miles of pipes. The number of 8-c.p. lamps in circuit had risen from 2,896 in 1888 to 8,853 in 1894, and the gross earnings of the Company since 1886 had been as follows:—1886, £1,679; 1887, £2,263; 1888, £3,529; 1889, £4,147; 1890, £4,736; 1891 (five quarters), £6,753; 1892 £5,463; 1893, £6,992. That showed that they were making steady progress. One thing that had exercised the minds of the Directors a great deal was the need of extending the system to Upperton and Old Town. They believed that if this were done a large increase of business would result. But they must have money, and they proposed to raise it by Debentures at 5 per cent., the present Debenture holders having agreed that the new issue should rank with those they held. He did not like saying anything about himself, but he might tell them that so satisfied was he with the stability of the Company that he had taken £1,000 worth of new Debentures.

Mr. LANGHAM seconded the motion. He agreed with the Chairman as to the desirability of extending the system to Upperton and Old Town, and reminded them that, although the estimated cost of the extension was £6,000, that estimate included a new engine and dynamo, and meant the duplication of their machinery, which was desirable as a matter of safety for the existing system.

The motion was unanimously adopted, and a dividend of 5 per cent. free of income-tax on the share capital was declared.

Mr. J. G. Langham was re-elected a Director; and on the motion of Mr. HOLLINS, seconded by Mr. HURST, £200 was voted to the Directors for their services, Mr. Hollins pointing out that for many years the Directors received nothing, and for the twelve years the Company had been in existence they had only received £550. Messrs. Hart Bros., Tibbetts and Co. were re-elected auditors, and votes of thanks were passed to Mr. Towner and Mr. Wilkinson for their services in their capacity of secretary and electrician respectively.

An extraordinary general meeting was subsequently held, and the following resolution was adopted unanimously:—

"*That the present first Debenture issue of £25,000, bearing interest at the rate of £5 per cent. per annum, be extended with the consent of the present holders of Debentures of such issue to £35,000; and that the whole of such extended issue shall bear interest at the rate of £5 per cent. per annum, and that all the Debentures forming part of such first issue of £35,000 shall rank* pari passu, *and without priority, both as to principal and interest, whether the same shall have been issued prior to or after the date of this resolution.*"

The following is the report of the Directors:—

The gross profit for the year ended December 31, 1893, after allowing a further sum of £400 for depreciation of machinery, plant, &c., is £1,981. 2s. 2d., of which sum £1,271. 3s. 8d. has been paid for interest on debentures and mortgages, leaving a balance (including £114. 5s. 2d. carried over from last year's accounts) of £824. 3s. 8d. available for dividend. The Directors recommend a dividend at the rate of £5 per cent. upon the share capital (free of income tax), which will absorb £508. 10s. and leave a balance of £315. 2s. 8d. to meet the Directors' remuneration, and to carry forward a surplus to the credit of the current year's accounts. The reserve fund to meet depreciations now amounts to £1,425.

Last year the Directors mentioned that the extension of the circuits to the Upperton and Old Town Districts was under consideration, and as the suggestion met with the approval of the shareholders, the matter has been carefully thought out, and it has been decided to carry it out. Estimates have been prepared of the cost of the extension, and the necessary plant and machinery for working it, and these show that about £6,000 will be required. To provide this sum it is proposed to issue further debentures, bearing interest at the rate of £5 per cent. per annum. The present debenture holders have been approached upon the subject, and they have kindly consented to the authorised first debenture issue of £25,000 being extended to £35,000, so that the further monies required for the extension may rank, both as to principal and interest, equally with the debentures already issued. They, however, made it a condition that the further issue should not be placed upon the public market, but should be privately subscribed. Upwards of £3,000 has already been so subscribed, but £3,000 further is still required for carrying out the extension. The Directors consider this will be a profitable operation for the Company, and invite the shareholders to contribute to the required capital.

The Company's machinery, plant and mains are in excellent condition. Upwards of 1,300 incandescent lamps have been taken during the year, and a contract entered into with the Eastbourne Town Council for the supply of five additional arc lamps to the Royal Parade, which are now running. The number of lamps at present in use are as follows:—Arcs, 27; incandescents of ten candle-power, 8,454; as against 21 arcs and 7,136 incandescents in use at December 31, 1893.

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Mr. James George Langham retires from the direction this year, but is eligible for re-election. The auditors, Messrs. Hart Brothers, Tibbetts and Co., also retire, but may be re-elected.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, pages 320-348, *&c., &c.*]

ANGULAR-HOLE MACHINE COMPANY (LIMITED).—This Company has been registered with a capital of £35,000, divided into 82,000 Preference shares of 5s. each, 44,000 Deferred shares of 5s. each, and 3,500 Founders' shares of £1 each, to acquire the businesses carried on by the Square Drilling Machine Company (Limited) and the Ainley-Oakes Square Drill Syndicate (Limited).

ARDROSSAN FOUNDRY COMPANY (LIMITED).—This Company has been registered in Edinburgh, with a capital of £7,000, divided into 700 shares of £10 each, to carry on the business known as that of the Old Foundry, Ardrossan.

JOSEPH MILLS AND CO. (LIMITED).—This Company was registered on March 12th, with a capital of £2,000, in £1 shares, to acquire and take over as a going concern the electrical business carried on by Joseph Mills, at Sheffield.

KERR, STUART AND CO. (LIMITED).—This Company has been registered with a capital of £60,000, in £10 shares, to carry on business as railway carriage and waggon builders, railway and tramway plant contractors, steel rail manufacturers, locomotive builders, mechanical engineers, consulting engineers, &c.

LONDON REFUSE STEAM GENERATOR AND ELECTRICAL POWER CORPORATION (LIMITED).—This Company was registered on March 16th with a capital of £600,000, in £1 shares, to enter into and carry into effect an agreement with the Atlas Contracting Syndicate (Limited), to acquire certain patents and inventions relating to the disposal of street refuse within the district of London, and to carry on the business of mechanical engineers, boiler makers, suppliers of electricity, electrical contractors, electrical engineers, and contractors for the construction, fixing and carrying out of all necessary cables, wires, lines, accumulators, lamps and works for the generation, accumulation, distribution, and supply of electricity.

TAYLOR'S SMOKELESS BOILER SYNDICATE (LIMITED).—This Company was registered on March 10th, with a capital of £30,000, in £5 shares, to acquire certain inventions for improvements in or connected with self-contained gas-fired steam generators, for which British and foreign Letters Patent have been granted to Mr. Wilhelm O. A. Lowe, and to carry on business as metal manufacturers and merchants, mechanical engineers, machinists, metal workers, fitters, &c.

ELECTROLYTIC CAUSTIC SODA AND CHLORINE TRUST (LIMITED).—The annual return of this Company, made up to November 16th last, has been filed. Out of a nominal capital of £20,000, in shares of £10 each, 1,500 have been taken up, and 500 of these have been issued as fully paid. Upon 750 a call of £10 per share has been made, and upon the remaining 250 shares a call of £6 per share has been made, resulting in a total payment of £9,000.

ELECTRO-PROTECTOR SYNDICATE (LIMITED).—The statutory return of this Company, made up to January 29th, was filed on the 6th ult., when 7,607 shares out of a nominal capital of £10,000, in £1 shares, were taken up; 7,000 of these were issued as fully paid, and the full amount called on the remainder. The calls paid amount to £500.

ELMORE'S PATENT COPPER DEPOSITING COMPANY (LIMITED).—The annual return of this Company, made up to December 6th, has been filed. The nominal capital is £200,000, divided into 91,195 Ordinary and 8,805 Preference shares of £2 each. 91,195 Ordinary and 8,610 Preference shares have been taken up, and 23,300 Ordinary shares have been issued as fully paid. Upon the remaining 67,895 Ordinary and the 8,610 Preference shares a call of £2 per share has been made, resulting in a payment of £152,577. 10s.

ELMORE'S WIRE MANUFACTURING COMPANY (LIMITED). — The annual return of this Company, made up to December 26th, has been filed. The nominal capital is £300,020, divided into 150,000 Ordinary and 10 Founders' shares of £2 each. 67,278 Ordinary and the 10 Founders' shares have been taken up, and the full amount called. The calls paid amount to £13,137 10s., leaving £3,953 10s. unpaid. No less than 1,610 Ordinary shares have been forfeited, together with £515 paid in respect thereof.

ESTON ARC LAMP SYNDICATE (LIMITED).—In reply to inquiries, the solicitor states that the Company did not go to allotment, and no business of any kind has ever been done. The name of the Company is to be struck off the register.

FIBRITE SYNDICATE (LIMITED).—This Company, although incorporated in September, 1891, has never filed any returns, and will be struck off the Register of Joint Stock Companies should the same not be forthcoming.

FOREIGN AND COLONIAL ARC ACCUMULATOR COMPANY.—An agreement dated March 6, 1894, between the above Company, William Wright, and William Baker (executors of Anthony Reckenzaun, the inventor of the patents to be sold to the Company), Henry Edmunds, and Robert W. Winthrop, provides for the allotment of 331 fully-paid shares to William Wright and William Baker, and of 662 fully-paid shares to Robert W. Blackwell (who has bought Henry Edmund's interest) in consideration for the sale to the Company of certain Belgian, French, Australian, and United States letters patent for "Improvements in the manufacture of plates for secondary batteries."

FOWLER-WARING CABLES COMPANY (LIMITED).—The annual return of this Company, made up to January 26th, has been filed. Out of a nominal capital of £200,000, divided into 39,700 Ordinary and 300 Founders' shares of £5 each, 20,000 Ordinary and the Founders' shares have been taken up, the latter being considered as fully paid. The full amount has been called and paid on the 20,000 Ordinary shares.

GORDON ELECTRIC TRACTION SYNDICATE (LIMITED).—The annual return of this Company, made up to November 28th, has been filed. The whole nominal capital of £2,400, in shares of £10 each, was taken up. Of these shares 60 have been issued as fully paid. The full amount of £1,800 has been called and paid on the remainder.

HOPE-JONES ELECTRIC ORGAN COMPANY (LIMITED).—The annual return of this Company, made up to November 14th, has been filed. The nominal capital is £25,000, divided into 1,200 Preference and 1,300 Ordinary shares, of which 695 Preference and 1,300 Ordinary have been taken up, all the latter being issued as fully paid to the vendor and Thomas Threlfall. Upon the 695 Preference shares, the full amount has been called, resulting in the payment of £6,910, and leaving £40 in arrears.

J. E. HOPKINSON AND CO. (LIMITED).—The first annual return of this Company, made up to February 19th, has been filed; 13,007 shares were taken up, and 10,000 issued as fully paid. Upon the remaining 3,007 shares the full amounts have been called and paid.

LAURENCE, SCOTT AND CO. (LIMITED).—The annual return of this concern, just filed, states that of 1,406 shares out of a capital of £30,000, in £10 shares, 500 have been issued as fully paid, and the full amount of £9,060 has been paid on the remainder.

LONDON ELECTRIC WIRE COMPANY (LIMITED).—The annual return of this Company, made up to February 9th, has been filed. The nominal capital is £50,000, divided into 5,000 Preference and 5,000 Ordinary shares of £5 each, and 4,188 Preference and 4,597 Ordinary shares have been taken up; 3,860 of each class have been issued as fully paid, and the full amount has been called on the remaining 328 Preference and 737 Ordinary shares, resulting in the payment of £5,325.

CITY NOTES.

CHELSEA ELECTRICITY SUPPLY COMPANY (LIMITED).—Letters of allotment for the recent issue of Six per Cent. Preference Shares in this Company have been posted.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended March 18th were £926, as against £880 in the corresponding period of last year, being an increase of £46. The total receipts for the half-year amount to £10,400, as against £10,412 for the corresponding period of last year, a decrease of £12.

EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY, LIMITED.—Notice is given that the eleventh drawing for payment of the 5 per cent. Australasian Government Subsidy Debentures, will take place on Monday, the 2nd April, at 11.30 a.m., at the offices of the Company, Winchester House, E.C. 371 debentures are to be drawn.

GREAT NORTHERN TELEGRAPH COMPANY.—The ordinary general meeting of this Company is to be held at the Exchange, Copenhagen, on Saturday, the 21st April, at 3.15 p.m.

HOVE ELECTRIC LIGHTING COMPANY (LIMITED).—This Company is making a public appeal for further capital to the extent of £12,500 in Five per Cent. First Mortgage Debenture Bonds.

LONDON REFUSE STEAM GENERATOR AND ELECTRICAL POWER CORPORATION (LIMITED).—A prospectus has been issued inviting applications for shares in this Company, which has a capital of no less than £600,000, in £1 shares. The prospectus states that the Company is formed to acquire the Livêt patents for destroying town refuse, and for the economical and rapid generation of heat in furnaces for electric lighting and other purposes. *The Electrician* for February 16th contained particulars of this system. It would appear that if success attends the launching of the present Company, provincial companies will be formed for working these patents. It is difficult to believe that the Company will be able to earn a dividend on so large a capital in London alone, although the prospectus is crowded with sanguine anticipations. No less than £400,000 is to be paid for the patents which the Company is to acquire. Seeing that the Company may shortly have to share the field with a competitor for which many advantages over the Livêt system are claimed, the investment appears decidedly risky.

WATERLOO AND CITY RAILWAY COMPANY.—The prospectus has been issued this week of this Company. A tunnel line is to be built between Waterloo station and a point nearly opposite the Mansion House, and the motive power used will be electricity. This will give the London and South-Western Railway a much-needed station in the heart of the City. Several of the South-Western Directors are on the Board of the new Company, and the former guarantees a minimum dividend of 3 per cent. out of gross receipts, two-thirds of the net profit also to go to the Waterloo and City Company. The share capital is £540,000.

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WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended March 16th (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £3,550.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the two weeks ended March 15 were £2,824, as compared with £3,013 for the corresponding period of last year. The November receipts, estimated at £4,577, realised £4,615.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price, Mar. 14.		Price Tuesday, Mar. 20.		Rate per Cent. Yielded (£ s. d.)	Dividend Due	Business Done During Week Ending Mar. 20: Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	13/6	Anglo-American	42	44	42	41	5 13 8	Jan., Apr., July, Oct.	..	..
£2,932,680	Stock	27/0	Do. Preferred	78½	79¼	77½	78¼	6 7 5	" "	79⅝	77½
£2,932,680	Stock	5/0	Do. Deferred	6¾	7¼	7¼	7¾	..	.. ..	7⅛	7
£184,500	100	4%	African Direct Telegraph 4% Deb. (Reg. & Bearer)	100	103	100	103	3 17 8	January and July	102½	..
130,000	£10	3/0	Brazilian Submarine xd	11¾	12¼	11¾	12¼	5 4 0	Mar., June, Oct., Dec.	12⅜	12 1/16
£18,700	£100	5%	Do. 5 per Cent. Bonds	99	102	99	102	4 18 0	January and July	..	–
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	..	–
$10,000,000	$100	$1¾	Commercial Cable Capital Stock xd	145	150	146	150	4 13 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12	13	12	13	6 3 1	February and August	12 11/16	12½
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	–
12,931	5	1/7½	Direct Spanish (£4 paid)	2	3	2½	3½	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8	9	8½	9½	5 5 3	" "	8¾	..
60,710	20	8/0	Direct United States Cable, 1877	10¾	11	10⅜	10⅞	6 4 5	Jan., Apr., July, Oct.	11	10⅝
400,000	10	2/6	Eastern	14¾	15	14¾	15	4 6 8	" "	15 1/16	14¾
70,000	10	6%	Do. 6 per Cent. Preference	15¾	16¼	16	16½	3 12 9	" "	16 3/16	15 15/16
£1,294,10·	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	113	116	3 9 0	May and November	114½	113½
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	106	109	106	109	4 11 9	February & August	..	..
250,000	10	2/6	Eastern Extension	15¼	15½	15¼	15½	4 10 4	Jan., Apr., July, Oct.	15 7/16	15¼
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113	116	112	115	3 9 7	February & August	113	..
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103	106	103	106	4 14 4	January and July	104	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	103	106	103	106	4 14 4	" "	103	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103	106	103	106	3 15 6	February & August	..	..
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	107%	110%	107%	110%	3 12 9	May and November	..	..
180,227	10	1/3	Globe Telegraph and Trust	8⅜	8⅜	8⅜	8⅞	5 1 5	Jan., Apr., July, Oct.	8 13/16	8 11/16
180,042	10	6%	Do. 6 per Cent. Preference	15¼	15½	15	15¾	3 18 8	" "	15⅜	15¼
150,000	10	5/0	Great Northern	21	22	21	22	3 18 0	Jan., April, and July	..	..
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 13 6	March & September	..	..
17,000	25	12/6	Indo-European	43	45	43	45	5 11 1	May and November	..	..
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	..	" "	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	104	107	105	108	5 11 1	March & September	..	–
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red 1942	102	105	102	105	3 16 2	..	..	..
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	..	..
3,381	£100 Cert.	25/0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	" "	..	..
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July	..	..
£249,900	100	5%	Do. 5 per Cent. Debentures	98	101	98	101	4 19 0	March & September	100½	99
30,000	10	2/0	West Coast of America	2	2½	2¼	2¾	..	January and July	2½	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	97	101	98	102	7 16 10	June and December	..	..
88,321	10	1/0	West India and Panama	1⅛	1⅜	1⅛	1⅜	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10	10½	5 14 3	May and November	10⅜	10 5/16
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	106	109	106	109	4 11 9	June and December	..	..
64,242	15	4/6	Western and Brazilian	7½	8	7¾	8¼	..	May and November	7¾	7½
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	5¾	6¼	6	6½	..	..	6 5/16	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	1¾	2¼	2¼	2½	..	..	2¼	2 1/16
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	104	107	105	108	5 11 1	February & August	–	–
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	104	107	105	108	5 11 1	" "	..	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	117⅝	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	100	104	100	104	5 15 5	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	1½	2½	1½	2½	..	..	..	–
[illegible]	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
220,000	£1	6d.	Oriental Telephone and Electric xd	½	¾	..		..	Yearly	..	–
484,597	5	2/6	National	4½	4¾	4½	4¾	5 5 3	June and December	4¾	4⅝
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½	15½	14½	15½	3 17 5	" "	..	..
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	14	15	14	15	4 0 0	" "	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¼	5½	5¼	5½	4 10 11	..	5 7/16	..
925,017	£100	4½%	Do. Deb. Stk. 4½%	113	115	114	116	3 17 7	January and July	115⅝	115½
58,000	5	1/0	United River Plate	1½	2	1½	2	..	" "	..	–
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	–	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11	12	12	13	–	..	12 11/16	11¾
20,000	10	6/0	Do. 6 per Cent. Cumulative Pref. (fully paid)	13	13½	13¼	13¾	..	–	13½	13 5/16
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	–	–
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	–	–	–
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	–	–
8,322	£5	..	House to House Electric	..		..		–	–	–	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		..	–	–	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	–	–
30,000	£5	1/9	Liverpool Electric Supply (£4 10s. paid)	5⅞	6⅛	5⅞	6⅛	..	–	–	–
15,000	£5	2/6	Do. (fully paid)	6⅝	6¾	6 9/16	6 11/16	..	–	–	–
111,000	5	..	London Electric Supply	½	¾	¼	¾	..	..	..	–
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	8¼	8¾	8½	9	2 4 5	..	8⅝	8⅝
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	106	109	106	109	4 11 9	June and December	108	–
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	–	–	..	–
19,980	£5	4/6	St. James' and Pall Mall	6	6½	6¼	6¾	..	–	6 7/16	6¼
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	–	8 7/16	8⅜
59,900	5	2/6	Westminster Electric Supply (fully paid)	5¾	6¼	5¾	6¼	3 4 0	–	..	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2¾	3	2⅞	3⅛	5 15 1	–	2⅞	2¾
90,000		6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	–	2⅜	2
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	107	110	108	111	4 1 1	March & September	109½	108½
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	3½	4	3½	4	..	January and July	..	–
12,139	5	..	Edison and Swan United	–		–		–	–	–	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		–	–	–	–
120,000	2	..	Electric Construction	¼	¾	¼	¾	..	–	⅜	..
12,845	2	..	Do. 7% Cumulative Pref.	1½	2	1½	2	..	–	..	–
91,195	2	10/0	Elmore's Patent Copper Depositing	⅝	⅞	½	¾	..	..	½	..
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	–	..	..	–
50,000	10	15/0	India Rubber, Gutta Percha &c., Works	23	24	23	24	5 4 2	February & August	23¾	23¼
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	103	106	103	105	4 5 9	March & September	..	..
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	–	–	–
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	–	–
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	–	½	–	½	..	–	–	..
78,949	5	3/6	Swan United (£3. 10s. paid)	2	2½	2	2½	7 0 4	May and November	..	..
87,350	12	36/0	Telegraph Construction and Maintenance	39	41	39	41	4 7 10	March and July	40	39½
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	..		..		..	January and July	..	..
37,514	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		–	–	–	–
41,098	£5	..	Do. Preference (fully paid)	..		..		–	–	–	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	5%	City and South London Railway	27	32	27	32	4 5 11	May and November	..	..
87,500	£10	1%	Liverpool Overhead Railway	6½	6½	6¼	6½	–	–	–	–

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NOTES.

A few weeks ago the Waterloo and City Electric Railway came before the public under the ægis of the London and South-Western Railway Company; and this week the Charing Cross, Euston and Hampstead Railway Company invites subscriptions towards its authorised share capital of £1,416,000, and does so without any ostensible backing, other than the intrinsic merits of the proposed method of construction and working, and the need which exists for such a railway. The line of route is from the Strand, near King William-street, along Charing Cross-road, Tottenham Court-road, Hampstead-road, High-street, Camden Town, Haverstock Hill, to High-street, Hampstead, within five minutes' walk of Jack Straw's Castle; with intermediate stations at Oxford-street, Euston-road, Seymour-street, Camden Town, Chalk Farm and Belsize-park. Hampstead proper, so far as "rapid transit," is concerned, is practically isolated from the West End, and a convenient means of communication will no doubt be much appreciated. The wretched "yellow 'bus" service which infests the streets over part of this route is a disgrace to London, and the fares are higher—that is to say, a penny goes a fewer number of yards—than on any other Metropolitan line. The railway route, moreover, traverses a densely populated industrial quarter, and should secure a large holiday and Sunday traffic whenever meteorological conditions are favourable. The promoters state that it is intended to run "light trains at short intervals," and a 2½-minute service is promised. This looks as if the Liverpool Overhead Railway arrangements, rather than those of the City and South London Line, were to be the pattern. It is to be hoped this will be the case. Our railways suffered somewhat in their early days by following too closely on the lines of the old mail coaches, and those responsible for our electric suburban "undergrounds" will do well to avoid a similar mistake, and to disabuse their minds of the idea that they are building railways, when, as a matter of fact, they are constructing glorified tramways. Railways on our well-developed railway system are well adapted for communication between town and country, or between town and town; but the traffic from one part of a city to another should be arranged on a different principle.

The success which has attended the experiment at the works of Messrs. Mather and Platt has already given a great impetus to the eight-hours' movement, and is destined, we doubt not, to give it a still greater impetus. The experiment was, of course, carried out under exceptionally favourable, though not under artificially favourable, conditions; for it is not every firm that has 1,200 men in its employ engaged in such a wide variety of manufacture, and possesses such an admirable organiser as Mr. William Mather. On the other hand, it must be remembered that the past twelve months have been a period of almost unexampled trade depression, and it is to be noted, moreover, that although every effort was naturally made on either side to ensure the success of the experiment, no conditions were introduced which would not obtain in everyday practice. The net outcome is that the ratio of wages to turnover has increased by 0·4 per cent., as compared with the average of the six preceding years, when better prices ruled; and this increase is exactly balanced by the decreased cost of lighting, fuel, and general wear and tear. Men on piece-work, who might reasonably have been expected to lose considerably by an eight hours' day unless their wages were raised, have in twelve months nearly managed to make up for shorter hours by increased energy. Last, but not least, the proportion of "time lost without leave" to the total time worked has been reduced from 2·46 per cent. to 0·46 per cent. The results obtained at Salford are, perhaps, too good to be reached everywhere else at a bound, but they show that the eight hours' day is not incompatible with our commercial supremacy, and Mr. Mather's report should for ever dissuade Parliament from attempting to legislate mankind into rigid uniformity.

The dispute between the London County Council and the London Street Tramways Company, as to the terms upon which the latter undertaking is to be purchased under the Tramways Act of 1870, is of some interest to electric light undertakers, inasmuch as the purchase clause of the Electric Light (Amendment) Act of 1888 is much on the same lines as the 43rd section of the Tramways Act. Fortunately for those who have invested their money in electric light undertakings, the terms upon which these are to be bought up are far more explicit than is the case with tramway undertakings. The fight now going on in the Court of Appeal, which will in all probability be carried to the House of Lords, relates to the meaning of the expression "the then value of the tramway," the County Council taking it in its plain English sense as the cost of construction less depreciation, whilst the Company

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takes the view that the then value is to be arrived at by finding what the average earnings of the tramway are, and then allowing so many years' purchase; in which contention the Company has been upheld by the Divisional Court.

THIS particular ambiguity does not appertain to section 2 of the Electric Light (Amendment) Act of 1888, in which it is stated that the then value is to be deemed to be the fair market value of the property of the Company, taking into consideration its nature, condition, suitability to the purposes of the undertaking, and the fact that the plant is in a position ready for immediate working. This explanation, together with the express exclusion of any allowance in respect of compulsory purchase, goodwill, or past or prospective profits, does not seem to us to admit of much doubt as to the basis upon which the arbitrator of the future will estimate the money to be paid by local authorities to Electric Lighting Companies when the former purchase the undertakings of the latter. The terms are no doubt unwisely severe, and are, therefore, open to the objection that they tend to stifle individual enterprise, one of the mainsprings of national prosperity, but with the terms of purchase so clearly set forth, there can be no justification in this instance for the use of that much favoured word "confiscation."

THE *Physical Review* contains in its current number several Papers of interest. Prof. CARHART sends a record of careful experiments carried out for the purpose of confirming or refuting the conclusions of Mr. SANFORD on what he called a necessary modification of OHM's law. We were unable to accept those conclusions, which related to the electrical resistance of wires in dielectric liquids or vapours, and pointed out that the observed effects might very well have been due to changes of temperature. Prof. CARHART's students have repeated the experiments with sensitive apparatus, and have failed to discover any differences too large to be accounted for by errors of observation. A Paper by Mr. E. S. FERRY in the same number describes a series of photometrical experiments with rotating sectors, and arrives at the conclusion that this well-known device for reducing illumination is subject to considerable error if the two lights under comparison differ in colour composition, and if the total aperture between the rotating sectors is less than the area of the sectors themselves. Curves are given, of three sets of tests, showing errors which increase rapidly from about 1 per cent. for 120° total aperture to 4 to 7 per cent. for an aperture of 60°, and from 10 to 15 per cent. for an aperture of 24°. By "errors" the author means the difference between readings obtained by cutting off the more powerful illumination by means of the rotating sector (the photometer box being at the middle of the bar), and by the ordinary method of moving the photometer box. He therefore assumes that his photometer, which is a modification of the Ritchie arrangement, is perfect. With two lamps, the one of 150 c.p. and the other of 13 c.p., and the two identical monochromatic lights, no "error" was found; but the difference was observed when the lamp behind the revolving sectors was forced, that is, when it gave a larger proportion of blue rays than the other. The error is attributed to the lower luminosity of the more refrangible rays. The sectors used by Capt. ABNEY and Gen. FESTING consisted, if we remember right, in two openings of 90°, which can be reduced to nothing by means of adjustable sectors. Before this difference can be attributed to the revolving sectors as an error, comparisons should be made with many different kinds of photometers, and perhaps, with different modes of producing regular and periodic variations and extinctions.

Electrocution.—The dynamo for the electrocution of criminals at Sing Sing has been rewound to give 2,500 instead of 1,000 volts.

Prof. Kennedy.—The Senate of Glasgow University have decided to confer the honorary degree of LL.D. on Prof. Alexander B. W. Kennedy, F.R.S., Emeritus Professor of Engineering in University College, London.

Electric Launches at Bergen.—A Company has been formed at Bergen, says *Engineering*, for the purpose of running electric launches in the harbour for passenger traffic. The plan is to start with eight launches, and to commence running them in June.

Société Internationale des Électriciens.—The legacy of 100,000fr. placed at the disposal of the French Government by the late M. Giffard has been given by the Minister of Public Instruction to the Laboratory of the Société Internationale des Electriciens.

Personal.—Lieut. M. C. Maunsell, R.A., has been appointed Instructor in Electricity at the Royal Military Academy, Woolwich.——Dr. S. Rideal has fitted up laboratories at 28, Victoria-street, Westminster, S.W., in order to facilitate the execution of his analytical and consulting work.

Cable Interruptions:	Date of Interruption.
Cayenne-Paramaribo	Oct. 15th, 1893.
Bissao-Bolama	Nov. 24th „
Garachico-Santa Cruz de Palma	Dec. 27th „
Fao-Bushire	Mar. 20th, 1894.
Bonny-Cameroons	Mar. 21st „
Brest-St. Pierre (P.Q. Co.)	Mar. 29th „

Tram-Car Lighting.—The London Tramways Company is experimenting with an electrically-lit tramcar, on the Westminster and Streatham-hill line. Power is carried in secondary batteries, and the roof of the car is lit by two glow lamps placed in stout structures at each end of the roof. It is said that on any part of the roof the smallest print can be read in the light thus obtained.

Electrically-Driven Machine Tools.—An Exhibition of electrically-driven machine tools is to be held at Buda-Pesth from May 27 to September 30, 1894. Current for working the machines will be supplied, and plant not sold will have the return freight paid on it by the management of the Exhibition. Full particulars can be obtained from Mr. Charles Rath, Director of the Hungarian Commercial Museum, Buda-Pesth.

Electro-Medical Experiments.—Prof. Yarchanoff, of St. Petersburg, finds that if he attaches the terminals of a very delicate galvanometer to the skin in different parts of the body, and then either acts on the nerves of the skin, by means of a brush or needle prick, or acts on the nervous system generally by means of sound, light, taste, or smell, or even by blinking the eyes, a considerable deflection of the galvanometer is produced.

The Belknap Woven Wire and Graphite Brush.—A dynamo brush has recently been placed on the market by the Belknap Motor Company, of Portland, Me., which is a combination of graphite and copper wire cloth. The copper wire is made of selected copper, woven after a special pattern into cloth. The inner folds of the cloth are treated with a compound of graphite so that as the brush wears, the graphite furnishes the lubrication for the commutator.

The Rating of Electric Lighting Undertakings.—The financial progress which so many electric lighting companies are making is beginning to excite the attention of the rating

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authorities, with the result that assessments, in some instances of a most unreasonable character, are attempted to be put into force. The Eastbourne authorities some time ago raised the assessment of the Eastbourne Company from £150 to £795. No doubt some increase in the assessment was warranted by the progress the Company had made, but the Machinery Users' Association advised that the large increase was altogether unjustifiable, and the result of the appeal has been a reduction to £525, or about two-thirds. In another case, also conducted by the same Association, the Preston authorities have now offered to reduce the assessment of the National Electric Supply Company, from £1,095 to £675, but this offer has been declined, and an appeal to Quarter Sessions is intended.

Dividends, Gas and Electric.—In a letter to *The Times* on the commercial progress of electricity, Major Flood Page writes:—"I can well believe that our gas company friends may say I am easily satisfied, that our dividends are paltry, that we live on hope, and, in the assurance of their own steady dividends, can laugh and pour contempt on our humble efforts. But our progress has been phenomenal when compared with that of gas. On May 13, 1879, Mr. Corbett Woodall, M.I.C.E., engineer-in-chief of the Phœnix Gas Company, gave evidence before the Parliamentary Committee to which I have already referred and said, 'As a rule in early years gas companies did not pay any dividend at all, or a very small one. Before coming away I sought to find the dividends paid by my Company since 1824. I was unable to find them up to 1851, but I believe they never reached 3 per cent. before 1851.' That is, for 27 years. Surely we have good ground for hope."

The Bolometer.—In the report of the Smithsonian Institute for the year ending June, 1893, it is stated that Prof. Langley has continued his important investigations with the bolometer. The instrument, as now constructed, is a minute strip of metal barely $\frac{1}{500}$ of an inch wide, and less than $\frac{1}{5000}$ of an inch thick. Through this thread of metal a current is continually kept flowing. When the spectrum, visible or invisible, is thrown upon it, the thread is warmed and the resistance increased by an amount corresponding to the intensity of the effect received, while instruments specially mounted and constructed are in electric connection with the thread, and now automatically record every minute change in the current. With late improvements these instruments are so delicate that a change of temperature of one-millionth of a degree is readily detected and even measured, and it is easy to see that, as a consequence of this delicacy, the greatest care must be taken in their use.

Viscosity Test.—For testing the viscosity of lubricating oil, the following apparatus is in use on the Philadelphia and Reading Railroad. A cylinder, 2 in. by $1\frac{1}{2}$in. long, is suspended in the oil to be tested, by means of a fine steel wire attached at its upper end to a knob inserted in a stiff frame. By twisting this knob the wire can be subjected to torsion. About the middle of its length the wire has attached to it a horizontal disc, graduated in degrees, which rotates with the wire when the latter is turned, and serves to measure the angles of oscillation. In making a test the oil is surrounded by a bath of water or paraffin to bring it to the required temperature. The disc on the wire is clamped, and the knob at the top turned through an angle of 360°. The clamp holding the disc is then released, and the torsion in the wire causes the cylinder immersed in the oil to move through angles which become less at each succeeding oscillation. These angles are measured by the disc, and form a criterion of the viscosity of the oil.

Electrical Communication with Lightships.—On Saturday morning telephonic communication was opened up between the North Goodwin lightvessel and Ramsgate. In this case the distance is much shorter than that between the Kentish Knock and the shore, being only a little over five miles; but, as this lightship practically commands the Goodwin Sands, her electric connection is likely to prove of much service in affording the means of giving information at the earliest possible moment of casualties in the vicinity of the sands. The arrangements for carrying the electric cable clear of the ship's moorings are in all respects similar to those adopted for the Kentish Knock. The electric cable is taken ashore at Dumpton Gap and then connected with the Ramsgate Post Office. The ships engaged in completing this second lightship were the Post Office cable-ship "Monarch" and the Trinity steamers "Vestal" and "Warden." The Goodwin lightvessel is probably the most perfect and complete specimen of a lightship afloat.

A Big Opening for Small Arcs.—The enormous importance of the ease of sub-division which was afforded by the invention of the glow lamp, says the *Electrical Engineer* of New York, under the above heading, "can be no better brought home to economists than by adverting to the well-known fact that for the same amount of electrical energy expended, the arc lamp produces 10 times as much illumination as the incandescent lamp, and yet the incandescent lamp has triumphed. With this condition of affairs confronting us, it requires no great amount of discernment to predict that the next step towards improvement in arc lighting must be in the direction of arcs of small power, say, from 50 c.p. up." Our American contemporary then proceeds to pin its faith on the "Howard arc enclosing cylinder," which we gather is a device for reducing the rate of consumption of arc light carbons, and points out what can be done in the way of arc lighting on constant potential circuits by instancing the 2,700 lamps now burning in Brooklyn, with 400 more waiting to get on the central station circuit.

Royal Institution.—We have received further particulars of the arrangements for lectures at the Royal Institution during the present session. The following lectures on electrical and allied subjects will be given on Friday evenings:—"Electric Discharges Through Gases," by Prof. J. J. Thomson, on April 13th; "The Splash of a Drop and Allied Phenomena," by Prof. A. M. Worthington, on May 18th; "The Work of Hertz," by Prof. O. J. Lodge, on June 1st; and "The Newtonian Constant of Gravitation," by Mr. C. V. Boys, on June 8th. Courses of lectures will be delivered during the session as follows:—Four lectures on "Electric Illumination," by Prof. J. A. Fleming, on Tuesdays, April 3rd to 24th; three lectures on "The Modern Microscope: an Instrument for Recreation and Research," by the Rev. W. H. Dallinger, on Tuesdays, May 22nd to June 5th; three lectures on "The Solid and Liquid States of Matter," by Prof. Dewar, on Thursdays, May 3rd to 17th; and three lectures on "Colour Vision," by Captain Abney, on Saturdays, May 5th to 19th. The lectures on Fridays commence at nine o'clock in the evening, and the lectures in the courses commence at 3 p.m.

Electric Motors on H.M.S. "Barfleur."—On Saturday, the 10th instant, the battleship "Barfleur" went through her trials. The gun mountings and barbettes of the "Barfleur" are precisely of the same character as those of her sister ship "Centurion," which were tested at Portsmouth on January 4th. In view of the long-expressed desire to simplify as much as possible the handling of the guns, the primary principle of the design has been hand operating throughout; but, as in this case the extreme range of elevation from −7deg. to +35deg. gives a large angle to work through, Messrs. Whitworth and Co. have, in conjunction with Messrs. Siemens Brothers, applied electric motors for the purpose of elevating the gun and actuating the ammunition hoists as an auxiliary to the original hand-power. The trial of these motors attracted considerable attention, as the "Barfleur" and "Centurion" are the first English ships on which such motor appliances have been introduced for operating large guns. The "Capitan Prat" for Chili and the "Jauréguiberry" for the French Government, as well as the "Latouche Tréville" and her sister ships, have been or are being fitted with electricity as a motive power. The current is taken from the electric lighting main. The motors are "ironclad" and watertight. There is a motor provided for each operation—one under the sighting stations for elevating the gun, and connected by gearing with the hand-elevating appliance; while another is placed on the turn-table, and works the ammunition hoists. By means of the electric motors the guns can be moved through the angle of 42deg. in 14sec., and the charges brought to the rear of the gun in 19sec. The motors were used in the fore-barbette on Saturday with such satisfactory results as to afford a promise of their extension to all guns of a like nature.

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Sheffield Electric Power Station.—Last Saturday week the new electric power station of the Sheffield Electric Light and Power Company was formally opened. The station is erected in three spans, covering an area of 2,060 square feet. Two spans are allotted to the engines and dynamos, the third forms the boiler house. The walls are lined inside with glazed brick. The present plant includes four Mordey alternators, rope-driven from separate vertical steam engines. In the boiler house there are five Babcock-Wilcox boilers, each capable of evaporating 5,000lb. of water per hour. The tubes are of Mannesmann weldless mild steel, instead of the usual lap-welded wrought-iron type. There is also an economiser which will deal with 3,000 gallons of water per hour. Over the boiler house is erected a tank holding a reserve of 20,000 gallons of water. At one end of the boiler house is a horizontal compound jet condensing engine belted to a countershaft supplying power to three Thomson-Houston arc lighting machines. Each machine will maintain 50 10-ampere lamps in series. The steam mains are 15in. internal diameter, and of wrought steel lap-welded, and are in duplicate. All the engines exhaust into a main exhaust trunk, 12in. diameter, to which is attached an independent condenser. Any engine may be shut off from the exhaust trunk, and relief valves are provided for the engines to exhaust into atmosphere if required. All the alternator fields are excited in parallel. Each exciter carries its own automatic switching gear and electrical governor. All the alternators feed into one pair of bus mains. Each alternator has its own synchronising pillar, with switching gear. The primary circuits are concentric, insulated with vulcanised rubber, and drawn into 3in. cast iron pipes. The arc light circuits are concentric and of paper insulation lead covered. The secondary circuits are laid in iron troughs, and filled in with solid bitumen.

Petroleum in Somersetshire.—It is now some time, says the *Engineer*, since paragraphs began to appear in the daily press concerning the find of petroleum in Somersetshire. The presence of petroleum in the house well at Ashwick, which has suddenly found itself famous, is no new thing. The first considerable outburst which received attention was during the long drought of last year, and immediately subsequent to a slight earthquake shock. Evidence of the occurrence of this outburst has been collected in as trustworthy a form as possible. The spirit of impartial inquiry in which the investigation was conducted was rendered specially necessary by two facts, viz., that the well is situated in strata not usually considered to be petroleum bearing, and that the oil itself is not of the quality commonly characteristic of crude petroleum. The whole matter first passed into expert hands when a small sample of the oil was submitted to Mr. Boverton Redwood some months ago. With regard to the geological situation of the oil, it may be said that the carboniferous limestone in which the oil is found has not hitherto been identified with the occurrence of petroleum. The chemical characteristics of the oil are also different from those of most crude petroleum, the samples examined more nearly resembling a distillate of the crude oil than crude oil of normal quality. The high specific gravity and flashing point of the oil detract somewhat from its value as an illuminant. In spite of this drawback, it is probable that in distilling the oil some 75 per cent. of good burning oil could be obtained. Moreover, there is an increasing demand for high-flash petroleum for small motive power. Of the good quality of the Ashwick oil there can be no doubt, and the value of its discovery consequently depends upon its abundance. With all the facts before us we are of opinion that the quotation of English petroleum in "prices current" is a somewhat remote contingency, but that no stone should be left unturned to bring that possibility about.

Electrically-Actuated Valves.—In an interesting Paper on "Artificial Refrigeration through Street Pipe Lines from Central Stations," which recently appeared in the *Journal* of the Franklin Institute, the author, Mr. Branson, expresses himself as follows:—"In the matter of automatic control we had to solve the problem of supplying all degrees of temperature, not only on the same branch line or street, but often three or four in one building, or even in the different compartments of one refrigerating box, varying from ice-making and fish-freezing up to the very easy task of keeping rooms for furs and woollen goods free from moths, or taking a few degrees of heat and humidity from a restaurant dining-room, a public hall, business office, or hospital. To do this, numerous devices were invented and tested—nearly all with brilliant success at the start, only to be followed by dismal failure when put to the test of time and innumerable changing conditions. They choked up, froze up, gummed up, and broke up in every imaginable way. But one by one the weak points were weeded out, the strong features combined; until, finally, two forms of regulators were constructed, both of which have stood the test of every possible condition we could think of through the changing requirements of spring, summer, autumn, and winter. These automatic valves are operated by electric power supplied from a dynamo through a storage battery at the central station; thence through an insulated copper wire circuit laid in the same conduit which contains the pipe line, and they are caused to open and close by the action of an ordinary thermostat placed in the cooling box and easily adjusted by thumb screws to any required temperatnre. We ordinarily set them to open the valves at 1deg. above and close them at 1deg. below the average temperature required; though, with careful manipulation, they can be adjusted so as to permit of much less variation. In the preservation of eggs, for instance, we do not permit a variation of more than one-half of 1deg.; and, as a consequence, have had remarkable success in the preservation of this most perishable product. In connection with the automatic valve the electric circuit can be used to signal from any refrigerator on the line to the engineer at the station; and one form of valve is so constructed that, if it should get out of order, an electric bell would ring in the engine room until the valve is attended to."

The Use of Electricity in Metallurgical Operations.—In a recent number of the *Comptes Rendus*, M. Jules Garnier states that he has carried out in the workshops of M. Hillairet some experiments with a view to utilising electricity for the purpose of observing the various phases of certain metallurgical operations, and, thinking his method might be generally applicable, he gave the following account of it to the Académie des Sciences:—I placed in a tube of refractory earth some powdered oxide of nickel mixed with charcoal, two soft steel rods penetrated into the tube at either end, pressing the mixture, the thickness of which was a few centimetres, between them. This arrangement was placed horizontally in a small reverberatory furnace heated by coke, whilst the two steel rods formed part of an electric circuit. At first the resistance offered was perfect, the current being zero with the voltmeters 50, but after 15 minutes heating, the needles began to move, the current gradually rising, and the voltage diminishing so that at one time there were nearly 50 amperes passing, and hence next to no resistance. After remaining steady for an instant in this position, the needles of the ammeter and voltmeter slowly returned towards their original position, finally becoming steady at one or two amperes, at about 45 volts. These variations of the current first in one direction and then in another exhibited the reactions which went on in the mixture of oxide of nickel and charcoal. To begin with, the mixture stopped the passage of any current; at the moment when the oxide was beginning to be reduced to the metallic state, the current flowed at first feebly, then more and more freely so that at the precise moment when the reduced nickel formed a sort of interrupted chain from anode to cathode, the voltage was zero. It was then that the carburisation of the metal began, a phenomenon was exhibited on the voltmeter and ammeter by the reverse movement of their needles. The resistance, indeed, became considerable at the moment when the particles of carburetted nickel, which are easily fusible, united together in globules. In another experiment, in which I operated on a mixture of oxide of copper and nickel of iron, in spite of the complexity of the mixture, the variations in the current only showed the successive phases in the reduction of the three metals. One of the consequences to be drawn by these experiments is that we can follow electrically the progress of a certain number of metallurgical operations, especially the refining of metals, the conducting powers of which vary as their composition is altered.

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ELECTRIC MOTIVE POWER.*

BY ALBION T. SNELL.

(Continued from page 519.)

Compensators or Regulators.

The Thomson-Houston Company use in particular cases a compensator, whose functions are similar to those of the "regulator," referred to in a previous portion of this series, with two-wire continuous-current feeders and multiple-wire distributors. It may be of use for power work in cases where the regulation of the supply pressure presents difficulties. The plan of connection is shown in Fig. 91, the "compensator" being simply a choking coil with its circuit divided into as many parts as there are sub-circuits. Each of the distributing circuits are assumed to be at 125 volts.

When the load is evenly divided between the circuits the choking coils will carry practically no current, owing to the impedance of its coils which are wound round soft iron wire. But if the load be removed from one of the four circuits, the compen-

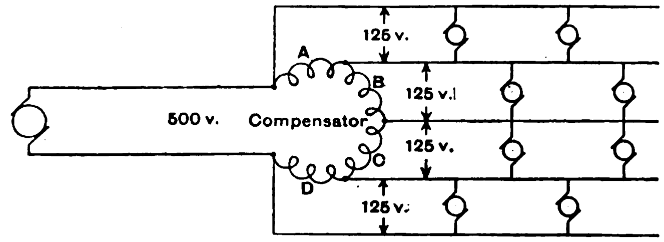

FIG. 91.—Prof. Elihu Thomson's "Compensator" system applied to a Power Circuit.

sator coil, say coil A, in parallel to it will act as the primary of a transformer, and induce in the remaining coils of the compensator B, C, D, a secondary current in the same direction as the main current. In this particular case the ratio of conversion will be 1:3, and therefore the coils B, C, D will supply $\frac{i}{3}$ amperes, i being the current for two motors (assuming them to be equally loaded), and the alternator will supply $\frac{2}{3}\,i$ amperes. If the two circuits A and B were opened then the coils C and D would supply $\frac{i}{2}$ of the current, and the alternator an equal amount. The regulating capacity of the compensator is therefore seen to be in this case equal to four times the current it is designed to carry. It is evident that small differences of load between the various circuits are readily compensated by this ingenious device, which may be defined as a combination of a transformer and a direct system of distribution.

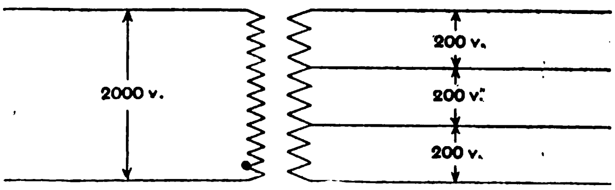

FIG. 92.

As far as the author is aware this method of multiple-wire distribution with alternate currents has not been applied to power work, although it has been used to some extent for lighting in America. The evident objection to it is that it brings the high pressure of the primary circuit into the consumers' premises, and, therefore, constitutes a source of possible danger. A better arrangement for power work, when it is desired to use a multiple-wire distributing system, is to divide the secondary circuit of a large transformer at the sub-station into as many circuits as may be required, and at suitable pressures for the work (they need not be of the same value) *see* Fig. 92. This separates the high-pressure mains from the distributing circuit, and the total secondary pressure can be made of any desired value. A transformer thus loaded will work as well as if the secondary circuit were not divided, and it will maintain the same ratio of pressure between the distributors, neglecting the drop due to the resistance, if the primary circuit, as a whole, adjusts the power according to the output. Difficulty, however, may be found if more than one transformer be used unless both the primaries are coupled in parallel, and also both the secondaries; or better still if the primaries are coupled in parallel, and the secondaries in series. This latter arrangement requires for four-wire distributors three transformers, the middle wires being coupled to the junctions of the secondaries.

It must be understood that these proposals offer no advantages as regards the transformers, they simply permit the use of a multiple-wire distribution, which is a point of some importance in power work.

Coupling Free-running Alternators in Parallel.

Before an alternator is coupled parallel it should be ascertained to be as nearly as possible in step with those already in circuit. The practical methods of judging this condition vary with the types of machines and their relative sizes and speeds, but in most cases there is no difficulty. If the alternators are of similar make, all that is necessary is to raise the pressure to the omnibus voltage and to notice that the frequencies are approximately the same before closing the

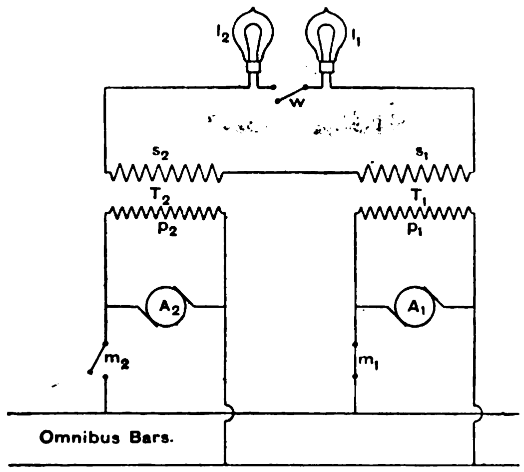

FIG. 93.—Diagram of Phase Indicator or Synchroniser.

parallel switch. At the instant of making circuit, there may be a comparatively large rush of current and then the bank of alternators will drop into step and the load may be adjusted between them, if necessary, by their excitation. The author has seen Mordey and Gülcher alternators put parallel without further precautions; but, of course, the lamps pulsated until the machines were in step.

It is customary, however, in most lighting stations to use a phase indicator. This consists of two transformers, one of the primaries being coupled to the alternator running the load, and the other to the incoming machine. The secondary circuits are coupled in series with two incandescent lamps of suitable pressure. The arrangement of details is as shown in Fig. 93.

The procedure is usually as follows:—The incoming alternator, A_2 say, is run up to proper speed and its field excited, so that it gives the terminal pressure of the omnibus bars. Sometimes it is coupled to the station lamps or an artificial resistance, but this is not essential in most cases. The synchroniser switch W is then closed, and the lamps l_1 and l_2, being fed with the joint currents from the transformers T_1 and T_2, will be black or luminous, according as the alternators A_1 and A_2 are in similar or opposite phase. The instant the two are in step the lamps will become steadily black or luminous (according to the coupling up of the secondaries), and then the main switch m_2 may be closed without disturbing the lamps on the outer circuit. During the short interval of time required for the machines to get into step, the lamps pulsate with luminous

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"beats" as the lagging machine overtakes the leading one. The synchroniser can be coupled successively to any pair of the alternators.

It is found convenient with the Ganz alternators, and most of the Continental alternators, to run the incoming machine on an artificial load to approximately the same current as it is required to give on the main circuit before using the synchroniser, and closing the main switch. This precaution seems to be only necessary with armatures of large self-induction, in which the terminal pressure varies considerably with changes of current. In England it is not customary to use an artificial load.

The Thomson-Houston Company insert a variable impedance coil in the armature circuit of the incoming alternator in order to check any in-rush or out-rush of current. The method of using these impedance coils with the synchroniser is shown in Fig. 94.

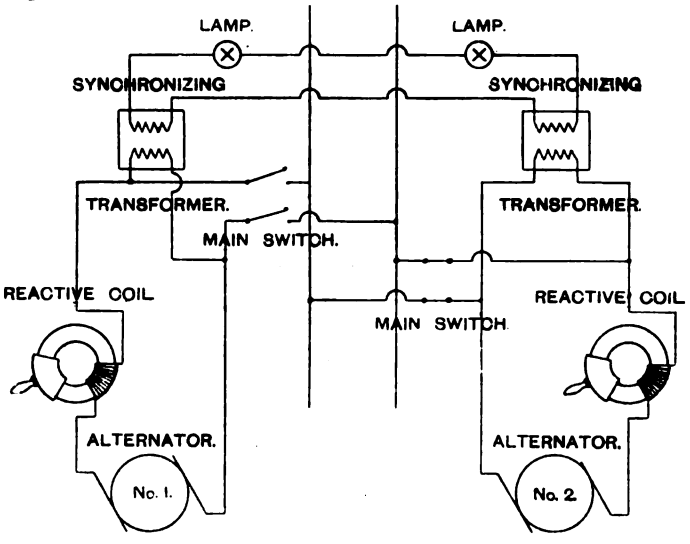


FIG. 94.—Arrangement of Reactive Coils, used in putting Thomson Alternators in Parallel.

The impedance coil is shown separately in Fig. 95. It consists of a laminated iron ring, with a few turns of well-insulated wire wound round about one eighth of the circumference. A copper sheath is arranged so as to be capable of rotation about the centre. The sheath is of such width as just to surround the coil. When the winding is covered, the device corresponds to a transformer with the secondary circuit short-circuited, and the impedance is then very slight; as the sheath is gradually removed the impedance increases; when the stationary coil is entirely uncovered the device has its maximum effect. In some forms the impedance coil is short circuited when the sheath completely encloses it These impedance coils are useful for balancing loads between machines, varying the pressure of feeders, and generally act the same as rheostats with continuous currents; but have the advantage of consuming less power.

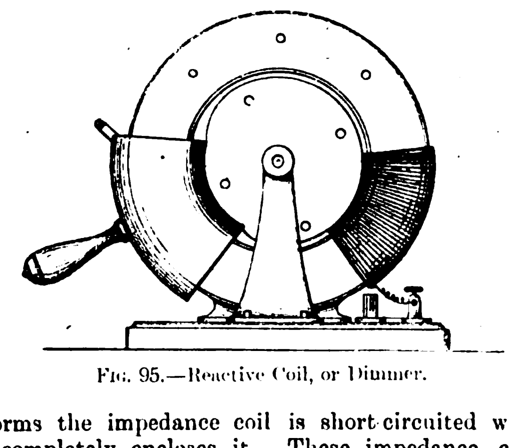


FIG. 95.—Reactive Coil, or Dimmer.

Parallel working is without doubt assisted by using a moderate rate of frequency, say, not more than about 100 ∿. but there is no gain in reducing it below about 50 to 60 ∿, It is also necessary to synchronise the engines as well as the alternators if the running is to be perfect. This points to high-speed engines with flywheels and moving parts of small inertia, so as to readily lead or lag as the conditions of working may require. For the same reason the engine should not be governed directly, as the better the governor the greater the difficulty of varying the rate of speed. The station governor should be designed to control the steam admission to the bank of engines, and the load should be distributed proportionately by varying the excitation. A "trip" governor should be used on all engines of this class to check racing in the event of a belt breaking or slipping off, a fuse blowing, or other similar accident.

Alternate-Current Measuring Instruments.

It has already been stated that the energy of an alternate-current circuit is proportional to the $\sqrt{\text{mean square}}$ value of the instantaneous values of the current, and it has also been stated that this $\sqrt{\text{mean square}}$ is equivalent to that of a continuous current that will produce the same heating effects. Therefore, alternate-current measuring instruments are calibrated by direct currents, and the readings on the scales are accordingly proportional to the $\sqrt{\text{mean square}}$ of either continuous or alternate currents. A few hints of a practical nature will assist engineers in selecting suitable instruments.

Precautions to be observed in Alternate-Current Working.

Owing to induction and capacity effects, it is usually necessary in alternate-current circuits to observe certain precautions in starting and stopping alternators, in opening and closing circuits, and in adding or withdrawing feeders from omnibus bars. It is proposed to suggest a few of the more common difficulties which may arise in practice. It must be recollected, however, that these effects are largely the result of the self-induction of the alternators, and that generally there will be no difficulty when the armatures have comparatively small reactions; as is the case with the Mordey Alternator, for example.

The chief danger to be apprehended is a sudden variation of pressure which may be sufficiently large to break down the insulation of the circuit at one or more points or to seriously affect the load. This is due both to the change of conversion ratio in the transformers and to the variations of impressed pressure in the alternators.

The precautions to be observed are:—

Never *open* a high-pressure circuit containing self-induction or capacity, without first slowing the alternator or weakening its excitation, or reduce the load by an impedance coil.

Never switch an alternator into parallel with another machine without first adjusting its excitation so that the *coupled* alternators will give the proper omnibus pressure.

Never switch an alternator out of parallel without adjusting its excitation (and that of the remaining machines if necessary) so as to leave the omnibus pressure unaffected.

An alternator of large self-induction requires to be excited to a higher pressure than that of the omnibus bars before coupling parallel as the terminal pressure will fall considerably when the circuit is closed. In taking such a machine out of parallel the excitation may be reduced until the current is nearly zero; or the speed may be lessened until the same end is attained. The switch under these conditions may be opened without a dangerous spark.

If, however, the conversion ratio of the transformers be effected by the capacity of the circuit (such as occurs with step-up transformers and concentric mains) then the incoming alternators with large self-induction must be under-excited in order to bring it into such a condition that it can be coupled to the active machines without affecting the pressure at the far end of the feeders; and conversely in taking it out of parallel, the excitation must be raised a little in order to avoid serious sparking on opening the circuit. These facts have been noticed in practice, and are explained by an alteration of the capacity and self-induction of the circuit affecting the conversion ratio of the transformer.

(To be continued.)

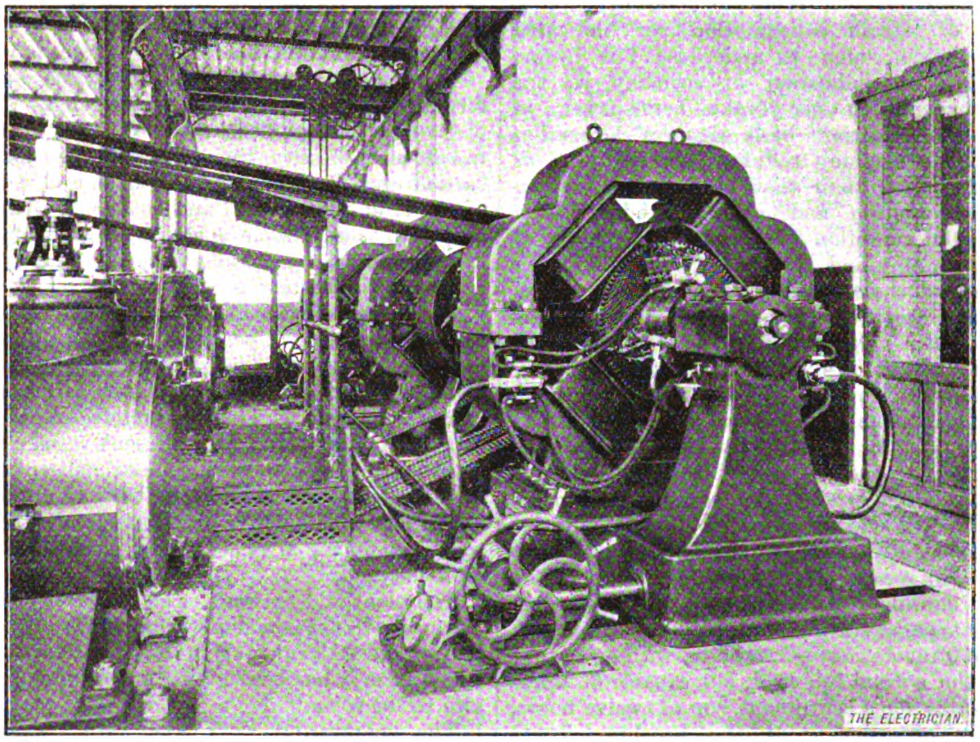
BRUSSELS CENTRAL ELECTRIC LIGHT STATION.

The electric lighting of the city of Brussels has been under the consideration of the Municipal Council for many years. The question of whether a concession should be granted to a company, or the enterprise be retained by the municipality in in its own hands, after having been much discussed, was eventually decided in favour of the latter alternative. Accordingly, in April, 1891, a general specification was drawn up and tenders were invited for a complete scheme of private and public lighting, the contractor selected to carry out the work being required to undertake the working of the station for two years, and to submit to heavy fines in the event of the actual working costs during this period exceeding their estimated costs.

Of the schemes submitted, including both alternating and continuous current plants, a three-wire low pressure distribution worked in conjunction with accumulators was selected; and on the 5th December, 1892, the India-Rubber, Gutta Percha and Telegraph Works Company, of Silvertown and Persan Beaumont, represented in Belgium by M. Boty, was entrusted with the execution of the contract, on the understanding that—as far as possible—all machinery, &c., should be constructed in Belgium. The site selected for the power station was that occupied by the old church of St. Catherine, Rue Melsens, in the lower part of the town, adjoining the main boulevard.

The station building includes a boiler and machine room on the ground floor, and on the first floor a battery room, repairing shop and stores over the machine room, whilst the coal store, water purifiers, and tanks are placed over the boiler room. The chimney is 190ft. high, and 8ft. 4in. internal diameter at the top. The coal store, of 200 tons capacity, being on the first floor; an electric lift has been constructed to convey the fuel to it. From the coal store the fuel is conveyed by suitable shoots to the stoke hold, these shoots being telescopic, so that they may be lowered to avoid the making of dust when coal is being discharged and raised out of the way at other times. The coal is hand-fed on to the grates. The water supply, both for condensation and feed, is obtained from the canal, which is distant about 350 yards, two 18in. pipes having been laid with a slight fall from the canal to a small reservoir under the machine room, to which are brought the suction pipes of the condenser pumps. A certain quantity of the condensing water, according to requirements, is pumped up to the water purifier, from which it is discharged into the main tanks. The water purifier, of the Dervaux type, is capable of dealing with about 2,500 gallons of water per hour, and the capacity of the main tanks, two in number, is about 22,500 gallons.

When complete the station will contain plant of 3,000 I.H.P., the unit adopted being a 500-H.P. engine driving two 250-H.P. dynamos. Provision is made for placing six such units, one being for reserve; but as the specification of the municipality stipulated that the machinery should be capable of working at 25 per cent. in excess of its normal full load, the ultimate maximum working capacity of the station may be taken as 3,000 H.P., not including reserve. The present boiler plant consists of three Babcock and Wilcox boilers, constructed by Brouhon of Liege, each of 2,440 square feet heating surface, and capable of evaporating 7,500lb. of water per hour with a good quality of Belgium coal. The boilers are of the usual type, working at 130lb. pressure, but with specially large grate surface (56 square feet) to allow of coke being used for firing, instead of coal. These boilers are fed by one Worthington pump, another being held in reserve, each pump capable of supplying to the boilers 2,600 gallons of water per hour. The feed water passes from the pumps through a Green's economiser, of which two have been provided, each of 2,160 square feet heating surface, and thence to the boilers. All the feed piping is in duplicate. All the steam piping is also in duplicate, two main pipes running across the tops of the boilers being carried through into the machine room, and running in a subway the whole length of it. Each boiler is connected to each of the two main pipes by a branch provided with a stop-valve; and a branch is taken from each main pipe to each engine.



Brussels Electric Light Station.—Engine Room; showing Dynamos, part of Engines, &c.

The machine room, which is 120ft. by 52ft. by 28ft., contains the engines, dynamos and switchboard, and is fitted with a traveller running its whole length, and capable of lifting 15 tons. To fulfil the stringent conditions as to the absence of vibration, a block of concrete, about 6ft. thick has been laid as a sub-foundation, which extends over the whole surface of the engine room, but is entirely independent of and isolated from the foundations of the building; and on this block the brickwork foundations for the engines and dynamos have been built; also separated from the walls of the building. The engines, two in number, are of Sulzer horizontal, side by side, compound condensing type, with adjustable cut-off supplied

by Carel frères of Ghent. The low-pressure cylinders are 40in. diameter, and the high-pressure cylinders 26in. diameter, the length of stroke being 4ft. The speed is capable of variation between 62 and 75 revolutions per minute, the higher speed being necessary for charging the accumulators. Each engine is fitted with two nine-grooved fly-wheels 20ft. in diameter, and weighing 20 tons. The most economical load for each machine is arranged at 400 H.P.; in order that over a range of 250 to 625 H.P. the consumption of steam per B.H.P. may be small, and a good efficiency be assured on the average working load throughout the year. For engines of a similar type, constructed by the same firm, tests carried on by the Association for the Supervision of Boilers, are said to have given the following results:—With an engine constructed for a normal output of 500 H.P. at 60 revolutions, when working at 138 H.P. with 84lb. pressure, the steam consumption on a test of eight hours was rather less than 13lb. steam per indicated horse-power-hour. With a similar type engine, 400 H.P. size, working at 85lb. pressure, and indicating 250 H.P., the steam consumption was 13·1lb. The same engine, tested $5\frac{1}{2}$ years later, had, it is said, a consumption of rather less than 14lb., working at 100lb. pressure and indicating 330 H.P.

With regard to these tests, it is to be observed—firstly, that the estimate of steam consumption per indicated horse-power in an engine which is under-loaded is by no means so satisfactory an indication of economy as the estimate of the consumption per brake horse-power, in any given time. The former basis ignores altogether the large proportion of engine friction, and merely shows an economy a little worse than that at full load, on account of extra condensation and other cylinder losses. When we take the consumption per brake horse-power at reduced loads we invariably find that it is very much higher than at full load, because the engine friction is practically constant. In the second place, it is to be observed that these tests tell us nothing about the performance of the engines at full load; and further, that the tests can only be properly appreciated when the details of the way in which they were taken are given. As they stand, the figures are so vastly superior to any practice in electric light engines with which we are acquainted, that we are quite unable to accept them on the mere statement of the Association to which reference has been made.

The engines are erected side by side with the cylinders at right angles to the length of the hall, and each engine drives two dynamos, by means of eighteen $1\frac{5}{8}$in. ropes. The dynamos, which are shown in the accompanying illustration, are of the four-pole type, shunt-wound with drum armature, running at 300 to 360 revolutions per minute, with an output of 145 kilowatts as the normal full load, but capable of working up to 180 kilowatts for a continuous run of twelve hours, without overheating or sparking at the brushes. These dynamos are carried on slide rails, to allow of the tightening of the rope drive as required, and are fitted with self-oiling bearings. They have been constructed, as also has the switchboard, by the Société Electricité et Hydraulique, to designs and plans supplied by the Silvertown Company. The switchboard, fitted for six pairs of dynamos, a battery of accumulators, and twenty-four feeders, is mounted on a gallery at a height of about 14ft. above the floor, so that the attendants have an uninterrupted view of all the machines. The general scheme of connection of the switchboard is as follows: each set of connections being the same for each pair of dynamos. The + pole of No. 1 dynamo is connected permanently to the − pole of dynamo No. 2, and both are connected by a cable, and a fusible cut-out to the neutral omnibus bar of the switchboard. The − pole of No. 1 dynamo is connected through a fusible cut-out and an ammeter to the fixed terminal of a two-way switch, by means of which the circuit can be made either on to the charging circuit of the accumulators, or on to the negative omnibus bar. The + pole of No. 2 dynamo is connected in the same way to the accumulators or positive omnibus bar. The exciting circuit of the dynamo is arranged as follows:—The + terminal of the shunt on dynamo No. 1, and the negative of No. 2 dynamo are permanently connected to the corresponding main dynamo terminals, and therefore to the neutral omnibus bar on the switchboard. The negative terminal of the shunt on dynamo No. 1 is connected to a switch fixed on the dynamo through which the circuit is connected to the negative omnibus bar, and adjustable resistance fixed on the switchboard being interposed to permit of variation in the exciting current. The + terminal of No. 2 dynamo is connected in the same way to the + omnibus bar on the switchboard. The shunt circuit switches on the dynamos are specially arranged to close the circuit of the shunt on that of an auxiliary resistance at the moment of rupture, to diminish the sparking and strains on the insulation.

For the main feeder circuits, 24 in number, each + feeder is connected through a separate adjustable main resistance and fusible cut-out with the + omnibus bar, the − feeder being connected in the same way to the − omnibus bar. The intermediate feeder is connected directly to the intermediate omnibus bar. To each distributing centre is led a three-core potential cable, 7/20 L.S.G., connected at one end to the three main cables in the distributing box at the "centre" and the other ends to a pair of voltmeters mounted on the switchboard, to indicate the pressure between the + feeder and the intermediate, as also between the − feeder and the intermediate. The pressure is kept constant on each side of the intermediate cable by varying the absorbing resistances in the main feeder circuits. The main resistance is of platinoid strip and fitted with contacts, to allow of separate adjustments of $\frac{1}{2}$ volt.

The accumulators, of the Julien type, are 140 in number, forming two batteries each of 70 cells. Each cell is capable of giving a normal discharge of 350 amperes for 10 hours, and in case of necessity the discharge may for a short time be carried up to 1,400 amperes without undue deterioration. The cases are of alloy of lead and antimony. The plates are widely separated, and ample space is left at the bottom for all material that may become detached during work. The total weight of the battery is 80 tons.

For the three-wire distribution each cable is drawn into a separate cast-iron pipe, with the exception of the potential cable, which is drawn into the same pipe as the intermediate cable. All the cables are continuously insulated, all joints being vulcanised. The conductors are of high-conductivity copper, 100 per cent. Matthiessen's standard, tinned and insulated with pure under-vulcanised indiarubber, taped overall, and the whole vulcanised together and strongly braided. The insulation resistance is 1,500 megohms per mile, tested in water at 60°F., after 24 hours' immersion and one minute's electrification.

The plant and network of mains having been duly examined and passed, the station was formally opened by the Burgermaster and Aldermen of Brussels on November 9, 1893, since which time it has been giving a continuous night and day service to the town.

The engineering work has been carried out under the superintendence of Mr. Stuart A. Russell, the contracting company's engineer; and the laying of the network and cables were carried out by Mr. Daubeny, the assistant engineer.

ON THE PROBABILITY OF IDENTITY BETWEEN SPECIFIC ELECTROSTATIC CAPACITY AND SPECIFIC ETHER DENSITY.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

The following simple consequence of Maxwell's electromagnetic theory of light may have escaped notice, or if noticed and already published, does not appear to have found its way into current literature.

Assuming that the magnetic permeability of ordinary transparent dielectrics is sensibly equal to that of the ether in free space, it was pointed out by Clerk Maxwell that as a necessary result of his electromagnetic theory of light, the specific electrostatic capacity of an isotropic dielectric medium should be equal to the square of its optical index of refraction for radiant energy waves of greatest length. This prediction is well-known to have been fairly well verified in quite a number of

transparent, solid, and liquid dielectrics, with notable exceptions in animal and vegetable oils.

But the index of refraction of a substance for a given wavelength is known to be the ratio of transmission velocity for such waves in free space to their transmission velocity within the body, and there is experimental evidence tending to show that it is the ether within a transparent substance which transmits light, and not the molecules of the substance itself.

The mechanism by which ether transmits radiant energy is not known, even though it be granted to be electromagnetic, especially since the exact nature of the ether is itself problematical, but Fizeau in 1859* first demonstrated experimentally that the velocity added to light traversing a moving transparent body was not the full component velocity of the body in the direction of luminous transmission, but a fraction thereof; namely, $(n^2-1)/n^2$, where n is the index of refraction. This experimental result was verified by Michelson and Morley in 1886.† The natural interpretation of this observation appears to be that the ether is denser within the substance of a body than in free space, and that this mean specific density must be the square of the index of refraction. Such a relation is in conformity also with the ordinary formulæ for the transmission of disturbance through material bodies; namely, $v \propto \sqrt{E/D}$.

If this indication of the Fizeau-Michelson-Morley experiments be admitted, it then follows that the numeric representing the specific electrostatic capacity of a body must be equal to the numeric representing the mean specific density of the ether in that body. Or in current notation, $v = 1/\sqrt{K\mu}$, and if $\mu = 1$, $n^2 = K$ and since $D = n^2 \therefore D = K$. If the ether possesses inertia, this deduction appears to favour the view that electrostatic displacement and stress are of kinetic nature, *i.e.*, that they involve motion, whirling, for example, of the ether particles. On the other hand, if the ether be devoid of inertia, the argument is, perhaps, reversed.

A further inference from Maxwell's verified theory and Fizeau's interpreted experiment is that crystals have different mean ether densities in different directions.

The following are a few specific ether densities according to the above view, and Klemencic's values:—

Air	1·000293
Hydrogen	1·000132
Carbonic acid	1·000492
Carbonic oxide	1·000347
Nitrous oxide	1·000579
Olefiant gas	1·000729
Marsh gas	1·000476
Carbonic disulphide	1·000450
Sulphurous acid	1·004770
Ether	1·003720
Ethyl chloride	1·007760
Ethyl bromide	1·007730

CORLISS COMPOUND ENGINES FOR ELECTRIC LIGHT WORK.‡

BY E. L. DEBELL.

The question of the utility of slow-speed Corliss engines for electric light work has been discussed at length among those interested in the subject, and a unanimous verdict has apparently not yet been arrived at. It is claimed by some that their motion is not steady enough for the work, while others believe they are suited for arc lighting, but not for the more sensitive incandescent lamp. Without attempting comparisons with other types, the writer will endeavour to give the conclusions arrived at from their use in the plant at Sheboygan, leaving such of you as are interested to compare them with results or knowledge obtained of the other types.

In our plant we have been running steadily for the past 15 months a Corliss cross compound, 24in. by 48in. high-pressure cylinder; two 46in. diameter low pressure; speed, 74 revolutions per minute; rated capacity about 650 h.p. We use a syphon condenser, supplied by a duplex pump with two 18in. steam and two 12in. water cylinders, 12in. stroke. We carry constantly 25in. of vacuum, which, however, can be readily increased to 28in. should the load be very heavy. When the load is light we consider it the best practice to keep it at 25in. and reduce the steam pressure.

A good Corliss engine of this size and type should handle its rated economical load on 18 pounds of water evaporated per horse-power-hour, and within a range of 20 per cent. above or below that point, or not over ½ pound additional. With good boilers properly fired and allowing 7½ pounds of water evaporated per pound of coal, this would equal 2 4-10 pounds of coal per horse-power-hour.

The first cost of the Corliss engine may be placed at one-third more than an equally well-made one of the high speed type, and it takes up about one-third more room. Its life, however, is generally conceded to be 50 per cent. longer, on account of larger wearing surface and slow speed.

The cost of attendance and oil and waste is practically the same as on any other good engine, while the cost of and the facility of making repairs seems to be in their favour. The latter feature is particularly true of the cross-compound, as the valves and valve gears can be readily overhauled in either cylinder without disturbing the other.

In the tandem compound, one cylinder being directly back of the other, the pistons and heads have to be removed from both to get at the cylinder next the engine frame. In an engine the size of ours it would be practically impossible to do this and make repairs between shutting down and starting time, which is a serious matter in plants depending upon one engine.

The cross-compound being connected to both ends of the shaft divides the wear between two sets of cranks, crossheads and bearings, while the tandem being connected to one end only the wear falls all on one set.

Another feature of the Corliss engine is that trouble usually develops slowly, in most cases giving warning of its existence in time to permit of the proper remedy before it becomes serious, sometimes saving a shut down of more or less duration.

The selection of proper sizes is a very important consideration, as the addition of an extra cylinder reduces the range of economy.

The load in nearly every electric light plant is so variable that one engine cannot do the work profitably, and it is probable that in most cases three engines of one size will give the best results. They should be large enough so that one will handle the light load, two of them the heavy load, leaving one always in reserve.

The cost of three engines will not be very much greater than the same capacity in one or two engines.

We are able to furnish a good light with our Corliss engine, and it is so regarded by our customers. At any time it is found otherwise the trouble is soon traced to some fault in operation and readily subdued. The conclusion we have arrived at is that these engines are well adapted for our work, economical in the use of fuel, durable and easy of repair.

* Fizeau. *Ann. de Chemie et Physique* (III.), Vol. LVII., p. 385, 1859.

† Michelson and Morley. *American Journal of Science*, Vol. CXXXI., No. 185, p. 377, May, 1886.

‡ Abstract of a Paper read before the North-Western Electrical Association, Milwaukee, January 18, 1894.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, March 30th.

ELECTRO-HARMONIC SOCIETY.

8 p.m. Smoking Concert at the St. James' Hall Restaurant.

MONDAY, April 2nd.

ROYAL INSTITUTION.

5 p.m. General Monthly Meeting.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture. "Photometry," by Capt. W. de W. Abney.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

8 p.m. Smoking Concert at the Palatine Hotel, Hunt's Bank, Manchester.

TUESDAY, April 3rd.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "Electric Illumination," by Prof. J. A. Fleming.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Monthly Ballot. The following Paper will be read: "The Construction of Gas Works," by Charles Hunt.

WEDNESDAY, April 4th.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Conversazione at St. Martin's Town Hall.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read: "The Elements of Beauty in Ceramics," by C. F. Binns.

FRIDAY, April 6th.

ROYAL INSTITUTION.

9 p.m. Friday Evening Discourse. "Destructive Effects of Projectiles," by Prof. V. Horsley.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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COAL AND "COAL."

Ever since the old school of engineers began to reckon the "duty" of engines in foot pounds, per pound, hundred pounds, or per bushel of coal, it has been recognised that the quality of coal varies widely in different parts of the country. The voltmeter and ammeter afford to the engineer of to-day means for measuring the output of an engine with an accuracy undreamed of by the older engineers, who reckoned the work done by their pumping engines the diameter, length, and number of strokes and lift. While they used to speak of millions of foot pounds, simply because half a dozen cyphers had to appear in the value, some engineers of to-day run to an unnecessary number of decimal places simply because long division is so easy. The corrections which must be considered if the third figure, that is, the hundredths of a pound of coal per horse-power hour, or per Board of Trade unit, is to have any value, would probably entail more work than all the rest of a coal test. It is the custom, whenever coal consumption is recorded, to disparage the coal. "Stuff that they call coal," "slack," "duff," "smudge," or some other ill-favoured word is used; on rare occasions a chemical analysis with a merry row of decimal places gives tone to the test, but as a rule we are merely told that the calorific value is so much per cent. of the best Welsh coal.

The scientific method would be to state the duty of an engine in watt hours per unit of thermal value, thus eliminating the quality of the coal. A more practical way would be to assume a standard fuel, and this, for international comparisons, should be carbon. The use of the "carbon value" of a fuel was first suggested by Prof. UNWIN. Thus, one pound of best Welsh steam coal is equal to 1·104lb. of pure carbon; one pound of average British coal may be taken at 0·987lb. of carbon; an average sample of coke is only worth 0·934lb. of carbon, while an average sample of patent block fuel is worth

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about 1·040lb. of carbon. Instead of quaint examples of local dialect, we should be simply informed that a kilowatt hour was obtained from the equivalent of so many pounds of carbon. To explain details of grate surface or stoking, the precise kind of rubbish may be described in suitably abusive terms.

In the first of two lectures delivered by Prof. A. B. W. Kennedy at the Finsbury Technical College in December last, the subject of boiler testing was considered from a thoroughly practical point of view. Many ridiculous reports have been made on tests of engines and boilers by engineers who, if ignorant of the principles as well as the numerous details which must be attended to in such work, were at the same time unconscious of their ignorance. We are glad to be able to give our readers a report of these lectures, and print the first one in our present issue. Tests of this kind consist in nothing more than scrupulous attention to carefully arranged details. No great skill or theoretical knowledge is necessary, and no expensive laboratory instruments and standards are required. The measure of efficiency of the plant of an electric supply station is for all practical purposes to be ascertained from the pounds of coal, or more accurately, the carbon value of the fuel, burned per supply unit sold. The relative cost of management is, of course, affected by the output of the station, but the fuel per unit has but little to do with the size of the station, though it depends on the conditions of working as shown by the load factor. Ample excuses have hitherto been found and granted for the greater coal consumption with alternate-current supply than with continuous currents; but now that the fixing of transformers in each house is admittedly old-fashioned, and the efficiencies of transformers have been greatly improved, it becomes the more important to discover where any waste of fuel may occur.

Useful work has been done by the Committee on Data, of the American National Electric Light Association, which has recently held its session in Washington. This committee exists for the purpose of collecting and comparing statistics of the cost of running electric power stations in the United States. It is particularly interesting to compare the figures given in its Report with the figures representing electric generating practice in this country. A list of 65 power stations, with the performance of each, accompanies the report; and it appears that an average of 91·7 watt-hours is obtained in these 67 stations for every pound of coal consumed. This is equivalent to 8·14lb. of coal per horse-power per hour, or nearly 11lb. per Board of Trade unit generated. The report further shows that where stations have been running continuously a very much higher coal duty has been obtained than where the loads on the stations have come irregularly. For example, in a station running the full 24 hours at fairly even load, 208 watt-hours per pound of hard screenings were obtained; while in a station doing an irregular service for 7 hours per day, only 85 watt-hours were obtained per pound of soft coal. The report also states that even in the best instances available the performance does "not compare favourably with the results secured in generating power for manufacturing purposes."

It is a pity that something more definite than the name of the class of coal used in each station could not have accompanied the report. A little, but nothing very exact, can be learned from such memoranda as "slack," "soft," "screenings," &c., which are tabulated under the head of "kind" of fuel. American coal is generally inferior to British coal, and it would be foolish to expect so high a duty from it. This will partly account for the large consumption of fuel per unit of energy generated, as compared with English results. On the other hand, in comparing American electric generating stations with American mills, all questions of fuel are eliminated. We may take it, then, that the American generating station engineer has a long pull and a strong pull to make before he can fully realise the best commercial duty of the fuel available to him. He seems to be troubled about small load-factors as much as we are.

THE TESTING OF ENGINES AND BOILERS.*

BY PROF. ALEX. B. W. KENNEDY, F.R.S.

Lecture I.—BOILER TESTING.

From the commercial point of view—that is, from the point of view of the engine or boiler user—the chief thing to be measured in connection with engines and boilers is naturally the ratio between the amount of coal used at one end of the scale and the amount of useful power obtained at the other end. Not forgetting that the working of engines and boilers entails expenditure in water, in lubricants, in stoves, &c., still the fact remains that fuel is the largest single source of expense which can be very certainly measured, and in which there is the greatest room for economy.

From our point of view we have to consider not merely coal and power—we must sub-divide the matter very much further. We must in the first place keep clearly separated the three matters: coal, steam, and power. We must, then, further remember that in each of these three sections a further subdivision must be made. In the case of the coal, for instance, we may have to distinguish between the total put on the fire and the total actually burnt, because really if all the coal that is put on the fire is not burnt, the remainder must be wasted. The steam, similarly, has to be divided into two parts, the total steam actually formed, and the portion of this steam which gets to the engines. Unfortunately it is quite possible to use steam pipes and valve chests and other parts of the engine as condensers only, and so to liquify a large part of your steam before it gets to the engines at all. Lastly, the power has to be subdivided into indicated power and useful power, because it is quite possible to have an engine which will waste as much in the difference between its indicated and its useful power, as may more than make up for any economical advantages for the use of steam, which it may have. I shall have something to say about each of these subdivisions, as we go on.

Looking now again at the three principal subdivisions we see at once that they give us to important ratios, viz., the steam per coal and the power per steam. The former is mearured as pounds of steam formed per pound of coal burnt, the latter is invested and measured as pounds of steam used per horse-power. The steam evaporated per pound of coal is the measure of the economy of your boiler alone. The steam used per horse-power is the measure of the economy of your engine alone. I have already pointed out that naturally the steam-owner may chiefly want to know the amount of coal used per horse-power, and this is the product of the other two ratios. Notwithstanding the practical importance of this, still for any purposes of testing, it is absolutely necessary to measure the two ratios separately, otherwise it is impossible to say whether any defect is due to the engines or to the boilers, or to say whether either by itself is working to the greatest advantage.

Perhaps no measurement of any kind is quite so simple as it appears at first sight, and to-night I am going to speak to you mainly about the first section of the work, that is to say, about the method of measuring the steam evaporated in a boiler by a certain weight of coal, in other words, about methods used for testing boilers. Now, although, of course, the great matter is to ascertain the weight of the water and coal accurately, this of itself is not sufficient, for two reasons. In the first place the coal is or may be of very varying quality, and it is no use for

* Two lectures delivered at the Finsbury Technical College, Dec., 1893.

the purpose of comparison to put together an evaporation by good South Welsh coal, and another by the sort of rubbish that you get in Scotland; it is necessary to have some standard of comparative value. Secondly, it is not sufficient merely to weigh the water going into the boiler, because, as you know, it requires much more heat to evaporate water to a high steam pressure than to a low one, so that we must have a standard for the value of steam.

Leaving this for the present, let us consider the standard for value of fuel. Several have been proposed, before examining them let me first remind you of the constitution of coal by writing down a typical analysis of a Welsh coal:—

Carbon	87·8 per cent.
Hydrogen	4·1 " "
Ash or incombustible matter	2·2 " "
Nitrogen, sulphur and oxygen	4·9 " "
Water (moisture)	1·0 " "
	100·0 per cent.

An analysis of this sort, of course, can only be determined by a chemist. Examination of it shows at once that coal consists of practically only two combustibles—carbon and hydrogen. The ash is not only no good to us, it is altogether undesirable. The water, of course, is absolutely no good. Of the other constituents, sulphur is the only one which has any thermal value. Our work is seldom so extremely accurate throughout as to justify us in taking the calorific value of the sulphur into account. Let us omit it, therefore, and take only the carbon and hydrogen into account:—

	Thermal units.
The thermal value of a pound of carbon is	14,500
That of a pound of hydrogen	52,500*

And the thermal values corresponding to the percentages of the combustibles in our sample are:—

	Thermal units.
Carbon	12,700
Hydrogen	2,130
Add these together and the thermal value of the coal is...	14,830

Now what have we got to compare this with? I need not spend time in telling you of all the proposed standards, and will simply say that the only one which appears to me really satisfactory is the thermal value of 1lb. of pure carbon. Measure the coal in terms of its "carbon value," a most useful expression, introduced, I believe, by Prof. Unwin. Treat the coal first as *dry coal*, deducting the water, much of which may be present merely accidentally. This would bring the value given above to 15,000 thermal units. The "carbon value" is then, of course, simply 15,000 divided by 14,500, which is = 1·034. In other words, the value of the coal is in this case 3·4 per cent. above that of pure carbon.

It may occur to you that it is rather a discouragement from the engineering point of view to suggest that at the very start we depend on the chemist. I fear I cannot help it! But note that there are three ways in which you can estimate the value of coal. The first and best is, of course, by having an analysis made, unless you can make it yourself. The second method is by the use of a calorimeter, that is to say, making a direct experiment on the thermal value of the fuel without analysing it. A calorimeter of a very practical kind is on the table, and Mr. Legros has kindly undertaken to explain it to you after my lecture. It is an apparatus in which a sample of coal can be burnt perfectly, and the heat which a definite weight gives out in combustion accurately measured. That will not, of course, tell you anything about the analysis, but it will give you the final figure (as 14,830 above) as the thermal value for the coal, and the apparatus is one which can be placed in the hands of an engineer. Or thirdly, very often you can find out from where the coal was got, what pit it came from, &c., and then find out from the numerous published analyses that of the particular coal in question.

Whether for analysis or for calorimetric determination you must make sure that you have a fair sample of your fuel. This is a thing which cannot be obtained without a little trouble. I

* This is the value of perfectly-burnt hydrogen, *exclusive* of the latent heat of the water formed in combustion, which passes away, of course, as vapour, not as liquid.

of the whole bulk of the fuel used. The whole quantity must afterwards be broken up and reduced to powder for final sampling.

Coal Measurement.—On one or two trials I have had the luxury of having the coals weighed beforehand into bags, each bag numbered and labelled ready for use. In 19 cases out of 20, however, you will have to weigh your coal as the trial proceeds. You should, therefore, have a weighing machine on the stoke-hole floor, or close to it. The coal is conveniently weighed in wheel-barrows, and the arm of the steelyard in the weighing machine should be set so as to correspond to an even weight of coal, plus the weight of the barrow itself. You should always weigh the coal itself to an even figure, and keep on weighing and tipping the coal down on to the stoke-hole floor as it is wanted. There is no rule for the amount that should be weighed at one time. It is often convenient to let it be such as will keep the stokers going for half-an-hour. I have, however, known cases in which there was nothing for it but simply keep on weighing continuously; in an ordinary boiler trial, however, there is no pressure of that kind. From 100lb. to 400lb. at a time, according to the size of the boiler, is generally the figure. Have a log sheet ready prepared, somehave on my own trials made it a rule that with every lot of 2cwt. or 3cwt. a handful is pitched on one side of the stokehole. Altogether these portions may amount to 40 or 50 pounds, and are fairly representative under ordinary conditions thing in the following form, for the purpose of marking down the coal as it is used.

Number of barrows.	Time started.	Time finished.	Total coal on fires.

I do not apologise for giving you such details as these headings, as it is most important for the log sheets to be thoroughly convenient. Let me point out one thing here, do not write down 10:5 in the time column; it is very apt to be misleading. Put 10:05. You must never have any mistake about your times. It is important to remember, as you will see at once on plotting a coal line, that the starting times and the finishing times form two completely separate series of observations. You may probably not finally use, or plot, both, but it is advisable to have both logged, as one is an excellent check on the other. One definite rule affects these observations, as all others, and it is simply this, that having once been started the observations must go straight on from beginning to end. Do not let the observer be flurried or bothered by anything extraneous to his work; let him simply write down at once any special circumstance that occurs, without in any way discontinuing the particular set of observations which he is making.

One question occurs at the start. How long are we going to go on? What shall be the duration of a boiler trial? As to this there is, of course, no absolute rule, but I should say that as a minimum, under very special circumstances, and in the hands of those who are very much accustomed to make boiler trials, you might get one in six hours, but that from eight to ten hours is the proper minimum. It is only after making a very great number of trials that you can shorten it. One occasionally hears of boiler trials which last two hours, or less. These are absolutely and entirely valueless, even when they are not simply frauds. No engineer who was at the same time both honest and experienced would ever put forward figures based on such trials. If you wish to get a really average boiler result, in such a case as that of an electric lighting station, a period of eight or ten hours is much too short, you will probably have to make the trial 24 hours or even 48.

Water Measurement.—There are three ways of doing this. You can, in the first place, measure water by meter, and on the wall I have shown the arrangement of meters which was used for measuring water on board the paddle-steamer "Ville de Douvres." It was a trial carried out by the Marine Engine Committee of the Institution of Mechanical Engineers. In this case we had duplicate meters and such an arrangement of pipes and valves as would enable us to run either meter in case of a breakdown of the other. Under ordinary

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circumstances this is quite unnecessary. The meters used in this case were those of my namesake, Mr. Kennedy, of Kilmarnock, and are very satisfactory. But there are other meters—the Schönheyder meter, for example—which are well adapted for measuring large quantities of water. You cannot always get a water meter, however, and it is often a good deal of trouble to check it. There are then still two ways open to you. One very simple method is to weigh the water through a small tank placed upon a weighing machine, letting it run from this into a reservoir tank from which the feed pump takes its supply direct. The object of having this auxiliary tank is that your feed pumps may work continuously, otherwise you would have to stop while you were filling up the measuring tank. The method is a very good one, for the scale on which you weigh can easily be checked by standard weights. In some of the largest feed-water measurements which have been made, viz., for the engine trials of the Marine Engine Committee of the Institution of Mechanical Engineers, we used simply two measuring tanks, emptying and filling them alternately. At their sides were glass water gauges of their full depth. The top of each was made slightly conical, and carried an over-flow pipe 1½in. diameter open at the top. These tanks serve to measure enormous quantities of feed water. Nothing, of course, is directly weighed, the tanks are simply filled up alternately until they overflow at the top. If you use this method—the volumetric method—of measuring feed water, you must, of course, have previously checked the capacity of the tanks carefully by weighing water into them, at the right temperature, for which purpose it is convenient to use a standard ten-gallon can such as I have placed on the table.

The log sheets required for water measurements by the first method may be something like this:—

Time.	Number of weighed tanks finished.	Level in auxiliary tank.	Total water to boilers.

Of course, practically, you will keep the level in the auxiliary tank always the same. If you are going to use the double-tank method, you really want something like this:—

Right-hand tank. Number.	Time.	Left-hand tank. Number.

In a case of that kind, where you have to measure feed water continuously and "against time," you cannot have your log sheets too simple. You use simply numbers, and refer them to right and left hand, about which there can be no mistake. In the case of marine engines, such as those on the "Ville de Douvres," the water is going back to your boiler, surface condensed, and the level in the boiler ought to be constant except for the unavoidable loss of water. In ordinary land boilers the engine has no condenser, or if it has, it has not a surface condenser, and the water is therefore discharged to waste, so that the steadiness of the water level in your boilers depends on your stoker. As it is rather a nuisance to have to correct for the alterations of the water level, it is convenient to adopt the following methods: First, make the stoker keep the water a little too high, especially at the time when you have finished a tank. Stop the pump when the auxiliary tank is right, and then take for the time at which the measuring tank is finished the moment when you see that the water level has fallen to the proper point in the gauges.

This point must, of course, have been marked at the start, and it is not to be forgotten that the glass should be blown out before reading it. For marking the level, you can either tie a little bit of yarn round the glass so that the stoker can see it, or jam a piece of chalked wood between the nuts and make a good black mark on it. Do all you can to make the stoker keep his level as near right as possible continuously, and also to stoke as regularly as possible. You will then have the happy result that after the minimum time has passed, your trial cannot be wasted whatever happens. There is another thing to be done before the trial is started, namely, to go round and examine all the pipes, pumps and tanks and the boilers themselves, and to see that they are all tight, note all joints that are at all doubtful, and in any case where possible leakage might spoil your results, do not hesitate for a moment to use blank flanges. Look out for blow-off cock leaks. See that the boiler itself is not leaking anywhere, if you can possibly get at it. Make quite sure that the fittings and the feed pipes are not leaking. Of course, it is no use testing if the boiler is in bad order. During the trial do not let the safety valve blow off.

I think that after all these preliminaries we may now begin our trial. I remember there used to be a great deal of fuss made about the starting and finishing of a trial; it was thought to be necessary to draw all the fires and re-light them at the start, and then at the end to burn them down until they had practically gone out. This is unnecessary. Make sure that the boiler is at work two hours or more before the trial begins, the longer the better, so that everything may be hot and in normal working before you begin. After everything thus has been in full work for a time, then a little before you wish to begin (say, 10 or 15 minutes), stop stoking altogether. Clean up your stoke-hole floor and your ash pit. Necessarily your pressure will begin to drop. When it has dropped, say, 10lb., if you are working at 150, 5lb. if at 100, that is, when it has dropped so much that the fires cannot keep the work going any longer, mark the level on the water gauges, note the pressure, and commence the trial, calling this moment the time of start. (The full load must have been on the boiler all this time.) Note whether your feed pumps are on or off at the start—it is perhaps better that they should be off. As soon as the time of start has been definitely marked down, commence stoking your first lot of weighed coal.

When you come to the end of the trial do not try to finish at a particular instant fixed beforehand. Finish as you started, in this way:—Having made up your mind for a trial, say, of 10 hours, find out how long each weighed lot of coal lasts you, let us say half an hour. Then, when you have run for 9½ hours simply refrain from putting any more coal on the floor. Let the stokers make what they can of the last weighed lot. See that you keep the pressure as long as possible steady. Eventually, of course, it must go down, and the instant when it has fallen to the point at which you started is the real end of your trial, although, of course, except by chance, it will not be exactly 10 hours. By this means you have ensured that the fires at the end are as nearly as possible in the condition in which they were at the start. At the end of the trial the water level should also be the same as at the start, but sometimes it requires a little dodging with the pumps to get both the coal and the water measurements to finish exactly at the same time. In case it has proved impossible, as it sometimes does, to get a good start with your coal and a good start with your feed water at the same time, you can always get the average of each with sufficient accuracy from the plotted results, if your log sheets have been properly kept, and if your trial is of sufficient duration.

We may take it that we have now measured the total water and the total coal, and are able to standardise the latter. As to the standard for water you have simply to reduce the quantity that you have actually evaporated to the corresponding quantity, supposing the evaporation had taken place from and at 212°F. In general you will find that you have to multiply by 1·1 or 1·2 in order to bring the water to standard.

You have measured how much coal was actually put on the fires; how much has been actually burnt is got at by sampling the ashes and clinkers afterwards, and carefully finding out how much combustible there is left in them. It is quite possible that the waste material sent away as incombustible may be twice the weight of the ash, which would correspond to the original analysis of the coal. This, of course, means that you have wasted so much good burnable stuff, in addition to the real incombustible matter in the fuel.

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The next question is, Did you evaporate all the water as steam, and not pass it away as water, because you must not credit your coal with evaporating anything which simply passed as water into the steam pipes? To find this out it is necessary to measure the priming, if there be any. There are two or three methods of doing this. In the United States, I believe, an apparatus is often used which is really a steam superheater, and the amount of wetness in the steam is determined by passing it through a narrow orifice, and measuring the rise of temperature above that of saturation. This method has several drawbacks. One is, that it is very difficult to measure accurately the increase in the temperature of the superheated steam. Another is, that extremely little is known of the properties of steam when only slightly superheated, and that the constants used in the determination have been calculated rather than found experimentally. But even if the method could be trusted it would not really give priming, but only *wetness*, which is quite another matter. Steam may be wet because of condensation in pipes, or other such causes, and yet there may have been no priming whatever. I have often found this to be the case, and the distinction is, of course, a very important one.

There is another and a very old method, which consists of blowing a certain quantity of the steam to be examined into a vessel of water, measuring its increase of weight and its increase of temperature, and calculating the wetness (for here again the priming proper is not determined) from these data. I have found this to be a most difficult and unsatisfactory method, and do not believe that under ordinary conditions it is possible to get anything by it beyond a general indication as to whether wetness is practically absent or is excessively large. The quantity looked for is so small, and the measurements are so liable to error, that the method is, in fact, quite useless.

The method which I have most often used myself (not that it is by any means perfect, but because it is the best I know of) is one for which the apparatus is on the table, and which will be shown by Mr. Burstall after the lecture. During the trial samples of steam are passed through a little surface condenser, and so collected as water, and taken away. An equal number of samples of water are taken out of the boiler at the same times as the steam samples. Use is made of the fact that chlorine can be detected in solution when present in very minute quantity by means of its reaction with silver nitrate solution in the presence of potassium chromate. The quantity of chlorine required is so small that in general it is unnecessary to add salt to the boiler water, but where this is extremely pure an addition of as much as 2lb. of salt per ton, or 0·1 per cent., is sufficient to enable the test to be carried out with an accuracy of within 0·5 per cent. in the determination of *priming*. If silver nitrate solution is added to a solution of any chloride in water, in the presence of potassium chromate, a white precipitate of silver chlorine is formed until no chlorine is left in solution. Immediately after the whole of the chlorine is precipitated silver chromate is formed, which is a deep red-coloured precipitate. The change of colour is very well marked, the addition of one drop of the solution of silver nitrate used being sufficient to produce a marked change of colour. As the addition of silver nitrate proceeds an indication of the degree of completeness of precipitation of the chloride is given by local reddish colouration, which disappears on shaking or stirring, some silver chromate being formed and decomposed on meeting the remaining chloride on mixing. If equal volumes of the steam and water samples are then treated with the silver nitrate solution the relative volumes of standard silver nitrate solution required to produce the red colouration will indicate the quantities of chlorine in the two samples, and therefore the amount of the boiler water which has been carried over as priming, so that if the boiler water required 100 c.c. of silver solution to produce the red colouration, and the same volume of condensed steam required 1 c.c. to produce it, then the quantities of chlorine present are as 100 to 1, and the priming is 1 per cent. It will be seen that the strength of the standard solution does not come into the results, the quantity of priming being read off on the scale of the burette used. The test is, as far as it goes, absolutely accurate, but it has two drawbacks: first, that it is very difficult to sample the steam, and, secondly, that it is not easy to sample the water. You can sample the steam by putting a little bent pipe (with its nose turned towards the steam) into the steam pipe, but you do not know that the steam obtained through this represents the average of the steam, and it is open to this objection. To sample the water in the boiler is also a little difficult, because you cannot say absolutely that the water taken from the gauge, and therefore near the surface in the boiler, fairly represents the average of that contained in the boiler, but it is most likely to be this water that is thrown up in priming. If you find 1 per cent. of priming by the test you can only say that it is about that amount, but if you find no salt present in the condensed steam you can say definitely that there is no priming, and this may be the case, although the steam at the engine is found to be very wet, owing to condensation in the steam pipe.

We may now assume that the total coal burnt and the total water evaporated have been measured, and further that by reducing both to standard we have been able to measure the thermal unit which the coal ought to have given up in its combustion, and the thermal unit which the water actually has taken up in its heating and evaporation. The ratio between the two quantities of heat is the "efficiency of the boiler," of which the value may be anywhere between 60 and (exceptionally) 80 per cent. There remains, therefore, a balance of 40 or 20 per cent. with which we have not as yet dealt. Clearly until we have found where this has gone the test cannot be considered complete. As to this, I can only in a few words point out where you have to look for it. First of all, most of it has gone up the chimney. For every pound of coal burnt you have probably sent 20 lbs. of gases up your chimney and away to waste. But this huge weight of material does not go up the chimney of its own accord. You must expend some energy to send it up, and this is the heat which carries it off. The exact determination of this quantity of heat is to a large extent a chemical matter. First, clearly you must find the weight of the gases. To do this you must sample them during the trial and then have them chemically analysed. When you have got their chemical composition, you can easily find the proportionate weight of the carbon in them. You already know the weight of the carbon which was put on the fire, and as this is the carbon which has gone up the chimney, it is only a matter of arithmetic to find from it the total weight of the gases. If for instance you have burn five tons of carbon, and you find, by analysis, that 4 per cent. of the total weight of the gases is carbon, then clearly the weight of the gases carried up the chimney is sensibly equal to $(\frac{100}{4} \times 5) = 125$ tons.* The rise of temperature of the chimney gases you can measure. It is not perhaps, quite easy, however, because it is very difficult to put your thermometer in such a place as to get the real average temperature of the chimney gases. Further, if that temperature be at all high, it is not easy to get a thermometer to measure it. An ordinary mercury thermometer would not do. I have used a thermometer in which there is compressed nitrogen over the mercury. You can measure temperatures up to 900°F. with such a thermometer, and at present I believe it is the best ordinary method available. No doubt, it will be superseded presently by thermo-electric methods. Let me caution you against one thing if you are measuring the furnace gases, take care of air leaks! Brickwork is very apt to prove anything but solid with a considerable difference of pressure on its two sides, and air holes and cracks only too often exist. This is a matter which has to be most carefully examined before you can at all make sure that the gases which you have got in your samples are not mixed with air that never went through the furnaces at all!

The second cause of waste is one that is clearly avoidable. It is that the carbon is not completely burnt to carbonic acid, but has partly passed away as carbonic oxide. This you can also only find out from a chemical analysis.

The third cause of waste is that you may not have burnt some of the coal at all, that your ash and clinker carry away a

* I have said here "sensibly equal," because in an exact calculation the question of the steam in the gases (formed by combustion of the hydrogen) must be considered. This matter would take me beyond the present limit altogether.

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lot of combustible matter with him. This I have already mentioned. To find out how much this waste is you have to sample and analyse your ash, and find out how much combustible there is in it, again a chemical rather than an engineering process.

Lastly, there remains the continuous loss by radiation from the front of your boiler and all parts of its setting. I have made various attempts to measure this loss directly by finding the amount of coal which must be burnt in the boiler simply to keep the pressure up without any steam being made, but I must say, reluctantly, that the method is not a trustworthy one, and I do not know how to measure the radiation of a boiler. It may very often be a matter of 8, 10, or 12 per cent. As a matter of fact it comes in in the "heat account" really as a difference only, a quantity "unaccounted for," but necessary to make the heat expended tally with the heat taken away.

In my next lecture I shall have to speak of methods of testing *engines*.

ON CATHODE RAYS IN GASES UNDER ATMOSPHERIC PRESSURE AND IN EXTREME VACUA.*

BY PHILIPP LENARD.

(Continued from page 577.)

Cathode Rays in Vacuo.

12. When a discharge tube is exhausted to the highest degree the electric discharge is unable to pass through it. It is impossible to produce cathode rays in a perfect vacuum. It is, therefore, equally impossible to decide the question with an ordinary vacuum tube, whether the pressure of matter is necessary for the propagation of rays or not. But if we transfer the perfect vacuum from the discharge tube into the observing space, the corresponding experiment can be performed. Experiments to be detailed further on (18) showed that at moderate exhaustions in the observing space rays can be separated which increase in sharpness and length with decreasing pressure, and are affected by the magnet. For the highest vacua the apparatus was given the following form (Fig. 6):—

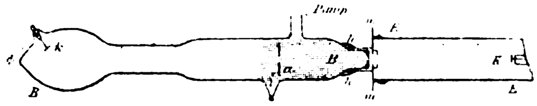

FIG. 6. (One quarter Size.)

To the windowed wall *m m* of the discharge tube E E (part only shown) is soldered the metal case *h h*, into which the glass tube B B, designed to enclose the observing space, is cemented. The tapered and cemented end of this tube is reduced to an aperture of 1·7mm., and over it is stuck the window (as usual, aluminium foil 0·0027mm. thick). The opening in *m m*, which before carried the window, is now free, and allows the rays to fall upon the window, while they are cut off by its cementation. This arrangement offers the advantage that the tube B B to be completely exhausted is not closed by any cementation except the inevitable fastening of the window. Into this observing tube are introduced the electrodes *a* and *k*. The electrode *a* is an aluminium disc, nearly filling the cross-section of the tube, and provided with a central hole 2·5mm. in diameter; it is also used as a diaphragm for cutting off some rays. The electrode *k* is a small disc of aluminium. The tube is joined to the same Geissler air-pump which also exhausts the discharge tube, but both spaces may be separately closed by cocks. The observing tube maintains the highest vacua unimpaired for hours, even when the discharge tube is filled with air. Hence the window must afford a perfectly tight joint. A case and screen are attached to the discharge tube as before.

If in the first instance the exhaustion in the observing space is about equal to that always maintained in the discharge tube, *i.e.*, equal to that used in Crooke's experiments, the following phenomena were observed. Between the window and the electrode, *a*, with the hole (now only acting as diaphragm), the whole glass wall glows bright green, while in the interior of the tube no light is perceptible. The green phosphorescent light of the glass also extends a little beyond the electrode, and penetrates a little into the tube leading to the pump, as shown in the figure by cross-hatching, and as required by a rectilinear propagation of cathode rays in all directions from the window. The window itself glows in the usual manner (3). From behind the electrode *a* up to the end of the tube the glass is dark except a pretty sharp patch Φ at the extreme end, about 9mm. across. Between the two electrodes *a* and *k* the air glows faintly blue.† If we bring a magnet near the observing tube, the distribution of the glass phosphorescence is altered, notably through the migration of the green patch Φ. If the south pole of a horse-shoe magnet is in front of the tube, and the north pole behind it, the patch is displaced downwards; on reversing the magnet it is displaced upwards. If the patch falls upon the electrode *k* it becomes invisible. The displacement of the patch is largest when the magnet is held between the diaphragm *a* and the window near the tube. The patch then approaches *a* pretty closely, and at the same time the glass phosphorescence is concentrated in front of the diaphragm more towards the side on which the patch falls.

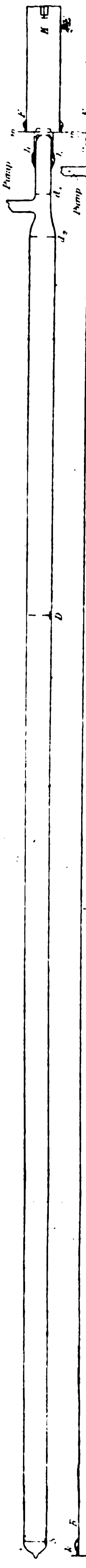

FIG. 7. (One quarter size.)

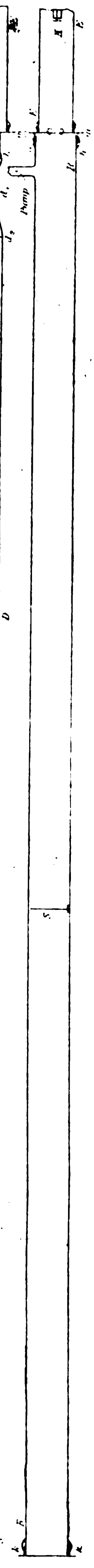

FIG. 9. (One quarter size.)

After the elimination of the greater portion of the turbid air, the rays have thus become nearly rectilinear, and have been propagated to much greater distances (30cm.) nearly without loss of intensity. Their behaviour in all cases, including that of the magnet, was quite the same as that characterising cathode rays in ordinary discharge tubes under equal exhaustions. Now, the chief interest of the experiment lies in the decision whether on further exhaustion of the observing space a reversal will take place, as it would if the discharge tube were further exhausted, viz., whether the glass phosphorescence will decrease in intensity and finally disappear. We disconnect, then, the discharge tube from the pump, and further exhaust the observing space alone. At the same time we connect the induction coil with the electrodes *a* and *k* of the observing space, to make sure that that exhaustion is reached at which reversal takes place. It takes several hours before the exhaustion is so far completed that the ringing impact of the mercury upon the cock of the air-pump indicates extreme exhaustion. At the same time the discharge between *a* and *k* becomes intermittent, the glass phosphorescence under the cathode *k* only flashes out now and then and in a few places, and shortly afterwards the discharge only takes place on the outside, in sparks running along the glass wall between *a* and *k*. The observing space is now exhausted so far that the reversal takes place, that it is impossible to *generate* cathode rays in it. If we now connect the induction coil in the usual manner with the discharge tube, we have the same phenomena as before in the observing space. Only the blue glow of the air between the electrodes is now absent; the interior of the observing space is now quite dark. The phosphorescence patch at the end of the tube can, therefore, be observed all the more easily. It is, perhaps, somewhat better defined than before, but not less bright. Between the diaphragm and the window the glass also glows very brightly. The deflection by the magnet is, in direction and estimated amount, the same as before. Granted the impossibility of *generating* cathode rays in this vacuum, yet that fact is no impediment to their *propagation*. The rays, also, do not introduce any perceptible amount of gas into the observing space; after the experiment the vacuum is entirely unaltered, the discharge between *a* and *k* failing, and the sound of the mercury in the pump being the same as before.

* *Wiedemann's Annalen.*

† As will be shown later on (17), this glow has no direct connection with the cathode rays.

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13. In a yet more perfect and successful manner the same experiment was performed as follows:—The brightness of the glass phosphorescence just observed led me to expect rays a metre long. The glass tube enclosing the observing space was now made 1·5m. long, and 2·5cm. wide (Fig. 7). It was provided with a window, and joined to the discharge tube as before, only the window now had a double thickness (0·0045mm., instead of 0·0027mm., as before); it closed perfectly air-tight. The observing tube was without any ground joints or cocks blown on to a Tœpler-Hagen air-pump; the connecting tube was 1cm. wide. The Geissler pump now only served the discharge-tube. To exclude any disturbing reflection of the cathode rays at the somewhat long tapered end of the observing tube (near the window), two diaphragms of zinc, d_1 and d_2, with central openings 3mm. in diameter, were permanently fixed in the observing tube at distances 6cm. and 12cm. from the window. Thus only a small pencil of rays is produced, which proceeds along the axis of the tube, and only meets its walls near the end. From this pencil a movable zinc diaphragm, D, with an aperture of 2·1mm., picks out yet narrower rays, which are observed on the movable screen S as bright circular spots. The movable diaphragm is shown in Fig. 7*a*, natural size (perspectively); its base *e e* is a bent piece of sheet iron, which can be moved up and down in the tube at pleasure by means of a magnet. The phosphorescent screen* is similarly equipped.

After exhausting the observing space and freeing the glass walls by repeated heating from the larger portion of the condensed gases—an operation which took several days—the pump, in spite of intervals of a quarter of an hour between one stroke and the next, only showed gas bubbles which were too small to fill the section of the capillary into which they passed from the pump vessel. For some time further it was possible to urge these bubbles into the expansion of the capillary by various artifices, but after that the efficiency of the pump had reached its limit. But

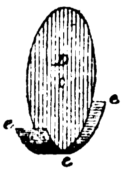

Fig. 7a. (Full Size.)

even this exhaustion, which was certainly higher than that attained in the previous experiment, offered no difficulty to the passage of the cathode rays. They were to be observed in remarkable purity, intensity, and definition. While the walls of the observing tube and its interior remained perfectly dark behind the first diaphragm, the phosphorescence patches on the screen were very bright and were in all positions of the diaphragm and he screen of the same size and definition, as might have been expected in the case of light radiated from a surface as large as the window. Only the strong deflection of the spots by the magnet indicated that the latter was not the case. As an example, we will give the diameters of the patches as found on the average when the diaphragm was placed at a distance of 50cm. from the window.

Table I.

Distance between screen and window.	Diameter of patch.	Calculated diameter.
Cm.	Mm.	Mm.
60	2·5	2·9
70	2·5	3·6
80	3·0	4·4
90	4·8	5·1
100	5·3	5·9
110	6·0	6·7
120	7·0	7·4
130	8·0	8·2
140	7·8	8·9
150	10·0	9·7

By the side of the observed diameters of the phosphorescence patches, in the third column, are placed the diameters as calculated under the assumption of rectilinear propagation, *i.e.*, the diameters of those circles to whose points straight lines lead from one point, at least, of the window surface (diameter, 1·7mm.) through the opening of the diaphragm (diameter, 2·1mm.).† It is seen that the observed patches are almost all a little smaller than the calculated ones, a circumstance which may be explained by the intensity decreasing gradually to zero at the margin of the patches, and which I have found to happen in the same manner in measuring patches of light. In a perfect vacuum, therefore, the propagation of cathode rays is not sensibly different from that of light.

It is to be noted that the patches did not always appear centrally on the screen, that often indeed they had to be brought on to the screen by the approach of a magnet. This is, however, not surprising, if we bear in mind that the iron supports of the diaphragm and screen acquired alternate permanent magnetism during use, as was shown by testing with a magnetic needle.

In this experiment also I tested whether the continued passage of cathode rays might be attended by increase of gas pressure in the observing space, but such an increase was not discovered. The volume of the small gas bubbles to which the 1,140 cubic cm. of the pumping vessel had contracted was estimated as before at 1 cubic mm., when a mercury column of 10mm. stood on these bubbles, communicating on the other side with the barometric vacuum. The gas pressure remaining in the observing space in this experiment comes out, therefore, as 0·000009mm. of mercury, or $0{\cdot}01 \times 10^{-6}$ atmosphere. The pressure of the mercury vapour from the pump at the temperature of the room would have been much larger (0·001mm.). But in this case the phosphoric acid tube between the observing space and the pump, together with a large empty sphere attached near the pump, was cooled down to − 21°C by a freezing mixture, so that the mercury vapour in the observing space could only have the pressure corresponding to this temperature, *i.e.*, 0·00002mm.*

14. We see, therefore, that cathode rays are also propagated in spaces which only contain matter in those states of extreme tenuity in which all its known effects vanish. Not to the traces of matter —whose more or less perfect removal was indeed without influence— but to the ether alone, which we are not able to banish from any space, must we therefore ascribe the causation of the intense effects

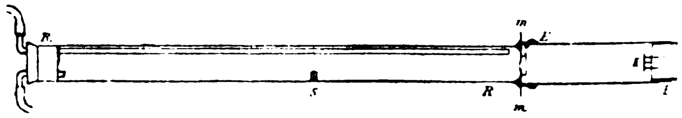

Fig. 8. (One quarter Size.)

observed. If this be granted, our experiment concerning the nature of the cathode rays will decide in favour of their being occurrences in the ether. This view is well known to have been adopted some time ago on other lines of reasoning by E. Wiedemann (*Wied. Ann.* 9, p. 159, 1880; 10, p. 251, 1880; 20, p. 781, 1883), and Hertz (*Wied. Ann.* 19, p. 816, 1883). It is also contained in Goldstein's views concerning the nature of electric discharges (*Wied. Ann.* 12, p. 264, 1881).

Cathode Rays in Various Gases.

15. The permeability of different gases for cathode rays is very different; it shows a connection with the densities of the gases. If coal-gas issues between the window and a phosphorescent screen, a perceptible brightening is noticed, best when the screen is already so far away from the window that it just remains dark in pure air. If the screen is to remain dark in the case of the coal-gas, it must be removed further from the window. The transparency of this gas, which is so opaque for infra-red and ultra-violet light, is truly surprising.

On filling the whole observing space with the gas to be tested, the results become purer, and the limiting distance of the screen from the window at which its luminosity just ceases gives a relative measure of the transparency of the gas investigated. For the performance of such experiments the glass tube R R, Fig. 8, 40 cm. long and 3cm. wide, is attached to the window wall, *m m*. At the other end it is closed by a stopper with two holes, through which are introduced a long and a short glass tube, as shown in the figure. The heavier gases are introduced through the lower and shorter, the lighter gases through the upper and longer tube, until they have completely displaced the air. From that time all gases enter by the long tube, so as to ensure having pure gas between window and screen. The screen S is again magnetically movable (13), Fig. 8*a* shows its natural size as seen from the window. On the window side it is completely covered with aluminium foil, so as to exclude all deception by light, especially the phoporescent light of the glass tube. Over the aluminium

* The ketone paper described in (4) can safely be employed, as special tests indicated—and this experiment confirms it—that the cathode rays separated from the electric discharge do not produce the usual decompositions accompanied by the evolution of gases.

† The diameters of those smaller circles, which are illuminated from all the points of the window surface would increase from 2·2mm. to 2·9mm. from the top to the bottom of the table.

* Calculated by Hertz's formula, *Wied. Ann.* 17, p. 198, 1882. Only after using the freezing mixture did the interior of the tube remain dark. This experiment was made in the summer; in the previous experiment (12) it was very cold, and the luminosity of the air disappeared, as stated, after simple exhaustion. The last trace of luminosity, or, as will be seen further on, the last trace of conductivity of the space, appears therefore to depend upon the presence of mercury vapours

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lining is also laid a mica strip, *g g*. The screen is observed from the uncovered side, away from the window, and is alternately displaced and irradiated until the black shadow of the strip of mica, and hence the illumination of the screen altogether, has just vanished. This limiting position may be fixed with astonishing definition; by approaching it by 1mm. towards the window, traces of the mica shadow may be made to appear on the screen. This assumes, of course, that the cathode rays issuing from the window have constant initial intensity; that, in fact, the conditions of production are the same. Amongst the conditions of production special attention must be paid to the vacuum in the discharge-tube;* it was so adjusted that between the spheres, B (Fig. 1), now always placed 3cm. apart, sparks passed every now and then. This applies to all the following experiments, where nothing else is specified. The distances from the window of the screen in its limiting positions, read off on a strip of paper attached to the tube, are termed "radiation lengths" for the various gases (mean values).

Table II.

Gas.	Density.	Radiation length.
Hydrogen	1	29·5†
Nitrogen	14·0	6·5
Air	14·4	6·0
Oxygen	16·0	5·1
Carbonic acid	22·0	4·0
Sulphurous acid	32·0	2·3

The gases are arranged according to increasing densities. As is seen, this arrangement is also that according to increasing absorption. Large differences in density are attended by large differences in radiation length, and in accordance with the small differences between the densities of nitrogen, air, and oxygen we have only slight differences in radiation length. But that these differences do really exist I have proved to my satisfaction by repeated comparison of the three gases. Coal gas also ranged itself in the series, showing much longer rays than nitrogen, but not any lengths approaching hydrogen. Whether the air was free of dust, carbonic acid, or steam, or whether it was at rest or moving through the observing space, made no perceptible difference.

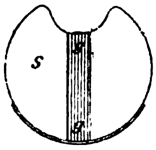

FIG. 8a. (Full Size.)

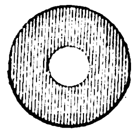

FIG. 9a. (Half Size.)

All the gases were illuminated by the cathode rays, like air (3). the light in this case is also limited to the vicinity of the window, and in hydrogen, for instance, does not extend anything like so far as the phosphorescence effect on the screen; in carbonic and sulphurous acids the light sheaf is very small, being larger in the less absorbing gases. Colour differences have not been observed in the various gases, but the apparatus is really little adapted to the purpose, owing to the bright phosphorescence of the glass walls. The much more visible luminosity of the window itself was always the same, in accordance with the explanation given above (4). The aluminium covering of the screen remained dark at all distances, and in all gases.

16. With increasing exhaustion the transparency of the gases increases; with great exhaustion the differences between the gases vanish. The transparency is again judged by the radiation length, but the observing space is arranged for exhaustion, and is made much longer and wider (Fig. 9). A glass tube 1·5m. long, 4·5 cm. wide, is cemented into a cup soldered to the window, and closed at the other end by a metal cap; a connecting tube leads to the Tœpler-Hagen pump. (The discharge tube is, as usual, connected with a Geissler pump). From this connecting tube another tube branches off, which terminates in a mercury valve (the lower part of a Bottomley‡ connecting piece), so that observing space and pump are closed against the air, and can also be connected with gas-generating apparatus without opening to the air. Everything closes tight enough to maintain the high vacua specified below. The phosphorescent screen, S, is constructed just as before; only its aluminium covering had now to be chosen especially thick, so that the observing space, 1·5m. in length, should be available for the higher exhaustions; this amounts to the use of a less highly phosphorescent screen. The covering consists of four aluminium films of 0·0133mm. total thickness (five times that of the window, 38 times that of aluminium foil). Across it is again fastened a strip casting a shadow.

As we exhaust the observing space through the various stages, find in each case the limiting position of the screen, and note its distance from the window as radiation length, we obtain for air and hydrogen the following table:—

Table III.

Air.		Hydrogen.	
Pressure.	Radiation length.	Pressure.	Radiation length.
mm.	cm.	mm.	cm.
760·0	2·35	760·0	10·6
331·0	4·53	335·0	21·1
165·0	8·38	167·0	32·4
83·7	12·1	88·0	38·8
40·5	17·1	42·2	56·1
19·3	27·2	20·3	74·9
10·0	49·5	10·3	96·8
2·7	73·0	3·3	122·0
0·78	107·0	0·65	125·0
0·074	127·0	0·065	126·0
0·019	140·0	0·030	131·0
0·0083	133·0	0·0164	130·0

It is seen, firstly, that the radiation length, and hence also the transparency, steadily and strongly increases with decreasing pressure; secondly, that it finally reaches the same limit in both gases. While the gas pressure is counted by millimetres of mercury the greater transparency of hydrogen is always strongly marked (approximately equal pressures are placed side by side in the table); but when the pressure has decreased to hundredths of a mm., the difference between the two gases has disappeared, and at the same time further exhaustion remains without influence. The differences of the radiation lengths contained in the last four lines of the table are not larger than their probable error, which I estimate at 5 per cent.* It is evident that the latter radiation lengths are no longer determined by the infinitesimal absorption due to the gaseous residuum, but the disappearance of the rays at the distances indicated is now only due to their rectilinear propagation in all directions from the window, according to which their intensity varies inversely as the square of the distance. In other gases it will be seen (18) that the transparency increases with diminishing pressure, whilst the differences between the various gases disappear.

How extraordinarily absorbent is air, and even hydrogen of ordinary pressure, will be gathered from a comparison of the lowest with the highest lines of the table: 130cm. radiation length in a vacuum, only 2cm. in air, and 10cm. in hydrogen. Quantitative conclusions derived from such observations will be more fitly reserved for a special communication to be devoted to absorption; but I might here introduce the observation forming the basis of such conclusions, viz., that the radiation lengths of the table are not perceptibly influenced by the presence of the glass walls of the observing space, that in fact they would not have been different if obtained in an open observing space. For two reasons the influence of the tube walls is thinkable. In the first place, the walls may, with a curvilinear propagation of the rays, make the screen appear darker than if they were absent, since they intercept a portion of the curvilinear paths between the window and the screen. Again, the walls might brighten the screen by reflection of the cathode rays. The first effect is only to be expected at higher pressures of gas (*see* 18); the second must, therefore, show itself in its greatest purity at the lowest pressures. To decide concerning the presence of an appreciable influence, a movable aluminium foil partition (Fig. 9a) was placed between the window and the screen, which, nearly touching the wall of the tube, left free a central hole 17mm. wide, *i.e.*, less than half the width of the tube. Let this partition at first be close to the window, where it must be quite ineffective, and let the screen be brought near its limiting position, where it only just distinctly shines out. If we now move the partition closer and closer to the screen we cut off more and more curvilinear paths from the window to the screen. Yet at first no distinct darkening of the latter is perceived. It is only when the partition has traversed more than half the way towards the screen, *i.e.*, when it also begins to cut off rectilinear paths, that it darkens the edge of the screen. The experiment was performed with equal success in air of 117, 15, 2·8 and 0·035mm. pressure.

* The E.M.F. of the accumulators feeding the induction coil was very constant, and was tested at regular intervals by means of a glow lamp.

† In my first communication, *Berl. Ber.* 1893, p. 7, this length is given as only 20cm. I had then not yet paid much attention to constant initial intensity. Under the precautions adopted, I have never, even in repeated experiments with constantly renewed hydrogen charges, obtained such a short radiation length.

‡ Bottomley. *Proc.* Roy. Soc., 40, p. 249, 1886.

* This comparatively great uncertainty is not attached to the limiting position of the screen, but is due to slight periodic variations of the initial intensity of the cathode rays connected with the state of the mercury interruptor.

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At the three higher pressures the darkening of the screen edge was blurred, at the lowest the partition cast a nearly sharp, circular shadow. This experiment shows, at the higher pressures, that curvilinear rays (although actually present) have no perceptible effect upon the screen in its limiting position. At the lowest pressure, where the rays are already rectilinear, the experiment shows that reflected rays are likewise imperceptible. For when the partition is midway between window and screen it casts into shadow the portion of the tube wall lying behind it up to the screen (as may also be seen by the absence of the glass phosphorescence), so that this portion cannot reflect at all. At the same time it prevents all rays reflected from the unobscured portion of the tube nearer the window from reaching the middle of the screen; yet this centre does not appear obscured; it is only the edge which shows the shadow of the partition. The assumption above enunciated is therefore proved (compare also the experiment (4) with the glass and tinfoil tube).

(To be concluded.)

LEGAL INTELLIGENCE.

Wise v. Metropolitan Electric Supply Company.

This action, which relates to alleged vibration caused by the Manchester-square Station electric-lighting plant, came on for hearing before Mr. Justice Stirling on Tuesday, March 13th. Mr. Graham Hastings, Q.C., and Mr. Beaumont appeared for the plaintiffs, and Sir Richard Webster, Q.C., Mr. Phipson Beale, Q.C., and Mr. Vernon Smith for the defendants. Mr. Graham Hastings opened the case for the plaintiffs, and called witnesses in support of his statements.

Prof. SILVANUS THOMPSON, examined by Mr. Graham Hastings, stated he attended at Mr. Wise's house, 43, Manchester-street, on November 16th last, Prof. Kennedy and Mr. Bailey, the defendants' engineer, being present at the time. There were ten machines in the station. No. 1 was still, and No. 10 was running light. The others were running and supplying current. The vibration at the house on that occasion was not nearly so strong as he felt it in the same house on subsequent occasions. Slight intermittent tremors were observable at Nos. 44 and 45. The time was about 6:45 p.m. They then crossed the road to No. 8, where he noticed a "howling" noise from the alternators. At No. 9, getting on for eight o'clock, there was a tremor which could be felt by leaning against the wooden partition. There was also a hum. His next visit was on December 14th, about six o'clock. He went to No. 43 first. In the second-floor sitting-room there was a perceptible tremor and an occasional rattle. Down to the basement there was nothing perceptible. In the back he noticed nothing; in the front nothing perceptible. In the cellar reaching out under the street the noise of the alternators was distinctly perceptible. Then he went across to No. 17, Mr. Grant's house, about 6:50 to 7. In the ground-floor front sitting-room there was a tremor perceptible; in the bed-room behind, the window rattled, though it was wedged up, and the "screaming" of the machines was perceptible in another building built out further behind the house. The next visit to No. 43 was on the 26th; the vibration felt on floor, table, and chairs of second floor front was most unpleasant. He went across to No. 17 at 5:37. The windows were rammed up with wooden wedges, so that the occupants could not open them. His next visit was on December 27th, it was earlier in the afternoon, at a quarter past 3; it was was a grey day, but it was daylight. He went to 43, Manchester-street. The second-floor front room was quieter than on any previous occasion, but tremors were perceptible in the floor and the table, and there was a slight rattle on the small side-board between the windows. In the third-floor front bed-roqm there was a slight rattle in the window, but the back bed-room was quiet. On the first-floor front room, the drawing-room, there was a tremor in the floor, faint, but quite perceptible. On the ground-floor front room, the dining-room, the window chattered incessantly, though fastened and tightly wedged. He then went across to No. 8, and he found faint tremors all over the house. He then went to No. 9. Similar visits with similar results were paid on December 23th, January 11th, and February 21st. On March 1st he inspected the Works to see what had been done in the way of alterations to the bed plates of the machinery, and the trench that had been cut. Before going to the Works he visited two of the houses, Nos. 43 and 17, and after the inspection he went back to them. Mr. Wise stated that the vibration was strong till 5 p.m. His next visit was on March 6th, to No. 17, at 4:34; to No. 43, Mr. Wise's, at 4:40; there was a perceptible vibration, but less than on any other previous occasion. He again visited the houses the same evening about 11:30. He went again the next day, March 7th, at five o'clock to No. 43, vibration was perceptible. He then went to No. 44, Mr. Leighfield's, and in the first-floor front room he found all the floor vibrating gently, the centre part strongly, the leaf of the palm-tree vibrating incessantly with an amplitude varying from an eighth of an inch to half an inch. He went down into the basement and crossed in the basement into No. 45. In the back basement, which had a stone floor, there was a sink inset in the back wall at a part where it appeared to be about 21in. thick. Standing on this sink was a small tub and the water in the tub showed a regular periodic ripple. The front basement of No. 44 was used as a parlour, he found the window rattling with intermittances of about nine seconds. He went across to No. 9; on the ground-floor front the floor was in vibration, which he found unpleasant when sitting in an armchair. On Friday, March 9th, he made some experiments with a phonograph. He had a little apparatus made, to enable him to distinguish as far as possible between any casual vibration due to motions in the house, and the kind of vibration that was set up by machinery, the continuous tremor. There was a pane of glass in a frame with a marble bullet held close to it on the end of thin wire. The little bullet could be set at various heights. One put this apparatus down in a house that was shaking and adjusted the stem until one found the position that responded best to the vibrations in the house. Then the little ball rattled against the pane of glass as long as there was regular vibration. As soon as the vibration died away the knocking of the bullet against the glass died away also, and a cab or even a heavy cart passing in the street could not produce any effect at all, because it required the repeated impulses coming one after the other to set the bullet in motion. He (the witness) then procured a phonograph to record the sounds. The records were in Court, so that his Lordship could listen to the tapping as recorded in the house. He made two records on the night of March 9th. One was in No. 46, the pane of glass being set up on the top of an iron safe standing in one corner of a room close to the wall. [His Lordship then listened to the phonograph records.] When he first went to the Manchester-square station on November 16th alterations were in progress. The bed plates originally stood on brick piers 12ft. high. They had now put them on iron cylinders intended to go 40ft. into the ground. He doubted whether what they had done would remove the noises and vibrations. In the first place, because the perpendicular cylinders passed through intermediate layers of sand, clay, gravel, and so forth, and unless they were isolated from the surrounding soil their vibration would certainly be communicated to the surrounding soil. In the second place, because, having regard to the very uncertain nature of the bottom there, he thought it extremely doubtful whether they had really got all the pillars footed on the same stratum. The fact that one could hear the actual sound of the station through the soil of the roadway showed that the soil admirably carried vibration.

Cross-examined by Mr. Phipson Beale, WITNESS stated he found differences not only in the same houses at different times, but between the different houses at the same time. He could not explain why in two houses, side by side, in two corresponding rooms he found the effect different. Something might be due, of course, to the structural defects of the house itself. He attributed the fact that a room that was comfortably quiet on one day was vibrating unpleasantly on another to some difference at the station. His impression was that upon his first visit to station the vertical columns at the station had all been put in. Witness had heard of alternators which made less noise than those at Manchester-square, though any alternator would probably make some noise. He thought the site of the station was unsuitable. They were not bound to put the station in the area at all.

The Rev. GEORGE WILLIAM SANFORD, examined by Mr. Beaumont, stated that he had from time to time stayed at either 8 or 9, Manchester-street (Mr. Gillam's houses) during the last ten years. He last stayed there in April, 1893, from the 11th to the 20th. He had had no reason to complain of the rooms before that time, but then the vibration was very serious. It varied considerably, but was practically always slightly perceptible. He had hitherto recommended Mr. Gillam's rooms, but would not feel at liberty to do so now without mentioning the vibration and noise.

Cross-examined by Mr. Phipson Beale, WITNESS said that he stayed at Mr. Gillam's before April of last year—in the spring of 1892—when the electric works were going. The annoyance then was nothing to complain of.

Mr. MACKENZIE, examined by Mr. Graham Hastings, said that he had stayed in Mr. Gillam's second floor, No. 8, for five years, from October, 1888, till October 29, 1893, when he left on account of the vibration, which he had noticed in the previous April had seriously increased.

Miss FLORENCE MARIAN COLLIER, examined by Mr. Graham Hastings, stated that she and her sister had stayed in one of Mr. Gillam's houses in Manchester-street from time to time during the last four years, very often for six or seven months at a time. She had had no reason to complain of the rooms except from the vibration. She was there in April, 1893, and found it very bad. She returned in October, November, and December; it was much worse still when she returned in October. It was almost like being on the sea.

Cross-examined by Mr. Phipson Beale, WITNESS stated she had stayed at Mr. Gillam's from October, 1893, till February last, with the exception of two or three weeks at Christmas.

Mr. REGINALD BRUCE FELLOWES, examined by Mr. Beaumont, gave evidence to the effect that the noise and vibration proved very tiresome when he tried to work. He left Mr. Gillam's in February.

Mr. FREDERICK HENRY THORNE and Mr. ERNEST WILLIAM ESSELL gave similar testimony.

Mr. FREDERICK WILLIAM HUNT, examined by Mr. Graham Hastings, stated that he was the agent for Lord Portman's Marylebone estate. The lessee of the site upon which the Manchester-square Station stood was a Mr. White. Witness objected to his transferring the agreement to the Electric Light Company. But he (witness) had every assurance from the Company's representatives that they were confident there would be no annoyance. Finally, the lease was taken over subject to all the covenants being observed. In 1891 the tenants began to distinctly complain, and had continued to do so up to the present time. On December 23, 1892, a meeting of petitioners took place at the Portman office. The secretary of the Company was present. Mr. Owen said the Company were making inquiries and asking advice as to what they should do to stop the annoyance. The annoyance was not denied. The plaintiffs' houses were very fairly substantial houses, and were put in very good repair by all the tenants from 1885 to 1888.

Cross-examined by Mr. Phipson Beale, WITNESS stated that the Vestry Clerk asked him if he could help him as to a site for electric light works. He (witness) was very glad that all the tenants should have the electric light. He did not recollect saying that in his opinion the present site was the most suitable of any place between Oxford-street and the

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Marylebone-road. He had never looked upon the site as being unsuitable for buildings requiring good foundations by reason of the Tyburn Brook, or anything of that kind.

Mr. MILES WALKER, examined by Mr. Beaumont, said he was assistant to Prof. Silvanus Thompson and agreed with his evidence.

Col. JAMES FREDERICK PEARSON, examined by Mr. Graham Hastings, stated that he resided at Eastbourne, and on coming to London had on several occasions taken rooms at Mr. Wise's house at 43, Manchester-street. He recollected staying there in January, 1889, for about three weeks, and on subsequent occasions. He first noticed vibration in November or December, 1892. He considered the vibration an intolerable nuisance.

Mr. JAMES WISE was examined by Mr. Beaumont, and stated that he first began to notice the vibration caused by the works in March, 1891. In the autumn of 1892 it began to be felt very strongly in the two upper floors. He did not make complaints till about the end of October or November. On November, 17, 1892, he and his neighbour went to the Manchester-square Station, and spoke to an official of the Company. An official there and then came over to his house, and admitted the vibrations. On November 21st, and on subsequent occasions, Mr. Bailey came and inspected his house. The nuisance had quite upset his nervous system, and he had had to consult Dr. Broadbent and also Dr. Jackson of Manchester-square. He had lost customers through the vibration. His receipts had fallen off considerably since September, 1892. He attributed this partly to the nuisance and partly to the bad times.

Cross-examined by Sir Richard Webster, WITNESS denied that he had told Mr. Bailey, or anyone else connected with the Company, that the vibration had been better during the last part of 1893. What he had said was that it affected his house differently from other houses, because it had been more felt through his house; but other years it had been confined to his two upper floors.

Mr. WILLIAM HENRY GRANT, examined by Mr. Graham Hastings, stated that he had been in 17, Manchester-street, since April, 1886. He first noticed vibration in June, 1890, and received complaints on the subject from lodgers in that year and in that month, and since.

Cross-examined by Sir Richard Webster, WITNESS stated that although the vibration was the main cause of complaint, the smuts would in time have become a nuisance.

Mr. F. G. Leighfield, Mr. W. Gillam, Mr. W. Barrell, Mr. W. Hales, and Mr. Frank Hudson Leighfield were then examined and gave evidence to the same effect as the other plaintiffs. Sir Richard Webster then opened the case for the defendants, and the Court adjourned over the Vacation.

Selfer and Meux's Brewery Company v. the City of London Electric Lighting Company (Limited).

These two actions, which came before Mr. Justice Kekewich last week, are by the tenant of the Waterman's Arms, Bankside, Southwark, and his landlords, and arise out of alleged detrimental vibration from the defendant Company's works. Counsel, representing all parties, asked that a day should be named for the trial, and for instructions as to their procedure. After some conversation, his Lordship said his experience was that affidavits, of which it seemed a considerable number had been filed, were of very little use in arriving at a conclusion in a case of this kind, and there would have to be a proper trial with witnesses. This was assented to on both sides.

CORRESPONDENCE.

TESTING IRON OF TRANSFORMERS BY A WORKSHOP METHOD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your number of March 23rd there is a misprint in the formula regarding the eddy-current loss per cubic centimetre for iron wires. Of course, this loss is smaller than that in iron sheets of equal thickness b (in mms.) The formulæ should be :—

for sheets, $$\left(\frac{b \cdot p \cdot \mathbf{B}_{max}}{2{\cdot}5 \times 10^6}\right)^2 \text{ watts,}$$

and for wires, $$\left(\frac{b \cdot p \cdot \mathbf{B}_{max}}{4 \times 10^6}\right)^2 \text{ watts.}$$

The values of the tables on *p.* 582 are calculated from these formulæ.

You would oblige me by publishing this correction in your esteemed journal.—Yours, &c.,

CLARENCE P. FELDMANN.

Cologne, March 27, 1894.

BOOKS RECEIVED.

Journal of the Institution of Electrical Engineers. Vol. XXIII. March. Price 3s. (London: E. and F. N. Spon.)

"Water or Hydraulic Motors." By Philip R. Björling. (London: E. and F. N. Spon. 1894.)

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.—The Directors of the Lancashire and Yorkshire Railway Company are prepared to receive tenders for the supply of a quantity of stores for the twelve months ending April 30, 1895. Some particulars are given in our advertisement columns, and further information and forms of tender can be had on application to the Stores Department, Osborne-street, Manchester. Tenders must be lodged with Mr. C. W. Bayley, the secretary, not later than 10 a.m. on Monday, April 9th.

TENDERS ACCEPTED.—The Vestry of St. Pancras has accepted the tender of Messrs. Crompton and Co. for the supply of engines and dynamos required for the new station at King's-road, for the sum of £6,917. 9s.

———— The School Board for Hanley have received the following tenders for lighting the Higher Grade Schools by electricity (Mr. E. Scrivener, Hanley, architect) :—

	£	s.	d.
B. Verity and Sons, Manchester Branch (accepted) ..	£398	11	6
Spagnoletti and Crookes, London	436	17	0
J. Blackburn, Nottingham	466	14	8
Maunsell Mercier and Co., Manchester	475	10	0
Fowler, Lancaster and Co., Birmingham	557	13	0
Laing, Wharton and Down, London	586	8	9
Brush Electrical Engineering Company, London	588	19	9
Ball and Co., Bristol	661	7	3

SALES BY AUCTION.—Messrs. G. A. Wilkinson and Sons announce the sale by auction at the Mart, Tokenhouse-yard, London, E.C., on Monday, April 23rd, at 2 o'clock, of the important freehold property, situated at Hammersmith-road, West Kensington, lately in the occupation of Messrs. Woodhouse and Rawson United (Limited). The premises comprise three large factories, engine and boiler houses, offices, stabling, &c., portions of which are let off at rentals amounting to £525 per annum. Further particulars are given in our advertisement columns, and all information can be obtained of Messrs. Langbourne, Stevens and Powell, 7, Lincoln's Inn-fields, W.C.; Messrs. Maddisons, 1, King's Arms-yard, E.C.; Messrs. Robinson and Leslie, 74, Coleman-street, E.C.; or the Auctioneers, 7, Poultry, E.C.

———— Messrs. Fuller, Horsey, Sons, and Cassell will sell by auction at the Dockyard, Chatham, on Monday, April 2nd, and following days, at 12 o'clock, a quantity of old and surplus stores, including six tons of india-rubber, 500 tons wire rope, 35 tons rivets, 50 tons brass, 19,550 yards electric cable, &c., &c. Catalogues can be obtained at the Dockyard, and of the Auctioneer, 11, Billiter-square, E.C.

APPOINTMENTS VACANT.—The Salt Lake and Ogden Gas and Electric Light Company (Limited) require a general manager at their works at Salt Lake City, Utah. A liberal salary is promised to a first-class man. Applications must be made by letter, to Mr. J. A. Kelman, secretary, Winchester House, London, E.C.

———— A clerk of the works to superintend the laying of the cables and fitting up of the central station equipment is required by the Corporation of the Borough of Southport. Applications must be sent in to Mr. J. Davies Williams, Town Clerk, Town Hall, Southport, not later than April 9th. Some further particulars are given in our advertisement columns.

LIQUIDATIONS.—The creditors and shareholders of Newington, Priddle and Co. (Limited) met before Mr. Warley, assistant receiver, on Thursday. Mr. Warley reported that the whole of the property and goodwill of the business had been sold for £330, and with the exception of the collection of the book debts, there was little more to be done under the liquidation proceedings. The case was left in the hands of the Official Receiver to be wound up in the usual manner.

———— A meeting of the members of the Orient Electric Lighting Company (Limited) will be held at 43, Finsbury-square, E.C., on April 21st, at 11 a.m., to receive the liquidator's account of the winding up.

———— Claims against Blakey, Emmott and Co., Limited (in voluntary liquidation), must be sent in to the liquidator, Mr. James Lakeman, 30 and 31, St. Swithin's-lane, London, E.C., by April 7th.

REMOVAL.—On and after May 1st the executive offices in New York of the Commercial Cable Company will be permanently located in the new Postal Telegraph Building, a huge block situate at the corner of Murray-street, 253, Broadway, where will also be located the executive offices and main operating department of the Postal Telegraph-Cable Company.

PERSONAL.—The Corporation of Kingston-upon-Thames have increased the salary of the Borough Electrical Engineer (Mr. J. E. Edgcome) to £250 a year, and have appointed him advising

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engineer to the Drainage Committee with regard to the machinery at the sewage works.

Mr. K. Schall.—We are in receipt of an illustrated price list giving particulars of new and second-hand batteries and instruments for sale by this firm.

Messrs. Baxendale and Co.—This firm's electrical department have recently obtained contracts for lighting the Bromley-street Mills, at Manchester, for which a complete plant is to be supplied. Included in a number of other contracts recently secured are the wiring of the Wesleyan Chapel, at Nelson, and of Messrs. W. Thompson and Co.'s two establishments at Spring-gardens, Manchester. The list of recent installations carried out by the firm number about seventy.

The Forty-Eight Hours' Week.—Mr. W. Mather, M.P., has just published a report of a year's trial given by Messrs. Mather and Platt (Limited), at their works at Manchester, of the forty-eight hours' week. After stating that the full complement of men employed at Salford is 1,200, subject, of course, to the various exigencies of business, Mr. Mather points out that during the period of trial no overtime was worked except for breakdowns and repairs. In the course of the report very full support is given to the advantages claimed for the eight-hours' system. The report concludes:—"Our year's trial has convinced us that we have found the happy medium in the number of hours during which only one meal and one stoppage are needed, and this resolves itself in the eight hours day or forty-eight hours' week."

Mining Plant.—The *South African Mining Journal* contains an account of the new electrical plant recently installed at the Crown Reef Mines. Electric pumping is being carried on and the electric light is in full working order. Electric locomotives have been run experimentally, with very satisfactory results; and Mr. Hubert Davies, who has designed and erected the plant, is congratulated on all sides. There are three 90-unit shunt-wound Elwell-Parker generators for power purposes and two alternators and two exciters for lighting. In the lighting eight 2,000-c.p. arcs are used, and 28 200-c.p. and 500 16-c.p. incandescents. Two sets of electric pumps are ultimately to be fixed at the dam pumping station to supply water to the mill. One of the pumps is already at work capable of supplying 60,000 gallons per hour through more than 3,000ft. of piping, under a vertical head of about 250ft. Trial runs have been made over the electric tramway, which is worked on the overhead system. The total weight of the locomotives (of which there are two) is about 10,000lb., and which will be capable of moving about 25 empty trucks from the mill to the mine at one run. This is the first instance in which electrical haulage has been adopted on the Rand, and is on a large scale.

"Willing's British and Irish PressGuide."—The new edition of this very handy list of newspapers and publications is just issued. Those likely to require the names of books or journals which are regularly published throughout the country will find them here set out in a very handy way. There is one complete alphabetical section in which everything, either daily, weekly, monthly, or quarterly, is combined, rendering the task of finding any particular publication a simple one. So far as we have tested the list, it is quite up to date.

Launch.—A new passenger steamer was launched last week from the shipbuilding yard of Messrs. W. B. Thompson and Co., of Dundee, named the "Fingal." The electric light has been adopted throughout, and has been installed by Messrs. W. C. Martin and Co., of Glasgow. The plant includes two sets of direct-acting engines and dynamos, and each section of the ship will be lighted by interchangeable appliances. The mast and side lights are on Martin's patent duplicate electric system.

Building Trades' Exhibition.—This annual exhibition has been held during the past ten days at the Agricultural Hall, Islington, and was chiefly noticeable for the almost complete absence of electric lighting exhibits, the only show worthy of the name being that made by Mr. Harry South, of Garrick-street, Covent-garden, who, in conjunction with the Coalbrookdale Company, had on view some handsome fittings and apparatus. Altogether this stand was an admirable one. A large group of exhibits interesting to those connected with building trades were on view, and there seems no reason why, with liberal treatment from the organisers of the exhibition, electric lighting firms should not be induced to lend their support, which is much needed. There was an absence of life which a few artistic electric light displays would do much to improve. Mr. Joseph Lewis, of Great Winchester-street, showed a number of lightning conductors, bells, and electrical sundries.

Brisbane (Queensland).—A deputation from the Brisbane Municipal Council recently waited upon the Hon. H. M. Nelson, chief secretary, to ask that the Government would introduce a bill giving the Council control of the electric wires in the city. There are already a large number of wires stretched over the city under no control whatever, except in the case of the telephone wires, which are controlled by the Electric Telegraph Department. The electric light wires are becoming so numerous that the Council think some authority should be exercised before the matter becomes more serious. The question of the municipal authority taking up the question of electric lighting was pressing, and with the Government's assistance it was proposed that a bill should be brought forward dealing with the subject. It was pointed out that the Tramway Company intended to introduce electricity as the motive power for their lines, which would necessitate the opening up of the roads, over which the Council has at present no control. Mr. Nelson has promised to introduce the matter on the earliest possible occasion.

Cheltenham.—After considerable delay, a special meeting of the Town Council, held last week, definitely decided to accept the tenders of Messrs. Galloways (Limited), Manchester, for two boilers at £438. 15s. each, and the tender of Messrs. Siemens Brothers and Co. for high-speed engines (Willans) and alternators at £4,610 (less £365 for boilers). The resolution was not, however, carried without considerable opposition.

Coatbridge.—Lord Kelvin has consented to open the central station which has been erected here by the House-to-House Company. The ceremony is to take place to-morrow (Saturday), when a large gathering is expected. The Town Council are negotiating for the light for the Municipal buildings, and it is expected that current for 500 incandescents and 8 arcs will be required. The wiring and fitting of the buildings has been entrusted to Messrs. Anderson and Munro, of Glasgow.

Church Lighting.—Messrs. H. F. Joel and Co. forward us neatly printed particulars of the lighting of the church of St. Nicholas Cole Abbey, Queen Victoria-street, London, E.C.—It has been decided to light Christ Church, Blackpool, by electricity.

Dundee.—Mr. Mitchell, Chairman of the Finance Committee of the Gas Commissioners, has reported that for the year ending the 15th inst. the revenue from the electric lighting works had amounted to £2,644, including £92 from meter rents, £2,384 of this sum had been realised from private lighting, and £167. 10s. from public lamps. At the time when the electric lighting scheme was gone into, a revenue of £2,000 and meter rents £35 was estimated, so that the result shows a considerable increase in revenue.

Finchley.—The scheme for lighting the Finchley Board Schools by electricity, at an estimated cost of about £700, has been abandoned.

Glasgow.—Messrs. D. and G. Graham have just completed an arc lamp installation in the grounds of the Celtic Football Club at Park Head, consisting of sixteen 2,000-c.p. arcs, arranged in three rows of four lamps, and two lamps at the top and bottom of the football field. This plan will enable the lamps to be swung round and used for illuminating the cycle and running tracks which encircle the football ground.

——— The Barony Parochial Board have rejected the proposal to adopt the electric light for the recreation hall and dining hall of the Asylum at Woodielee, which was estimated to cost £562. 13s. 8d., the estimate having been prepared by Messrs. Anderson and Munro. An amendment that gas be used was carried by 15 to 4.

Hanley.—In reply to questions as to the probable date for the completion of the electric lighting works, the Mayor informed the members at the last meeting of the Town Council that delays had occurred which they had not anticipated, but it was hoped that the scheme would be completed by the end of March.

Kingston.—The Lighting and Market Committee of the Corporation at their last meeting resolved to purchase a dynamo and connections for use during the daytime, at an estimated cost of about £240. Messrs. Willans and Robinson have written the Corporation alleging infringement of their patents in regard to the bed plate and crank chamber of the engines in use at the electricity works, and Messrs. Siemens Bros. and Co. have written acknowledging their liability to guarantee the Corporation against any claims in respect of patent rights and royalties on the plant.

Llandudno.—The electric lighting question has recently been under the consideration of the Llandudno Commissioners, who, whilst approving the general idea of the formation of a local company, have requested the promoters to submit a draft of their Provisional Order, together with a draft agreement showing the terms upon which they propose the Commissioners should ultimately have power to purchase the undertaking, upon receipt of which the Commissioners will give the matter further consideration.

London County Council.—At its next meeting a motion is to be made that the Highways Committee consider the advisability of widening the footways of the Victoria Embankment, in order to allow the electric light standards to be placed on the sides of the carriage-way. It will be remembered that the Council rejected the proposal to have the lamps in the centre of the roadway.

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MANCHESTER.—The question of lighting the workhouse at Crumpsall by electricity is under the consideration of the General Purposes Committee of the Board of Guardians.

MEDICAL QUACKS.—Another medical quack has been laid by the heels, this time at Liverpool. At the recent Assizes Francis M'Conville, trading as "Professor Hamilton," was charged with obtaining money under false pretences. It appeared from the evidence that an Irish labouring man had been induced by the specious representations of prisoner to part with £52. 12s. of his earnings, in order to procure relief by means of a so-called electro-pathic belt. After a patient hearing prisoner was sentenced to five years penal servitude, the maximum penalty. An investigation of his books showed that he was making between £3,000 and £4,000 per year, and was spending large sums on advertising.

NEW SWINDON.—The General Purposes Committee of the Local Board have received the report of Mr. Aldridge on the electric lighting question, which has been referred back to the Electrical Committee for their report as to the advisability or otherwise of applying for a Provisional Order.

SCARBOROUGH.—It has been decided to light the theatre at Scarborough Spa by electricity, and the general adoption of the electric light at the Spa is under consideration, and is likely to be carried out immediately.

SOUTHPORT.—At a special meeting of the Southport New Infirmary Committee to consider the question of the lighting of the buildings now in course of erection, a strong effort was made to induce the Committee to install the electric light, which it was estimated would cost about £1,500 in excess of the estimate already provided for gas lighting. It was, however, ultimately decided that gas lighting should be adopted.

SUNDERLAND.—A resolution will be moved at the next meeting of the Board of Guardians recommending the appointment of a committee to consider the advisability of lighting the whole of the workhouse buildings by electricity.

WESTON-SUPER-MARE.—An influentially-signed memorial has been presented to the Town Commissioners asking that body to immediately take in hand the lighting of the district by electricity. The memorial was discussed at the last meeting of the Commissioners, and an Electric Lighting Committee was formed to take the matter into consideration.

COMPANIES' MEETINGS AND REPORTS.

W. T. Henley's Telegraph Works Company (Limited).

The 15th ordinary general meeting of this Company was held at the offices, Martin's-lane, Cannon-street, on the 22nd inst., Mr. Sydney Gedge presiding.

The SECRETARY (Mr. G. H. White) having read the notice convening the meeting, the report was taken as read.

The CHAIRMAN: The report and balance-sheet are in your hands, and are signed by the auditors. The summary thereof is printed and annexed to the report, and you see the auditors' certificate at the foot. I think, considering all the circumstances of last year—the general depression of trade and the want of enterprise, resulting, apparently, from a want of confidence—we may congratulate ourselves that this Company has so good a report and balance-sheet to show as has been presented to you. There is very little in either to which it is necessary for me to call your special attention. You see that we have reduced the "B" debentures, which were £30,000 only two years ago, to £12,000 only, £4,000 having been paid off within the year. You see that we are able to pay 7 per cent. on the Preference shares, and a dividend of 5 per cent., free of income-tax, on the Ordinary shares, and that there is a very large sum which stands to reserve against investments, etc.—£46,019. The reason of that is this, that we have a very large investment in the International Cable Company, the liquidation of which is now nearly completed, and we thought it right, not knowing exactly how much would come back to us, to make a very liberal reserve. That matter will now be settled in the course of a few weeks, and we shall then know exactly how we stand. The other item of reserve under cable repairing contract, £1,723, represents the accumulation of the sum of £700 a year paid by the Government of the Bahamas, and invested in the joint names of the Crown Agents of the Colonies and your Chairman, in order to provide a fund wherewith to make the repairs of that cable should it be necessary to do so. It is very gratifying to us to know that the cable, which has been laid for two years, has not required to be repaired. The cable which we laid some time before that, between Halifax and Bermuda, has also never required the expenditure of a shilling on repairs, and we hope that the same will be the case with the other cable. If so, a very large proportion of our accumulations will at the end of twenty years come back to the Company as a good "plum," which I hope some of us will live to enjoy. The competition during the past year has been very great indeed, and with 2¾ Consols at or above par, it is not to be wondered at that there is great competition to make small profits of 4 per cent., 5 per cent., or 6 per cent., consequently, our profits are not quite so large on orders as they used to be. And there is another thing that makes our returns not so good as they would otherwise be. We do nothing but the best work, and are determined that as far as we are concerned there shall be no danger of our work being badly done. If we would give inferior work we should get more orders, but we feel that we are doing our duty to our shareholders and ourselves in maintaining the character of our work. The extension of our works has cost just under £16,000, for which £15,000 was raised by issue of Preference stock. The works are now in very first-class order. We are using electrical motors for a great portion of our new works, and although there are larger works, there are no more complete or efficient anywhere. This brings me to the question of finances. We should be glad of rather more capital, and the question is how can it best be obtained? The Directors have not come to any formal decision on the matter, but it has been talked of, and the consensus of opinion is that the best mode will be as follows:—The shareholders are aware that we have applied to the Stock Exchange for a quotation. The application has gone in; all the necessary alterations are made in our Articles of Association, everything in the way of declaration, statutory or otherwise, which the committee of the Stock Exchange require has been duly made, and the papers are lodged. Therefore, when it pleases the committee to take the matter into consideration we hope to get a quotation. Our shares, which a few years ago were a drug in the market at 3, it is now difficult to get at 7, or 8. I have lately bought some for a friend and have found it difficult to get them at between 7 and 8; and I believe that if we can put them in the ordinary way on the Stock Exchange, and get a quotation in the papers, they will soon arrive at par or very nearly par. I want to show you how we can bring them over par. The indebtedness of the Company is £10,000 on mortgage at 4½ per cent., and £15,000 of "A" debentures at 5 per cent. which have to be paid off in September, 1899. We shall, therefore, just finish the century by paying them off. There were £30,000, but there are now only £12,000 of "B" debentures at 6 per cent., which have to be paid off on September 1, 1896—two years and a half hence. The total, you will see, is £37,000, and the total interest paid on this amount is exactly £1,920. In considering the large sum expended on the works extensions you will remember that that is a sort of net sum, because there have been no contractors' profits. The additions have been effected by our own workmen, under the control of our manager at the works, Mr. Hatton, and they therefore really represent in that way more than the £16,000 which they have cost. We consider that our works and undertaking would form an exceptionally good security for a loan of £50,000 in debenture stock, which stock can be issued most certainly at 5 per cent. and, I hope, at 4½ per cent. We shall consult our brokers on this. Our idea is that we should take power when the thing is ripe by applying to the shareholders for authority to issue £50,000 on debenture stock redeemable at a small premium at the option of the Company in a certain number of years, as we may be advised by our brokers, and with the money pay off our first mortgage and our "A" and "B" debentures. The result would be this—that even supposing we could only get this loan at 5 per cent., 5 per cent. on £50,000 is only £2,500 as against the £1,920 we are now paying, or £580 more, but we should have £13,000 ot additional capital, by which we could make more profits. If we could raise the loan at 4½ per cent. the amount of interest would be so much less. Having this capital we shall be able to increase our business and avail ourselves of opportunities that present themselves of buying gutta percha, india rubber, and copper when the materials are favourable in price, instead of having to get supplies in when we want them. Then we should get this advantage—that we should only have to pay out of our profits the interest on our debenture stock, amounting to about £2,250, and the dividends on our Preference shares. The Ordinary shareholders would divide all the surplus profits. At present they cannot do so, because when the "B" debentures were issued, it was agreed that only 5 per cent. should be paid to the Ordinary shareholders, and that all the rest should go to replacing the debentures. Gentlemen present will see what a difference it would make next year or the year afterwards if we were to make £11,000 whether we were limited to paying 5 per cent. or could divide the balance over and above the interest on the debentures and Preference shares. Taking it at £2,250 a year for the one and £2,100 for the Preference shares, that would make £4,350, and all the balance would go as dividend to the Ordinary shareholders; and every £700 of additional profit would be 1 per cent. more. If we were to pay 7 per cent. on our Ordinary shares it ought to make them stand at a premium. I have thought it best to prepare the shareholders' minds for this proposal, because so much can be done by themselves. I know of an hotel company that raised £100,000 by Four per Cent. Debenture stock, and nearly the whole of it was taken up by their own shareholders, and we hope that when a financial operation of this kind comes on you will assist in subscribing for what you will know is a very first-class stock. This is pretty nearly all that I have to lay before you, but before I sit down I wish to say two things—first, that our profits have been made out of ordinary commercial business. You would be surprised if you saw the extent to which our connection has increased and the number of orders that come in each week from different quarters. It is not well that I should state the amount of the orders, but I may say that over 100 orders from different people come in each week, so you see that the average amount of each order is not very large. It is by paying attention to details that we are able to make our profits; and if we get some first-class cable-laying job, as we have had before, we shall have a very good state of things indeed to submit to you. Since the 1st January orders have come in which show that if they maintain the same rate we should exhibit an increase of 30 per cent. in our business, which would mean a good deal more profit. The next thing that I desire to mention is this—that the Board could not have set before you the satisfactory result they do had they not been ably assisted by all the officials of the Company, both in London and at North Woolwich, and the thanks of the shareholders are due to those gentlemen. With these remarks I move—

"*That the report and balance sheet now presented to the meeting be received and adopted.*"

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Mr. R. J. JENKINS, C.E., seconded the resolution. The Chairman had laid great stress on the advantage which would accrue to them if they were to issue one solid stock to replace the mortgage and debentures which at present existed. That must be apparent to all of them. The Board had been considering this matter for some time. The proposal would increase the capital of the Company by £13,000, but the Company had not a reserve which was a money reserve at the moment, and they required capital in order to enable them to make purchases and get discounts. Their Managing Director (Mr. Sutton) had told them that he could have secured parcels of gutta percha and other things required in the course of trading on advantageous terms had he had the means. The financial operation to which reference had been made would not injure, but would strengthen them, because they would feel themselves perfectly safe with this Debenture stock rather than with debentures which they might be called upon to pay at perhaps an inconvenient time. They had done a considerable amount of work, but it was not as profitable as the making and laying of cables. When they got into larger enterprises — such as the Bahamas, and the Halifax and Bermuda cables—there were profits which they were entitled to on account of the greater amount of risk. There were, at the present time, one or two cable projects before them, one of a rather important nature for a Foreign Government, and in the course of the present year they hoped they might obtain the order for one of these. They would all regret the absence of General Hutchinson, who had been seriously ill.

Mr. MICHELL said he thought the financial scheme shadowed forth would commend itself generally to the appreciation of the shareholders.

The motion was then adopted unanimously.

The CHAIRMAN next proposed the payment of dividends mentioned, that on the Ordinary shares to be free of income-tax.

The Hon. RANDOLPH STEWART seconded the motion, which was carried.

Resolutions were afterwards passed, re-electing the retiring Directors: Mr. Fredk. Newton and General George Hutchinson; and the Auditors: Messrs. Ball, Baker, Deed, Cornish, & Co.

Votes of thanks were then passed to Mr. R. J. Hatton, and the staff at North Woolwich and London, and to the Chairman and Directors, and the proceedings terminated.

House-to-House Electric Light Supply Company (Limited).

The sixth ordinary general meeting of this Company was held at the works, Richmond-road, on Thursday last week.

Mr. HENRY R. BEETON presided, and in moving the adoption of the report, stated that there was a steady growth in the business, and greater progress was made last year than in 1892. The general depression in trade had affected them, as possible consumers held back from adopting electric light. The income per lamp had fallen off, this being partly due to the absence of fog and partly to consumers being more economical in their use of current. It was satisfactory, however, that the Company had earned £1,421 more than in 1892, while the working expenses were £19 less. The capacity of the station, exclusive of reserve, amounted to 45,000 8-c.p. lamps, which was considerably in excess of the immediate demand. The nothern division of the area of supply had been transferred to the local authority.

The motion was carried unanimously, and a dividend of 7 per cent. on £25,000 Cumulative Preference shares was declared.

The following is the Directors' report:—

The revenue account for the year ended December 31, 1893, shows a credit balance of £4,231. 4s. 2d., which, with the sum of £525 guaranteed by the Leeds and London Electrical Engineering Company (Limited), referred to in another paragraph, and the balance, £40. 14s. 3d., brought forward from the previous year, makes a total of £4,796. 18s. 5d. After deducting £1,800 for interest paid on £30,000 Debentures, it is proposed to deal with the balance as follows:—In reduction of preliminary expenses, £500; in reduction of suspense renewals account, £100; depreciation fund, £700; dividend of 7 per cent. on £25,000 Cumulative Preference shares, £1,653. 10s. 2d.; balance carried forward to next account, £43. 8s. 3d.—£2,996. 18s. 5d.

That the Company's business has continued to increase is shown by the following table from January 1, 1890:—

Date.	Equivalent of 35 watt lamps ctd.	No. of houses connectd.	Ordinary revenue.	Revenue from construction business.	Total revenue.	Expenditure.	Profits.
Dec. 31,			£ s. d.	£	£ s. d.	£ s. d.	£ s. d.
1890	13 665	248	5,010 9 2	—	5,010 9 2	4,624 6 5	386 2 9
1891	19,383	373	8,328 3 11	—	8,328 3 11	6,077 14 10	2,250 9 1
1892	23,700	471	10,688 13 6	525	11,213 18 6	7,851 19 6	3,361 19 0
1893	28,429	599	12,063 10 10	525	12,588 10 10	7,832 6 8	4,756 4 2

It is most satisfactory to observe that, whereas the revenue derived from the sale of current shows an increase of £1,421 over last year, the working expenses show a decrease of £19.

Since the issue of the last report another engine and alternator have been laid down, bringing the capacity of the station, exclusive of reserve, to 45,000 8-c.p. lamps.

The balance of the issue decided on, of £25,000 Seven per Cent. Cumulative Preference shares, has been subscribed during the past year.

The guaranteed sum of £525 has been credited in account by the Leeds and London Electrical Engineering Company (Limited), for the year 1893, in connection with the business of Central Station Construction which that Company took over.

The Directors are pleased to report that the application to the Board of Trade to revoke that portion of the Company's Provisional Order which referred to the Northern division of the area of supply has been successful, and the Company are now released from their obligation to lay mains in that district.

Mr. Robert Hammond has retired from the Board, and has been appointed consulting-engineer to the Company. The Directors received with regret last year the resignation of their Manager, Mr. Albert Gay, on his appointment as Resident Engineer to the Vestry of St. Mary's, Islington. They have appointed Mr. Henry W. Bowden as chief engineer, and have every reason to be satisfied with their selection. Mr. W. F. Leese and Mr. W. R. Davies retire from the Board by rotation, and being eligible offer themselves for re-election. Messrs. Theobald Bros., Miall & Company the auditors of the Company, retire, and submit themselves for re-election.

Chatham, Rochester, and District Electric Lighting Company (Limited).

The annual general meeting of this Company was held on the 20th inst. at the works, Whittaker-street, Chatham, Mr. Henry Jasper presiding.

The CHAIRMAN, in moving the adoption of the report, said they had anticipated that a large number of lights would have been taken up, but it would seem that many people did not care to go to the expense although the cost had been much reduced. They would see by the report that a large number of consumers had adopted the meters, and had found them very satisfactory and very reliable, so much so that those who had them had put in additional lights. Consumers also felt they were not paying for the light unless they used it, which was as it should be. He had no hesitation in saying that before the close of the year every one of their customers would have meters. The price of lamps had much reduced owing to royalties falling through, and they were also supplying a much superior lamp, which was also of advantage to the consumers. Those items all tended in the direction of making the light more in favour with consumers than it had been in the past. They had no doubt heard at different times people expressing their doubts about the undertaking. He was happy to tell them that they had turned the corner—in fact, they had done a great deal more, as they had a great number of new customers since December 31st, and had a very fair number coming in now. They were young yet; they had not been in existence six years, and although it might be thought that it had taken them a long time to get themselves in order, it must be remembered what had been done in those six years elsewhere—what had been done in London and other parts of the country. The electric light was becoming very popular in London; there the companies had very large outputs, and were charging very much higher prices than they were. Their position was therefore very favourable, as their charge was 4½d., whilst the lowest price in London was 6d. and 7d., and even more, and yet the light was making great progress. The Directors had been somewhat disappointed with regard to the effort to obtain money on debentures. They wanted more money in the concern, so that they might extend it. They had the plant and machinery there, and felt justified in hoping shortly to make such extensions that their income must be increased very considerably. The Chairman then alluded to the ability of the Managing Director (Mr. Hurrell), who had brought them to the excellent position they were in. If they had been better guided in the first few years they would have been in a much better position, and had they had the benefit of his skill and ability they would have paid a dividend in two or three years. The Directors had decided not to recommend the payment of a dividend, although they had earned sufficient to pay 2½ per cent. They did so from the fact of the Debenture stock not being applied for, which showed rather a want of confidence on the part of investors.

Mr. GEORGE CHURCH seconded the motion, which was carried.

Motions for the re-election of Mr. W. King as Director, and of Messrs. G. F. Butts and J. E. Ratcliff as auditors, having been carried, a vote of thanks to the Chairman concluded the proceedings.

Hastings and St. Leonards-on-Sea Electric Light Company (Limited).

The annual general meeting of this Company was held on the 20th inst. at the Brassey Institute, Hastings, Mr. H. M. Baker presiding.

The CHAIRMAN, in moving the adoption of the Directors' report and balance-sheet, said those who were present at the last meeting might remember that attention was called to the fact that during the current year it would be necessary to call up a considerable amount of capital to carry on the largely-increased business. If they compared the balance-sheet with that of last year they would find that the Directors had called up £5,230 during the year, and that their revenue had increased from £4,276 to £5,390, or an increase of £1,114, a little more than 25 per cent. Although that was satisfactory so far as it went, it was only fair to say that it would have been very much more so if it were not that a considerable amount of expenditure would be realised during the current year, and notably that in connection with the lighting of the whole of the Front. As they were aware, the Front would not be lighted to the full extent until midsummer, and he would like to take that opportunity of publicly stating the fairness with which the Corporation had met them in all their transactions, and notably as regarded the increased electric lighting on the Front.

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The next point that he would refer to was, to the minds of the Directors, a most important one—in the interests of the Company they had decided to engage the services of Prof. Kennedy. They had appointed their sub-manager, Mr. M. G. Ross, to the vacancy caused by the unfortunate death of Mr. Mercer; and they had also been fortunate in retaining the services of their secretary. At the end of that meeting a special meeting would be held to consider the best means of coping with the increased demands for the electric light they were receiving on all hands. Under the Provisional Order granted them by the Board of Trade, by which they had to supply the whole of the district, there were certain conditions which, sooner or later, they would be called upon to fulfil.

Mr. SHORTER seconded, and the motion was carried.

The retiring Directors, Messrs. Langham, Reeves and Woodhams, were re-elected; the auditors were reappointed; and a vote of thanks to the Directors concluded the proceedings.

NEW COMPANIES, STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, pages 320-348, *&c., &c.*]

ALTRINCHAM ELECTRIC SUPPLY (LIMITED).—This Company was registered on March 22nd, with a capital of £50,000, in £1 shares, to take a transfer from the Manchester Edison-Swan Company (Limited) of a Provisional Order granted to them by the Board of Trade, and confirmed by the Electric Lighting Orders Confirmation (No. 4) Act, 1893, authorising the undertakers to produce, store, supply, and sell electricity, electric current, and other like energy for public and private purposes within the Local Board districts of Altrincham and Bowdon, in the parish of Bowdon, in the county of Cheshire; to adopt, complete, and carry out a provisional agreement to be made between the Manchester Edison-Swan Company (Limited) of the one part, and this Company of the other part, for such transfer; and to carry on the business of electricians, electrical engineers, and suppliers of electricity in accordance with such powers. The subscribers (with one share each) are:—W. J. Crossley, C. C. Dunkerley, W. P. J. Fawcus, H. T. Gaddum, W. O'Hanlon, W. Warburton, and W. A. Arnold. The first Directors are:—William J. Crossley, Charles C. Dunkerley, William Paul, James Fawcus, Henry T. Gaddum, William O'Hanlon, and E. J. Sidebothom.

ELECTRIC TRACTION COMPANY (LIMITED).—This Company was registered on March 22nd, with a capital of £300,000, divided into 29,880 shares of £10 each, and 1,200 shares of £1 each, to enter into contracts for the construction, repair, and maintenance of and to construct, equip, repair, and maintain any works, including railways, and other roads and ways, to be used for traction by electricity, steam or other power, to lay down pipes for the distribution of electricity, or for telegraphic or telephonic communication, and to carry on the business of electrical engineers, mechanical engineers, railway and tramway proprietors, suppliers of electricity, and other like business. The subscribers (with one share each) are:—E. T. Botwright, F. P. Shuckard, W. H. Adams, H. D. Brooke, W. B. Butler, W. Y. Yeoman, and G. Dewdney. The first Directors are to be appointed by the above-named signatories to the Memorandum of Association.

ROWLAND BARNETT AND CO. (LIMITED).—This Company was registered on March 20th, with a capital of £20,000, in £1 shares, to purchase, or otherwise acquire, the business of an electrical and mechanical engineer, carried on by Rowland Hill Barnett at Walker Gate, Northumberland, and 8, Moseley-street, Newcastle, under the trade style of Rowland Barnett and Co., with a view to such acquisition, to enter into and carry into effect the agreement with the vendor referred to in Clause 3 of the Articles of Association, and to carry on the business of electricians, electrical engineers, mechanical engineers, suppliers of electricity, the general business of an electric company, manufacturers of, and dealers in, all apparatus and things required for or capable of being used in connection with the generation, distribution, supply, accumulation and employment of electricity, iron and brass founders, tool makers, metal workers, millwrights, machinists, &c. The subscribers (with one share each) are:—R. H. Barnett, H. A. Westmacott, C. A. Woods, F. R. Fenwicke, C. Liddell, J. Cowper, A. W. Dixon, and J. R. Glass. The first Directors are Messrs. R. H. Barnett and H. A. Westmacott.

CITY NOTES.

ANGLO-PORTUGUESE TELEPHONE COMPANY (LIMITED).—The seventh ordinary general meeting of the shareholders of this Company was held yesterday at the offices, 53, New Broad-street. Representatives of the Press were not admitted. The Directors' report for the year ending December 31st last states that the amount to the credit of profit and loss is £6,171. 16s. 9d., which is carried forward to the current year's account, the declaration of a dividend being, on the advice of the Company's solicitors, postponed for the present. The report shows an increase of 80 in the number of subscribers, and in value of £721 over the preceding year.

CENTRAL LONDON RAILWAY.—It is announced that the prospectus of the Central London Railway Company is to be issued immediately by the Exploration Company. The Company is to construct two tunnels from the eastern angle of Shepherd's Bush Green, *viâ* Oxford-street, to Cornhill, E.C., and to connect the Mansion House to the Great Eastern Railway Station at Liverpool-street, giving a total of 6¾ miles. There are to be 14 stations on the line, which is to be worked entirely by electricity.

CHARING CROSS, EUSTON, AND HAMPSTEAD RAILWAY.—The prospectus is issued inviting applications for £1,416,000, in £10 shares. The Company has, in addition, power to raise £472,000 in Four per Cent. Debentures. The railway is to be about five miles in length, and is to run from Charing-cross, passing under King William-street, Charing-cross-road, Tottenham-court-road, Hampstead-road, Haverstock-hill, to the junction of High-street with Heath-street, Hampstead; a short branch from the Hampstead-road is to connect the Euston Station with the new line. Two separate tunnels are to be constructed under the Greathead system, and the motive power to be employed is electricity. The list of applications closes on Tuesday next.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended March 25th were £792, as against £859 in the corresponding period of last year, being a decrease of £67. The total receipts for the half-year amount to £11,191, as against £11,271 for the corresponding period of last year, a decrease of £80.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY (LIMITED).—The prospectus will be found elsewhere of this Company, which is formed with a share capital of £800,000, divided into 40,000 Preference and 40,000 Ordinary shares of £10 each, and the Directors have, in addition, power to raise £400,000 of Debentures. The present application is for 19,900 Ordinary shares of £10 each, offered for subscription at par by the Electric and General Investment Company (Limited), on behalf of the County of London Company. The instalments are payable £1 on application, £1 on allotment, and £2 on June 30, October 1, and December 31, 1894, and March 30, 1895. The Company was registered in June, 1891, for the purpose of undertaking the supply of electricity in certain districts in the county of London, and in the United Kingdom, where capital may be profitably employed in electric supply. The Provisional Orders already obtained include the united parish of St. James and St. John, Clerkenwell, St. Luke, Middlesex, the district served by the Wandsworth Board of Works, and the parish of St. George the Martyr, Southwark. In addition, the Company will undertake the erection and equipment of power stations in provincial towns where municipal authorities have obtained Provisional Orders, which they are prepared to transfer to a responsible company; and, in addition, the Company proposes to assist local companies with capital, &c. Work is to be at once commenced in the St. Luke, Clerkenwell, and Wandsworth districts, and a controlling interest is to be acquired in the local electric supply companies at Bournemouth, Dover and Canterbury, whilst at Shrewsbury, Bedford, Weston-super-Mare, and other towns, negotiations are in active progress. All contracts entered into by the Company are fully disclosed in the prospectus, which contains no waiver clause. Applications for shares must be made on the form accompanying the prospectus, which can be obtained from the bankers, Messrs. Glyn, Mills, Currie & Co., 67, Lombard-street, E.C.; the brokers, Messrs. Foster and Braithwaite, 27, Austin Friars, E.C., and at the offices of the Company, 49, Queen Victoria-street, E.C.

EDISON GOWER-BELL TELEPHONE COMPANY OF EUROPE (LIMITED).—The eleventh ordinary general meeting of this company was held at the offices, 53, New Broad-street, E.C. yesterday. Representatives of the Press were not admitted. In their report the Directors state that to December 31st last there was a balance to the credit of revenue account of £120. 6s. 10d., which it was proposed to carry forward.

MESSRS. EVERED AND CO. (LIMITED).—The Directors of this Company recommend that, after payment of Debenture interest and writing off the usual amount for depreciation, a dividend at the rate of 7½ per cent. per annum be paid for the half-year ended December 31st last, making 7½ per cent. for the whole year. £2,000 is placed to the building fund, £2,026 carried forward.

LONDON REFUSE STEAM GENERATOR AND ELECTRICAL POWER CORPORATION (LIMITED).—Interesting correspondence and articles dealing with the prospectus of this Company (which was referred to in our last issue) have appeared during the week in the *Pall Mall Gazette*. It is noticeable that no indication has been given by the Company as to whether the subscription to the issue of capital was sufficiently large to warrant the Directors in proceeding to allotment.

ROCKHAMPTON (QUEENSLAND).—The Directors of the Rockhampton Gas and Coke Company have issued their report, and announce that their electric light operations for the past year show an actual loss of £21, to which is added £294 brought forward. During the year they have carried out the lighting of the Fitzroy Bridge, and have received a notification from the Governor in Council expressing his satisfaction at the electric lighting work carried out by the Company. A similar approval has been received from the Rockhampton Municipal Council, and, as such a proof is necessary under the Companies Act for supplying the electric light in the district, the Directors express their satisfaction. From the profits of the general business of the Company a dividend of 10 per cent. has been declared.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT COMPANY (LIMITED). It is stated that the whole of the £30,000 Four per Cent. Debentures, recently issued by this Company, have been applied for and allotted.

WEST END LIGHTING.—The following delightfully vague paragraph appears in the *Glasgow Herald*, and shows the enterprise of its London correspondent:—"A powerful syndicate is about to be formed, with the support of one of the Rothschilds, with the view of applying for and putting into operation provisional orders for lighting by electricity some of the large and fashionable suburbs of London."

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WATERLOO AND CITY RAILWAY.—The capital of this Company has, we understand, been satisfactorily placed, the shares applied for being largely in excess of the number required. Letters of allotment and regret have been posted.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended March 23rd (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,735.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Divi-dend.	Name.	Previous Week's Price, Mar. 20.		Price Wednesday, Mar. 28.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending Mar. 28. Highest	Lowest.
			TELEGRAPHS.					£ s. d.			
£1,134,640	Stock	13/6	Anglo-American	42	44	4?	44	5 13 8	Jan. Apr., July, Oct.	..	..
£2,932,680	Stock	27/0	Do. Preferred	77½	78½	78½	79½	6 5 9	" "	79⅜	78¾
£2,932,680	Stock	5/0	Do. Deferred	7¼	7¾	7¼	7¾	..	.. ..	7⅜	–
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	100	103	100	103	3 17 8	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	11¾	12½	11¾	12½	5 4 0	Mar., June, Oct., Dec.	12 1/16	11¾
£18,700	£100	5%	Do. 5 per Cent. Bonds	99	102	99	102	4 18 0	January and July	..	–
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	..	–
10,000,000	$100	$1¾	Commercial Cable Capital Stock	146	150	146	150	4 13 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12	13	12	13	6 3 1	February and August	12¾	12½
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3		..	–
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3½	2½	3½	4 11 5	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9½	8½	9½	5 5 3	" "	..	..
60,710	20	8 0	Direct United States Cable, 1877	10⅝	10⅞	10⅝	10⅞	6 5 6	Jan., Apr., July Oct.	10⅝	10 7/16
400,000	10	2/6	Eastern	14¾	15	14¾	15	4 6 8	" "	15	14¾
70,000	10	6%	Do. 6 per Cent. Preference	16	16½	16	16½	3 12 9	" "	16	..
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	113	116	114	117	3 8 5	May and November	115¼	..
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	106	109	107	110	4 10 11	February & August	107	–
250,000	10	2/6	Eastern Extension	15¼	15½	15¼	15½	4 10 4	Jan., Apr., July, Oct.	15½	..
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	112	115	113	116	3 9 0	February & August	..	..
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103	106	103	106	4 14 4	January and July	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	103	106	103	106	4 14 4	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	103	106	104	107	3 14 9	February & August	–	..
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	107%	110%	107%	110%	3 12 9	May and November	..	..
180,227	10	1/3	Globe Telegraph and Trust	8⅝	8⅞	8⅝	8⅞	5 1 5	Jan., Apr., July, Oct.	8¾	8⅝
180,042	10	6%	Do. 6 per Cent. Preference	15	15½	15	15½	3 18 8	" "	15½	15
150,000	10	5/0	Great Northern	21	22	21½	22	3 18 0	Jan., April, and July	..	..
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 13 6	March & September	..	..
17,000	25	13/6	Indo-European	43	45	43	45	5 11 1	May and November	..	..
37,548	10	4/0	London Platino-Brazilian	4	6	4	6		" "	..	–
£100,000	100	6%	Do. 6 per Cent. Debentures	105	108	106	109	5 10 1	March & September	108¼	–
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red." 1942	102	105	102	105	3 16 2	..	..	..
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	..	..
8,381	£100 Cert.	25 0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	" "	..	..
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July	..	–
£249,900	100	5%	Do. 5 per Cent. Debentures	98	101	98	101	4 19 0	March & September	..	–
80,000	10	2/0	West Coast of America	2¼	2¾	2¼	2¾	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	98	102	99	103	7 15 4	June and December	102	..
88,321	10	1/0	West India and Panama	1⅛	1⅜	1⅛	1⅜	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10	10½	5 14 3	May and November	..	..
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	8½	9½	6 6 4	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	106	109	106	10?	4 11 9	June and December	..	..
64,242	15	4/6	Western and Brazilian	7¾	8¼	7¾	8¼	..	May and November	7⅞	..
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	6	6½	6	6½	..	..	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	2¼	2½	2	2½		..	2⅜	2¼
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105	108	105	108	5 11 1	February & August	..	–
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	105	108	105	108	5 11 1	" "	..	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	–
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	100	104	100	104	5 15 5	March & September	..	–
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	1½	2½	1½	2½	..	–	..	–
224,550	10/0	3½d	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
220,000	£1	6d.	Oriental Telephone and Electric	..		..		..	Yearly	..	–
484,597	5	2/6	National	4½	4¾	4½	4¾	5 5 3	June and December	4¾	4½
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½	15½	14½	15½	3 17 5	" "	..	–
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	14	15	14	15	4 0 0	" "	..	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5¼	5½	5⅝	5⅝	4 8 11		5 7/16	–
925,017	£100	4½%	Do. Deb. Stk. 4½%	114	116	115	117	3 6 11	January and July	117	115¾
58,000	5	1/0	United River Plate	1½	2	1½	2	..	" "	..	–
£146,370	Stock	5%	Do 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	–	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10		City of London Electric Lighting (fully paid)	12	13	11½	12½	–	..	12⅜	12¼
20,000	10	6 0	Do. 6 per Cent. Cumulative Pref. (fully paid)	13¼	13¾	13¼	13¾	..	–	13½	13¼
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	–	–
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	–	..	–
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		..	–	–	–
8,322	£5	..	House to House Electric	..		..		..	–	–	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		..	..	–	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	–	–
30,000	£5	1/9	Liverpool Electric Supply (£4 10s. paid)	5⅞	6½	5⅞	6½	..	–	..	–
15,000	£5	2/6	Do. (fully paid)	6 9/16	6 11/16	6 7/16	6 9/16	..	–	..	–
111,000	5	..	London Electric Supply	¼	¾	¼	¾	..	..	–	–
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	8½	9	8¼	8¾	2 5 8	..	8⅝	8⅝
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	106	109	106	109	4 11 9	June and December	108	–
6,452	£10		Notting Hill Electric	4½	5½	4½	5½		–	..	–
19,980	£5	4 6	St. James' and Pall Mall	6¼	6¾	6¼	6¾		–	..	..
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	–	8 7/16	–
59,900	5	2/6	Westminster Electric Supply (fully paid)	5¾	6¼	5¾	6¼	3 4 0	–	6	..
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅞	3⅛	2⅞	3⅛	5 15 1	–	..	..
90,000		6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1		..	..
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	108	111	108	111	4 1 1	March & September	110½	..
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	3½	4	3½	4	..	January and July	..	..
12,139	5	..	Edison and Swan United	..				..	–	–	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	–	–	–
120,000	2	..	Electric Construction	½	¾	½	¾	..		–	–
12,845	2	..	Do. 7% Cumulative Pref.	1½	2	1½	2	..	..	..	–
91,195	2	10/0	Elmore's Patent Copper Depositing	½	¾	½	¾			..	–
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½			..	..
50,000	10	15/0	India Rubber, Gutta Percha &c., Works	23	24	23	24	5 4 2	February & August	23⅞	23¼
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896 xd	103	105	101	103	4 7 5	March & September	..	..
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	–	–	–
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	–	–
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	—	⅛	—	⅛	..	–	–	..
78,949	5	3/6	Swan United (£3. 10s. paid)	2	2½	2	2½	7 0 4	May and November	..	–
37,350	12	36 0	Telegraph Construction and Maintenance	39	41	39	41	4 7 10	March and July	40	–
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	..		..		..	January and July	..	–
37,514	£5	..	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		–	–	–	–
41,098	£5	..	Do. Preference (fully paid)	..		..		–	–	–	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	⅝%	City and South London Railway	27	32	27	32	4 5 11	May and November	..	..
37,500	£10	1%	Liverpool Overhead Railway	6¼	6½	6⅞	7⅛	–	–	–	–

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THE ELECTRICIAN:

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NOTES.

Our New York Correspondent has already prepared our readers for the epoch-making discovery of Mr. C. F. Scott. He has evolved a system of alternate-current working, which consists of the combination of a two-phase with a three-phase arrangement. In another column we print an abstract of this Paper, the abstracting having been done with such reverence as befits the importance of the subject. It is difficult to appreciate the value of land-marks of history until time has allowed a true perspective view to be obtained, but Prof. Rowland joined with Prof. G. Forbes in the discussion at the National Electric Light Association, in proclaiming Mr. Scott's device as "one of the finest things that have come out in recent years in this [*i.e.*, U.S.A.] country." The "exceedingly interesting Paper," the "beautiful arrangement," "an extremely beautiful idea" which "appears on the face of it to be a feasible method" (a little bathos here), for which Prof. Forbes expressed his admiration, must, of course, be studied by alternate-current men in its entirety. Meanwhile, we hope that our abstract will suffice for plain continuous-current men, who may be thankful to see what they escape.

The Paper by Mr. Mordey on parallel working of alternators was justified as a "personal explanation" in reply to a statement made some time ago by Prof. Forbes. Neither the Paper nor the discussion has added anything to the subject, except, indeed, an analogy or two, which is always useful. We described the original experiments three years ago, and the recent tests have done nothing more than to confirm them. The suggestion that the hunting was due to the decrease of resistance of the lamps is interesting, and is quite as likely to point to the true cause as the more commonplace reference to the governor. If a fraction of the time and trouble spent over this Paper and its discussion had been devoted to the consideration of alternators, which, on account of the engines which drive them, or for other reasons, cannot be run in parallel, something more useful than clearing the character of the Mordey alternator from an unimportant imputation would have been achieved. We shall be interested to learn whether the gas-engine-driven alternators at Coatbridge will be habitually run in parallel on the ordinary lighting load. We shall not be surprised to hear that parallel running is not wanted at Coatbridge.

We are glad to learn that a Committee of the Trinity House has recently visited the French coast for the purpose of examining some of the important developments which have been made in the use of the electric light for lighthouses. One of the chief characteristics of the French system is the use of *feux éclairs*, or quick flashes, which were described in our leading article on September 1, 1893. On that occasion we pointed out the great advantage of rapid revolution of an optical apparatus of few panels, as compared with the slowly revolving arrangement of many panels as used on our coasts. The importance of the French system can only be fully appreciated during fogs sufficiently thick to obscure the light itself, and to leave only a general diffused light in the direction of the lighthouse. Another feature of French practice is the use of genuine arcs of 45 volts, exposing the bright surfaces of the carbons, instead of the 35 to 38 volts used at St. Catherine's Point. Besides these two highly-important details, there are many other points on which co-operation is desirable, and it is gratifying to learn that the Committee was received by the Lighthouse Department of the Ministry of Public Works with great cordiality.

In our issue for March 16th (p. 557) we gave the charges for telephone service in many of the more important cities of Europe. We have received further information confirming most of the figures already published, but partly supplementing and partly contradicting them. Besides the £8 service in Paris, which appears to be for overhead lines, there is a £16 service for underground lines, and, as in many continental cities, a charge per kilometre for lines extending beyond the local exchange area. In Marseilles there is a £12 underground service in addition to the £8 service. The tariff in Italy for districts with more than 100,000 inhabitants is £12, and for other districts £6. The items which go to make up the charge at Vienna amount to £10, and not £5, as was given by mistake in our recent article. The charges in Russia vary from £39 to £23. 15s. per annum. The rates for the Metropolitan are £20, but under a five years' contract which contains several stringent conditions, a rebate of £3 is allowed. Second and additional connections are made for £15, or for £12. 10s., under a five years' contract; private house connections £12 and £10 respectively. These rates are for connection within one mile of the nearest exchange, and enable a subscriber to speak to any other in the Metropolitan system, which extends over 500 square miles, equivalent to a circle of about 12½ miles radius. We willingly publish this information, but cannot

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admit that the rates compare favourably with those in other countries. It is true that a Metropolitan subscriber enjoys a vast potentiality of communication with any one of thousands of subscribers; but he generally wants to speak to only 50 or 100, as is evidenced by the list which is, as a rule, to be found hung up near a telephone. He has to pay for the privilege of unlimited talk whether he avails himself of it or no.

It has been suggested to us that in Paris and elsewhere, the subscribers have to purchase their instruments, while in this country they are provided by the telephone company. We cannot admit that this is a valuable concession. A telephone is such a nuisance, though perhaps a necessary nuisance, that it is very common to place the main instrument in the clerk's office for general use, and to provide a desk instrument in the private office. But the annual charge, namely, £2. 2s. for a wall instrument, or £2. 12s. 6d. for the desk, is about the same as the retail price at which any subscriber could, if he were allowed, buy the apparatus outright for himself. At present he has no choice but to take the instrument which the Company provides, and these have almost invariably been fitted with Blake transmitters while better ones were available. If, like the electric supply companies, the telephone company brought their wires up to a pair of terminals, and allowed the subscriber to apply whatever apparatus he liked to them, the service would be much better appreciated.

In alluding last week to the Charing Cross and Hampstead line we innocently remarked, "The promoters state that it is intended to run 'light trains at short intervals,' and a 2½ minute service is promised. This looks as if the Liverpool Overhead Railway arrangements, rather than those of the City and South London line, were to be the pattern." By the Liverpool arrangements we merely meant the general idea of motor cars as against locomotives and the general assimilation of the undertaking to a glorified tramway, and we had no intention of conveying the idea which some of our readers have run away with that the trains at Liverpool actually were lighter or ran more frequently than those belonging to the City and South London Railway Company. As a matter of fact, the two-motor-car "trains" on the Liverpool line weigh when full 38¼ tons and seat 114 passengers, whilst those on the City and South London line weigh 37½ tons and seat 96 passengers. So far so good, but whilst the weight of a full train on the City and South London line is 871lb. per passenger, the figure for Liverpool is only 752lb. per passenger, a gain due to the use of motor-cars in place of the locomotives employed by the plucky pioneer electric railway of the world.

Telephone Trunk Lines.—The telephone trunk wire connecting Berlin with Elberfeld-Barmen came into operation last month.

Personal.—Mr. A. B. Blackburn, M.I.C.E. (late with Messrs. Mather and Platt, Limited), has been appointed chief engineer of the Electric Construction Company (Limited).

Glasgow and West of Scotland Technical College.—It is stated that the Glasgow and West of Scotland Technical College is to receive a donation of £25,000 from the Bellahouston trustees.

Coatbridge.—The electric supply station at Coatbridge was opened last Saturday by Lord Kelvin. The plant at this station is entirely driven by gas power, and the alternate current transformer system has been adopted.

Royal Institution.—At the general monthly meeting of this Institution, on Monday last, the special thanks of the members were returned for the following donations to the fund for the promotion of experimental research at low temperatures:—Prof. Dewar, £50; Hugh Leonard, Esq., £50.

Proposed Tubular Electric Railway in Paris.—The French Government, at the suggestion of M. Jonnart, Minister of Public Works, has placed before the Chamber a *projet de loi* empowering the City of Paris to construct a tubular electric railway connecting the Bois de Boulogne with the Bois de Vincennes. Strange to relate, no State aid is invoked.

The Verband der Elektrotechniker Deutschlands.—This Society is to hold its next annual general meeting in Leipzig from June 8th to 10th. The programme will shortly be published, but notice has been given that Mr. Gisbert Kapp, the proposed General Secretary of the Society, will give an address. An exhibition of electrical novelties is to be held during the meeting.

Cable Interruptions:

	Date of Interruption.
Cayenne-Paramaribo	Oct. 15th, 1893.
Bissao-Bolama	Nov. 24th „
Garachico-Santa Cruz de Palma	Dec. 27th „
Fao-Bushire	Mar. 20th, 1894.
Bonny-Cameroons	Mar. 21st „
Brest-St. Pierre (P.Q. Co.)	Mar. 29th „

Telephonic Communication in Italy.—Negotiations are in hand between the Italian and Swiss Governments with reference to the establishment of telephonic communication between Milan, Como, and Lugano, and other towns in Switzerland. The Telephone Company of Lombardy has also been granted a concession for the establishment and operation of a trunk line between Milan and Monza.

The Telegraph Revenue for 1893-94.—The revenue receipts under the heading of Telegraph Service, amounted for the quarter ending March 31st last to £585,000, as against £555,000 for the corresponding period of the previous financial year. The receipts for the year ending March 31st last amounted to £2,540,000, as against £2,480,000, an increase of £60,000, or 2·4 per cent.

The Goodwin Sands Lightship Telephone.—The first call by telephone from the Goodwin Sands lightship was received at Ramsgate on Wednesday evening last week to the effect that there was a vessel on the Goodwins. The Ramsgate, Deal, and Walmer lifeboats were launched, and it was found that a schooner had run ashore on the north sand head during a heavy fog, but was being assisted off by the Ramsgate lugger "Champion."

Electric Heating.—A new application of electricity to manufacturing purposes is reported from Germany in connection with the use of metal plates for pressing and finishing woollen goods. Such plates, which require to be heated, have hitherto usually been warmed either in an oven or by means of steam, but both these processes are troublesome, and involve loss of time, besides leading to uncertainty as to the temperature obtained. It is now proposed to heat the plates by electricity.

Nickel-Plated Electromagnetic Instruments.—In the current number of the *Zeitschrift für Instrumentenkunde*, Dr. A. Ebeling, of the Physikalisch-Technische Reichsanstalt, calls attention to the danger of nickel-plating delicate electromagnetic instruments. A case recently came under his notice in which a deflection of 8deg. could be produced by rotation of the case of an instrument parallel to the needle which was magnetised. He finds that plating, even when so thin as to be quite transparent, has a very marked magnetic effect.

American Institute of Electrical Engineers.—The American Institute of Electrical Engineers is now issuing advanced postcards which, in addition to giving the title of the next Paper, and the name of its author, gives the name of the member

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who will open the discussion. The idea is a good one, as the starting of a discussion is often a most difficult business, and many members who would otherwise not take the trouble to attend, would probably be induced to do so if they could make sure that the debate would be set going by a good speaker.

Société Internationale des Electriciens.—The following is the constitution of the Council of this Society for the year 1895-96 :—President : M. A. Potier ; Vice-Presidents : MM. Arsonval, Sartiaux, Sciama ; Secretaries : MM. René Arnoux, A. Bochet ; Treasurer : M. Hippolyte Clérac ; Members : MM. H. Baron, Ed. Bernheim, A. L. Blondel, Julien Boulanger, L. Clerc, E. Desroziers, G. Dumont, Georges Ebel, G. Gaiffe, Ch.-Ed. Guillaume, A. Larnaude, Max de Nansouty, Louis de Place, Jules Pollard, Radiguet, Jules Richard, de Romilly, Gaston Sautter, Léon Violet.

A Proposed International Electrical Exhibition.—An International Electrical Exhibition, to be opened in July, 1895, is being talked of in Paris. The idea is to make use of the Palais des Machines on the Champs de Mars and the Palais de l'Industrie in the Champs Elysées. In the former will be placed the generators, and in the latter the motors, the powers generated on the Champs de Mars being transmitted to the Champs Élysées. The two buildings are moreover to be connected by an electric tramway, and electric launches are to be run on the Seine.

Friday's Aurora and the Telegraph Wires.—The following query has been addressed by Mr. Preece to the editor of *The Times* :—

Sir : There was an extremely brilliant display of aurora between 10 and 10:45 p.m. on Friday, the 30th ult. It was accompanied, as usual, by very strong earth currents on all telegraph lines. But at 10:20 p.m., when all the telegraph circuits were idle, a peculiar frizzling and bubbling noise was heard upon a telephone inserted upon a long Irish wire at Llanfairpwll in Anglesey. At 2 a.m. on Saturday, the 31st ult., "twangs" were heard, as if a stretched wire had been struck. These were followed by a kind of whistling sound. Were these signals from space, or mere disturbances of atmospheric electricity ?

Thunderstorms.— At Ambleside, last Saturday, lightning struck a gas pipe in the church belfry, ignited the gas, and caused a portion of the structure to be destroyed. At Bradford, last Wednesday, two horses in a stable were killed, and a window in the building was shattered, while a stableman standing near the horses was uninjured. On the same evening a house at Danesmoor was struck by lightning, doors and windows were cut to pieces like matchwood, furniture was smashed, and one of the inmates received an electric shock.

The Telegraph Department.—In answer to a question in the House of Commons on Tuesday evening last, the Paymaster-General said the Departmental Committee upon the working of the Telegraph Department were now considering their report, and he had reason to believe that it would be in his hands in a few weeks. The Committee, however, which was mainly intended to inquire into the possibility of introducing economy into the service, would report for the information and guidance of the Department, and it was not consequently certain that their report would be one which could properly be laid before Parliament.

Royal Meteorological Society's Exhibition.—The Royal Meteorological Society's Fourteenth Exhibition of Instruments, which will open on Tuesday next in the rooms of the Institution of Civil Engineers, 25, Great George-street, Westminster, will be devoted mostly to instruments, drawings, and photographs relating to the representation and measurement of clouds. The exhibition promises to be a very interesting one, and will include original cloud sketches by the late Luke Howard, F.R.S., as well as photographs of clouds by the highest authorities in various parts of the world. The exhibition will remain open till the 20th instant.

Electrical Fires.—Mr. William H. Merrill, Electrician of the Chicago Fire Underwriters' Association, has recently issued his second report, giving 77 instances where fires were caused, or said to be caused, by electricity. The list, says the *Electrical Engineer*, of New York, is very interesting and instructive, showing that in nearly every instance the damage could have been prevented by using better wiring material or by exercising a little common sense in the use of the appliances. In one instance, the cause of a fire was as follows :—"Bell wire tapped to incandescent 50 volt alternating circuit by employees in building, cotton and paraffin insulating covering ignited. Loss considerable."

Capt. Abney on Photometry.—At the Society of Arts on Monday last Capt. Abney commenced a course of lectures on Photometry. He disclaimed any intention of discussing the art of gas testing which is so often confused with photometry. The sperm candle of to-day gave less light than when Parliament in its wisdom decreed that the standard of light should be thus defined, because recent chemical improvements had refined the sperm, and in refining it, had removed certain light-giving constituents. Capt. Abney had used the arc as a quantitative standard of white light for upwards of ten years, and he alluded to the "rediscovery" of this source of light as a quantitative standard, but gave no definite information as to the construction of a standard of any given number of candle-power. He predicted that note-book records of photometric work would soon become obsolete, and that photographic records would become general. The experiment described in a Note in our issue of March 23rd, consisting in the focussing of the sun's rays on a candle flame was admirably illustrated by photographs, and it was shown that the light reflected from the small particles was polarised.

Continuous Rails.—An experiment with continuous rails is about to be tried on an adequate scale by the Baden Railway of St. Louis, U.S.A. The railway, according to the *Railway World*, is practically a street tramway, and is undergoing conversion from horse to electric traction. One provision of the contract for the work calls for the welding of all rail joints for a length of three and a half miles of double track. Experiments on a smaller scale on the West End tramways of Boston have apparently proved successful, as far as the strength of the welds is concerned, for the welding company guarantees no breaking ; but that the "creeping" of the rails, and their expansion and contraction under varying temperatures will not make the continuous rail impracticable, has yet to be determined. The tramway company will furnish the current (300 amperes at 500 volts) for welding. Should the results be favourable, one of the most troublesome features of electric traction, where the rails are used for the return circuit, will be removed, and the experiment will be watched with special interest by tramway companies using this form of traction.

The Use of Gas Motors in Germany.—Prominent among the economies which have been introduced during recent years in Germany, writes Mr. F. H. Mason, the United States Consul-General to Germany, in a report on the use of gas motors, is the use of gas motors in place of steam engines in all the smaller forms of manufacture where the motive force required does not exceed 75 to 150 H.P. At the Frankfort Electrical Exhibition of 1891 most of the dynamos were driven by gas and "caloric" engines, and the display of these motors at that time was almost as varied and interesting to the general public as that of the electrical apparatus to which they were technically subsidiary. There were in operation at that time throughout Germany about 18,000 gas motors, with an aggregate motive force of 60,000 H.P. Since then the gradual cheapening of gas and the rapid extension of electrical lighting and electrolysis have combined to increase very rapidly the use of gas motors, the effectiveness and economy of which were so brilliantly demonstrated at the Frankfort Exhibition. No statistics are available to show the precise number that are at present in use ; but, as the two principal makers of gas engines in Germany have alone made and delivered during the past two years 1,950 motors, it may fairly be inferred that the number in actual service in this country is not far short of 24,000 or 25,000.

Zurich Electric Tramway.—On March 5th some sixty people availed themselves of the Directors' invitation to the trial run on this tramway. The line is 4·6km. long, and is of one metre gauge ; the inclines are severe, and reach a maximum of 6·2 per cent. over a length of 115 metres. The rails are laid

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direct on a stone bed, and weigh about 38kg. per metre. The cars, delivered by the Schweizerische Industriegesellschaft, carry 24–26 passengers; they have each one 18 H.P. Oerlikon motor, of the completely enclosed type, geared by single reduction to the wheels. These cars weigh nearly four tons light, and about $5\frac{1}{2}$ when fully loaded. The conductor is overhead, on iron or wooden poles, and is 7mm. in diameter, and about 20ft. from the ground, and the return is through the rails. These conductors are divided into four pieces, insulated from one another, each section being connected to the station by a feeder of 66 square mm. cross-section. The plant at the station consists of two vertical compound engines of 90 H.P. each, speed, 240 revolutions per minute, driving by belts shunt-dynamos of Oerlikon type XI, giving 66 kilowatts at 550 volts, with 450 revolutions per minute; each of these sets is sufficient to drive the whole system. There is some novelty in the use of accumulators in shunt with the dynamos, to provide the excess current wanted for a moment or two at intervals. The mean current is 90 amperes, and the maximum reaches 200; Tudor cells of 245 ampere hours capacity are used, with an automatic charge and discharge switch. All the electrical plant and fittings were supplied by the Maschinenfabrik Oerlikon. On March 8th the line was opened to the public, who utilised it in extraordinarily large numbers, crowding the cars to an uncomfortable extent.

The Transformation of Mechanical Force into Chemical Change.—A remarkable series of experiments has been carried out by Mr. M. Carey Lea, with the object of ascertaining whether the effects of pressure upon certain substances could be made to yield the same results as light. Mr. Lea began by squeezing the silver haloids, and found these salts were readily blackened in this way, and so gave evidence of partial reduction. It was then tried whether the same agent—mechanical force—would be capable of bringing about analogous chemical changes in other compounds. These experiments differed fundamentally from the pressure experiments of Spring and Bullock, inasmuch as in the present instance, the reactions produced are all endothermic. Energy is consumed in accomplishing them; and this energy is supplied by mechanical force. The results of subjecting a large number of chemical compounds to heavy squeezing in Mr. Lea's apparatus, which was capable of exerting a pressure of upwards of 1,000,000lb. to the square inch, were highly encouraging. The darkening of colour was in many examples well marked. The same results were subsequently repeated with greater ease by the substitution of a shearing for a compression stress on the materials. Mr. Lea's general conclusion from his experiments is that mechanical force can bring about reactions which require expenditure of energy, such energy being supplied by mechanical force in precisely the same way that light, heat, and electricity supply energy for the endothermic changes brought about by these agencies. The converse transformation—that of chemical energy into work—is, from the industrial point of view, by far the greatest chemical problem now awaiting solution. It is by no means certain that such a transformation is practically possible. At least it seems probable, says Mr. Lea, that the improvement in our method of obtaining work from the chemical energy of carbon may be in the direction of substituting electricity for heat as the intermediary.

The Sweating of Coke.—Some observations on the sweating of coke have been communicated by Mr. W. N. Page to the *Engineering and Mining Journal*, of New York. Mr. Page refers to a series of examinations made by himself over a period of ten years upon different cokes, as showing that during the hot summer months dry coke, containing not more than 1 per cent. of moisture, drawn fresh from the ovens and loaded direct into tight box trucks, without any contact with water in the yard, and in complete absence of rain, will become saturated with water when the doors of the truck are tightly closed; while if the doors are left open no such result follows. In the case of a truck so loaded with coke drawn from a beehive oven at red heat, the doors being closed, at the end of a week water would be dripping from the bottom of the truck, and the coke would average from 5 to 10 per cent. of moisture; while in a similar truck, loaded at the same time, but the doors being left open and all other conditions the same, the coke would contain less than 1 per cent. of moisture. These observations being founded upon facts, what is the explanation? It is known that dry carbon, notably fresh charcoal, possesses the peculiar quality of condensing or quietly absorbing and combining oxygen and hydrogen into water; but in the case of the wet coke, while the oxygen can be accounted for, where does the hydrogen come from? Mr. Page asks if it is possible for sufficient quantities of this gas to be contained in the cells of the coke, and be given up so slowly as to diffuse with the oxygen in a closed truck, while escaping from an open one. Though Mr. Page cannot say that sweating does not occur with coke in winter, his attention has been more particularly directed to the phenomenon during dry and hot weather. A remarkable feature observed is that the moisture contained in the coke under such conditions seems in excess of its capacity for absorbing by immersion in water, even for 24 hours. When the coke has laid in stock for some time the sweating is less apparent, or is entirely absent. Ventilation certainly prevents it. In nearly every complaint made by purchasers of their consignments of coke arriving wet, it was found that the trucks had been tightly closed during transit. One obvious deduction to be drawn by coke users is that, although coke stores should be sheltered and roofed in, they should be very thoroughly ventilated.

The Moissan Electric Furnace.—A further communication upon the artificial preparation of the diamond is, says *Nature*, contributed to the *Comptes Rendus* by M. Moissan. It was shown in an earlier memoir that when carbon is dissolved in various fused metals at the temperature of the electric furnace and at the ordinary pressure, it invariably crystallises out upon cooling in the form of graphite of density about 2; but that when the operation is performed under increased pressure the density and hardness of the carbon which eventually separates are augmented, and black diamonds are produced in considerable quantity. A modification of the original form of these pressure experiments is now described, which results in the production of small but perfectly transparent and colourless diamonds similar to those found naturally. The former experiments were made with iron and silver as solvents for the carbon, the mixture of metal and excess of charcoal being heated in the arc of the electric furnace under pressure until most of the charcoal was dissolved in the white-hot metal, after which the hot crucible was thrown into a tank of water to effect sudden cooling. Bismuth has since been tried as a solvent, but is not found suitable, as a violent explosion is caused when the fused mass is projected into water, probably owing to the sudden decomposition of a carbide of bismuth. Iron is therefore used, and the cooling is effected by pouring the contents of the crucible into a bath of just melted lead. The solution of carbon in molten iron, being lighter than liquid lead, rises to the surface in spherical globules; the smaller spheres solidify before reaching the surface of the lead, but the larger ones are still liquid, and are still so hot that they cause the lead at the surface to burn in contact with the air, incandescent particles of metal and oxide being projected out, and torrents of fumes of litharge produced. Upon removing the globules floating at the surface of the lead, dissolving their leaden coating in nitric acid, and subsequently removing the iron by suitable solvents, as previously described by M. Moissan, the transparent diamonds are readily isolated. They frequently exhibit well-defined crystal faces, which are usually curved and striated and etched with cubical markings exactly like those of natural diamonds. They possess the same wonderful limpidity, high refractive power, hardness, and density (3·5) as native diamonds, and exhibit many of the properties, such as anomalous polarisation and occasional spontaneous disruption, owing to their state of strain resulting from their formation under high pressure, which are characteristic of some Cape diamonds. The hemihedral forms of the cubic system appear to predominate in the crystals examined. They scratch rubies, and resist the action of a mixture of potassium chlorate and fuming nitric acid, but burn in oxygen at a temperature of about 900deg. with formation of pure carbon dioxide.

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THE AYRTON-MATHER GALVANOMETER SHUNT.

The Paper on "A Universal Shunt Box for Galvanometers," which was read before the Institution of Electrical Engineers last week, suggests by its title that the device therein described is of universal, that is to say general, application. It might be inferred, from one or two passages in the Paper, that a shunt box of the kind described is suitable for use with almost any galvanometer, and for almost any of the purposes to which galvanometers are commonly applied. Several qualifications, however, are necessary, although the method will no doubt prove of use in a large number of cases. One of these qualifications is admitted, namely, that the current in the main circuit must be kept constant,

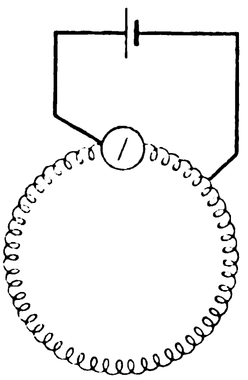

FIG. 1.

but this is not made sufficiently prominent. An ordinary shunt-box used, as is the common practice, with its own galvanometer, has a definite multiplying power, and the plug-holes are stamped $\frac{1}{10}$, $\frac{1}{100}$, &c., to denote this power; and similarly a shunt for damping a ballistic galvanometer has a definite damping constant. In neither of these respects does the Ayrton-Mather shunt-box appear to fulfil the same purpose. The illustrations, which we reproduce in our reprint of the Paper, are partly diagrammatic and partly realistic. Fig. 1 of the Paper requires a little investigation before the connections can be traced. We venture to offer the accompanying diagram to those who have no time or inclination for this investigation. Fig. 1 represents a battery, galvanometer,

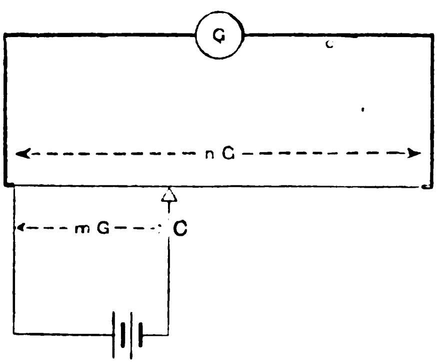

FIG. 2.

and resistance. Two circuits are offered to the current, the one through the galvanometer and one tenth of the resistance, and the other through nine-tenths of the resistance.

The simplest way of examining this method of shunting a galvanometer, is the one suggested by Mr. Crompton, and is illustrated in the accompanying figure (Fig. 2). If we have a galvanometer of any resistance, G, and we place it in series with a stretched wire resistance, n times G, and then intercept an amount m G of this wire between the battery contacts, it is easily seen that the amount of current which will go through the galvanometer will be

$$c = C\frac{m}{n+1},$$

where C is the whole current in the battery circuit. Therefore the absolute multiplying power of the shunt is

$$\frac{n+1}{m},$$

and this requires that both n and m should be known. Moreover, in order that C might be constant, some compensating resistance must generally be introduced into the battery circuit; and the value of this would vary with every different galvanometer resistance; as also would the absolute multiplying power. There is one case where a compensating resistance might be dispensed with; namely where the resistance in the battery circuit is practically infinite as compared with n G.

As Professor Ayrton has shown, the relative values of the shunts, on this system, are quite independent of the galvanometer resistance. In other words, if half the wire is intercepted between the battery contacts then half the current will pass through the galvanometer that would pass if the whole wire were intercepted. Not, be it noticed, half the *main* current. Now, operations where it is useful to know the first relation are the exception rather than the rule, for it is generally desired to find the value of the current in the main. Prof. Ayrton admits as much when he says that it is necessary to make n so large that practically the wire does not shunt the galvanometer at all when it is all intercepted between the battery contacts. Therefore the shunt n G must be practically infinite as compared with G; while, as we have just seen, the external resistances in the battery circuit must be practically infinite as compared with n G. This introduces two infinities at a stroke.

In regard to stock shunt-boxes, we are inclined to doubt that they would have any very extensive use. Apart from the fact that when using them the operator would, as a rule, be completely ignorant of their absolute multiplying power, unless special tests had been made to discover it, there are two other objections. Firstly, they could only be used with galvanometers of very low resistance; secondly, there would always be an annoying element of doubt about the limits of error in the galvanometer readings where it is desired to measure the main current.

Prof. Ayrton expressed some astonishment at the fact that this simple device was not more generally known, and that "stock" shunt-boxes were not sold by instrument makers. Supposing for a moment that the arrangement were well known, would it be to the interest of instrument makers to push it? Would they not very much prefer to go on selling specially made boxes with each galvanometer? This is a deplorably unscientific suggestion, but we are speaking of tradesmen as tradesmen, not as skilled physicists, which they happen sometimes to be.

A UNIVERSAL SHUNT BOX FOR GALVANOMETERS.*

BY W. E. AYRTON, F.R.S., AND T. MATHER.

Several years ago Mr. Latimer Clark drew attention to the fact that when shunts were used with a ballistic galvanometer in the comparison of the capacities of condensers, the results were inaccurate if the multiplying powers of the shunts were assumed to be the same as those employed with steady currents; shortly afterwards the matter was investigated mathematically by the late Mr. Hockin, and he showed that the inaccuracy was caused by the change which the application of the shunt produced in the damping of the swing of the ballistic galvanometer. Hence the instantaneous deflection of a galvanometer when shunted showed an extra diminution, as if its resistance had been increased by an amount which depended on the details of the construction of the particular galvanometer, and on the adjustment of the controlling magnet.

In 1892, when giving a preliminary account of our "workshop ballistic galvanometers" at the Physical Society, we incidentally mentioned a method that we had devised of constructing shunts which entirely overcame this difficulty. At that time we had only perceived that our method of constructing *constant-damping* shunts was of value in connection with ballistic galvanometers; but subsequently it occurred to us, when specifying the resistance of such constant-damping shunts, that this method of construction not only removed the difficulty which had been pointed out by

* A Paper read before the Institution of Electrical Engineers.

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Mr. Latimer Clark in connection with ballistic galvanometers, but it enabled the same shunt box to be used with any number of different galvanometers of any resistance and of any type, and with an accuracy in the measurement far greater than could be obtained with the ordinary form of shunt box which had been specially constructed for the particular galvanometer.

As this method of making shunt boxes has not yet been published, and as it possesses important advantages of which we were not aware when we alluded to it at the Physical Society, we have thought that a short description of the method may interest the members of the Institution of Electrical Engineers.

To appreciate its advantages let us first consider the common, well-known method of constructing shunts, and the defects it possesses.

1. The resistances of the 1-10th, 1-100th, and 1-1,000th shunt must have exactly 1-9th, 1-99th, and 1-999th of the resistance of the galvanometer; therefore, if the resistance of the galvanometer be 1,000 ohms, for example, the shunts must have 111·1, 11·11, and 1·111 ohms resistance; hence we must construct the 1-1,000th shunt accurately to the 1-1,000th of an ohm if we wish it to be correct to even 1-10th per cent.

2. But the galvanometer is wound with copper wire; we are, therefore, at once met with the difficulty as to what wire we ought to employ in winding the shunts. If we use German silver, platinoid, manganin, or any substance of low temperature coefficient for the wires of the shunt coils, their resistances may be quite constant, but a rise of 10°C. in the temperature of both the shunts and of the galvanometer will make an error of 4 per cent. in the resistance of the former relatively to that of the latter.

If, on the other hand, we wind the shunts with copper wire, then, since the shunts are not inside the galvanometer case, it is very difficult to ensure, from the readings of thermometers, that there is not a difference of some two or three degrees between the mean temperatures of the shunt box and of the galvanometer, so that the resistances of the shunts may easily be 1 per cent. wrong relatively to that of the galvanometer.

In fact, except in the rare case when the galvanometer as well as the shunts are wound with German silver, manganin, or other wire of low temperature coefficient, it is useless spending time making accurate adjustments of the resistances of the shunt coils as ordinarily constructed.

3. Even if the resistances of the shunts be exactly 1-9th, 1-99th, and 1-999th of the galvanometer, they act as if they did not allow 1-10th, 1-100th, and 1-1000th respectively of the charge in a condenser to pass through the galvanometer when used ballistically.

4. Lastly, for each galvanometer there is needed a separate set of shunts.

All these defects arise from the fact that the method hitherto adopted of varying the current through a galvanometer while the current in the main circuit remained the same, has consisted in varying the resistance of the shunt to the galvanometer. If, however, we leave the shunt to the galvanometer untouched, and, instead, vary the current through the galvanometer by varying the point of attachment of the main leads, we remove all these difficulties at once.

A shunt box constructed in this latter way is seen in Fig, 1. The terminals A and B of the shunt box are permanently connected respectively with the terminals of the galvanometer G, while the terminals B and C of the box are connected with the two main wires which lead the current up to, and away from, the galvanometer and shunt. The ends of a coil of *any* resistance r ohms are permanently connected as shown, and at points in this coil corresponding with $\frac{r}{10}, \frac{r}{100}, \frac{r}{1,000}$ ohms permanent connections are made with the various blocks of the shunt box as illustrated.

Then, whatever be the resistance of this coil r, compared with the resistance of the galvanometer g (either, or both, of which may therefore be unknown), it is easy to show that if G amperes be the current flowing round the galvanometer when a plug is placed into the hole marked d, it will be $\frac{G}{10}, \frac{G}{100}$, and $\frac{G}{1,000}$ amperes respectively when the plug is put instead into the holes marked c, b and a respectively, provided that the current in the main circuit remains constant—the condition which is, of course, assumed to be true in the ordinary use of shunts. Or, if a definite quantity of electricity flow into or out of a condenser in the main circuit, and Q coulombs be the quantity of electricity that flows round the galvanometer when the plug is in the hole marked d, $\frac{Q}{10}, \frac{Q}{100}$, and $\frac{Q}{1,000}$ coulombs will be quantities that flow round the galvanometer when the plug is put into the holes c, b, and a respectively, and the deflections will correspond with these quantities.

For let the constant current in the main circuit be called A: then, when plug is in hole d, the galvanometer current equals

$$\frac{r}{r+g}\text{ A, say G};$$

when plug is in hole c, the galvanometer current equals

$$\frac{\frac{r}{10}}{\frac{r}{10}+\left(\frac{9}{10}r+g\right)}\text{ A, or }\frac{G}{10};$$

when plug is in hole b, the galvanometer current equals

$$\frac{\frac{r}{100}}{\frac{r}{100}+\left(\frac{99}{100}r+g\right)}\text{ A, or }\frac{G}{100};$$

when plug is in hole a the galvanometer current equals

$$\frac{\frac{r}{1,000}}{\frac{r}{1,000}+\left(\frac{999}{1,000}r+g\right)}\text{ A, or }\frac{G}{1,000}.$$

Similarly, if K be the number of coulombs flowing into, or out of, a condenser in the main circuit, and pK or Q be the number of coulombs that flow round the galvanometer when the plug is put into the hole marked d, it may be proved that, *since the resistance of the galvanometer plus that of the shunt is constant, and therefore the damping is constant*, the quantities of electricity will flow round the galvanometer when the plug is put instead into the holes marked c, b, a, respectively are $\frac{Q}{10}, \frac{Q}{100}, \frac{Q}{1,000}$ coulombs.

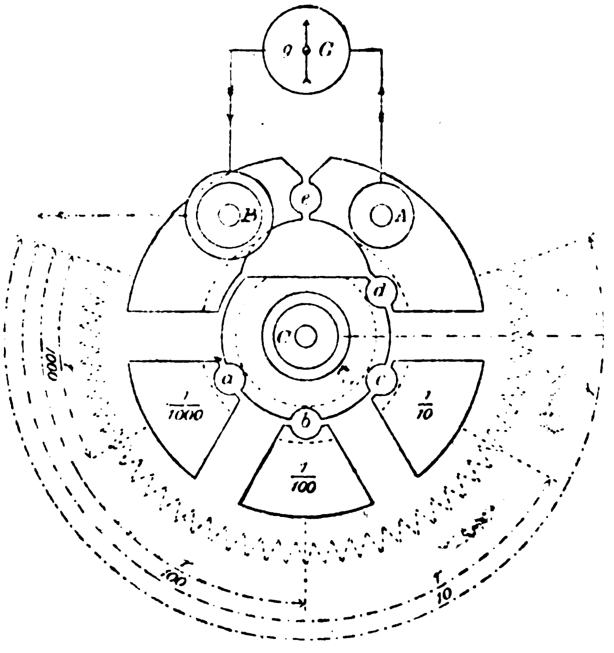

FIG. 1.

Hence the galvanometer may be wound with copper or with any other wire; a single set of shunts may be made of manganin wire, and be accurately subdivided into *exact* numbers of ohms, *fractions of an ohm being unnecessary with our system*; the galvanometer may have any resistance and be at any temperature, provided it is constant while a set of tests is being made—then the sub-division of a steady current or the sub-division of an instantaneous rush of electricity into parts having the ratios of $1, \frac{1}{10}, \frac{1}{100}, \frac{1}{1,000}$, is effected with *great accuracy*.

Stock shunt boxes, ready wound for use with any galvanometer, in the measurement of steady currents or of instantaneous rushes of electricity, are exhibited on the table.

The arrangement of shunt box illustrated in Fig. 1 may be regarded as possessing one defect—viz., that the whole current flowing in the mains cannot be sent round the galvanometer without disconnecting the main wire from the terminal C, and connecting it instead with the terminal A. To save the trouble of having to do this, and to enable every combination to be made by simply shifting the plugs, we sometimes construct the blocks of the shunt box as seen in Fig. 2. When one plug is placed and

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left in the hole marked *h*, and a second plug is placed in one or other of the holes marked *d*, *c*, *b*, or *a*, we obtain exactly the results already described in connection with the box seen in Fig. 1. Placing, however, one plug only in the hole marked *f*, the entire current flowing in the mains circulates round the galvanometer. If a plug be placed in the hole *f*, and another in the hole *j*, the galvanometer is short-circuited—a result obtained by placing the two plugs in the holes marked *d* and *e* in Fig. 1. The arrangement shown in Fig. 2 has the further advantage that it is possible, by putting a single plug into the hole marked *j*, to disconnect one terminal of the galvanometer from the circuit without breaking the circuit. This method of connecting is convenient to employ when taking the zero with a very sensitive galvanometer, for in that case it may happen that, although the galvanometer is apparently short-circuited through a very low resistance, enough of the main current, although but an extremely small fraction, passes round the galvanometer to produce a small deflection.

When, however, *r* is more than about ten times as great as *g*, the simpler form of shunt box illustrated in Fig. 1 is sufficient for ordinary purposes; for, although by merely shifting the plug with this type of box, it is impossible to send a greater current round the galvanometer than $\frac{r}{r+g}$ A amperes, where A is the current in the mains, this value of G, being more than $\frac{10}{11}$ A, is sufficiently near A for ordinary purposes.

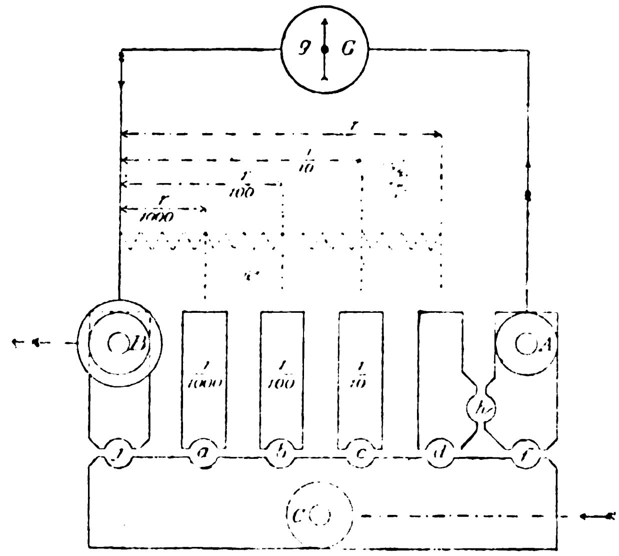

Fig. 2.

Of course, whatever be the value of *r*, whether large or small compared with that of *g*, the current that flows round the galvanometer when the plug is put into the poles marked *c*, *b*, and *a* respectively, is exactly 1-10th, 1-100th, and 1-1,000th of its value when put into the hole marked *d*. The only advantage that is gained by making *r* large compared with *g* is that $\frac{r}{r+g}$ A, or G, the unit current, becomes then practically equal to A.

The method of using shunts above described has, then, the advantage that it enables the same shunt box to be used with any galvanometer of any resistance, whether ballistic or not; but it does more than that, for a consideration of our method of varying the point of attachment of one of the mains, instead of varying the resistance of the shunt itself, shows that *any ordinary* resistance box can be employed as a shunt with *any* galvanometer, and the fractions of the current that pass round the galvanometer and through the shunt respectively can be read off at once, *without any calculation and without a knowledge of the resistance of the galvanometer*, to a far higher degree of accuracy than is possible with a set of shunts specially constructed for the particular galvanometer in the ordinary way.

By employing this device we also find that great simplification and cheapening of cost is effected in the employment of a d'Arsonval galvanometer with shunts of platinoid or manganin sheet for the measurement of electric currents over a wide range.

ADDENDUM, received April 2, 1894.

It is well known that with the ordinary method of constructing shunts the resistance of the circuit is altered when the shunt is varied. An interesting question, therefore, arises whether this change in the resistance of the circuit is greater with the method that we have proposed of constructing a shunt or with the ordinary method.

With the ordinary method of keeping the main leads M_1, M_2 (Fig. 3) permanently connected with the galvanometer G, and of varying the current through the galvanometer by altering the resistance, *s*, of the shunt, the change that is produced the in resistance of the circuit on applying this shunt is, as well known, *from* g to $\frac{sg}{s+g}$, that is, the resistance is diminished *by* $\frac{g^2}{s+g}$. If then the shunt be such as to allow $\frac{1}{n}$th of the current to pass through the galvanometer s equals $\frac{g}{n-1}$, and the resistance in circuit is diminished by $\frac{n-1}{n} \times g$ when this hunt s applied. For example, if n be 10, the resistance of the circuit will be diminished by $\frac{9}{10}$th of g.

With our proposed method of keeping a *fixed* resistance r attached to the galvanometer G (Fig. 4), and of varying the current through the galvanometer by varying the connection of one of the main wires, for example by moving the main wire M_2 from the point d to the point c, the resistance of the circuit is altered *from* $\frac{rg}{r+g}$ to $\frac{\frac{r}{n}\left(\frac{n-1}{n}r+g\right)}{r+g}$ that is the resistance in the circuit is diminished *by* $\frac{1}{r+g}\left\{\frac{n-1}{n}\cdot rg - \frac{n-1}{n^2}r^2\right\}$ . . . . (1)

Now this expression depends not merely on the values of n and g, but also on the value of r. If r is selected so as to be less than ng the expression (1) is positive, that is the resistance of the circuit is *lessened* by shifting the main M_2 from the point d to the point c; whereas, if r is selected so as to be greater than ng the expression (1) is negative, which means that shifting the main M_2 *increases* the resistance of the circuit. Lastly, if r be chosen so as to be exactly equal to ng, shifting the main produces *no change whatever* in the resistance of the circuit, so that the current *now* passing through the galvanometer after shifting M_2 is exactly $\frac{1}{n}$th of the current that *previously* passed through the galvanometer, for the current in the main circuit undergoes no change whether the resistance of the circuit be large or small.

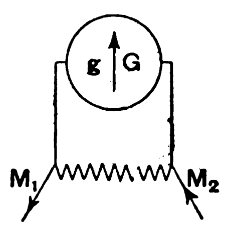

Fig. 3.

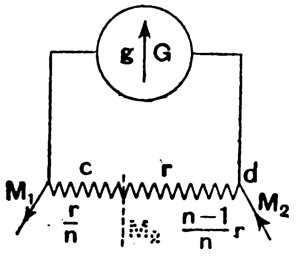

Fig. 4.

By selecting r, then, so that it is roughly equal to ng, our proposed arrangement gives the following result on shifting the main M_2 from d to c:—

(*a*) If the resistance of the rest of the circuit be large compared with that of the galvanometer, the current that now passes through the galvanometer is exactly $\frac{1}{n}$th of that which *previously* passed, whatever be the temperature.

(*b*) If the resistance of the rest of the circuit be even small compared with that of the galvanometer, the current that now passes through the galvanometer is very nearly $\frac{1}{n}$th of that which *previously* passed, whatever be the temperature.

Contrasted with this we have, with the ordinary method of applying a shunt, the result:—

(*a*) Even if the resistance of the rest of the circuit be large compared with that of the galvanometer, it is only when the temperature has one definite value that the current that now passes through the galvanometer is exactly $\frac{1}{n}$th of the current that *previously* passed.

(*b*) If the resistance of the rest of the circuit be small compared with that of the galvanometer, the current that *now* passes through the galvanometer is far greater than $\frac{1}{n}$th of the current that *previously* passed.

Lastly, whatever be the values of g, r, and n our method of altering the current through the galvanometer produces less change in the resistance of the circuit than the ordinary method. For, as already seen, with the ordinary method of applying a shunt the resistance of the circuit is diminished by $\frac{n-1}{n}g$, while on moving the main M, from d to c with our method the resistance of the circuit is diminished by

$$\frac{1}{r+g}\left(\frac{n-1}{n}rg - \frac{n-1}{n^2}r^2\right);$$

therefore the ordinary diminution of resistance, minus the diminution of resistance in our case, equals the difference between these expressions, which is

$$\frac{(n-1)(ng^2+r^2)}{n^2(r+g)} \quad . \; . \; . \; . \; . \; . \; . \; . \quad (2)$$

Now this expression (2) is always positive, when n is greater than unity, therefore our method of shunting produces the *less* change in the resistance of the circuit in all cases.

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DISCUSSION.

Speakers who have returned their proofs revised have their remarks prefaced by an asterisk.

Mr. HIGGINS sent a communication, which was read by the Secretary, in which was enclosed a drawing of a form of apparatus which he said he had used in exactly the same manner and for the same purpose for the past twenty years.

Mr. MORDEY said he had not, perhaps, followed Prof. Ayrton's description closely, and there might be others in the same difficulty. There were two points he would like to have made clear. Apparently, if the connection at one point were altered the resistance of the whole circuit was altered. The other point was whether the relative resistance of the shunt and the galvanometer did not matter.

Mr. CROMPTON said rather a simpler method was to use a graduated wire and shunt it, when they got into the potentiometer method at once.

*Prof. AYRTON said the graduated wire would not do at all when they were dealing with a galvanometer with a resistance of some thousand ohms, for they wanted the greater part of the current coming along the main to go through the galvanometer, and that would not be the case unless they had their graduated wire resistance large compared with that of the galvanometer. There was no doubt, of course, that every resistance box was a graduated wire, and they might say whenever they used a resistance box that they used a graduated wire, but that was not using a graduated wire in the ordinary sense. Mr. Higgins said he had used the principle of the method for twenty years. He could only say if Mr. Higgins had announced, when Mr. Latimer Clark's and Mr. Hockin's Papers were read, "Here is a method which gets over your difficulty, and which renders the mathematics of Mr. Hockin unnecessary," he would have conferred a very great benefit on electricians, for certainly they had not until recently seen how they could arrange a system of shunts so that for ballistic purposes the ratios would be exactly the same as they were for direct currents, and certainly they had not seen that it was possible to make stock shunt boxes do for any galvanometer. If they had, then why did the instrument makers not construct them? So far from the method of making a universal shunt box being previously recognised, why, even Mr. Mordey had not yet appreciated the principle that the resistances of the shunts might have any value if they were only properly related to one another, because, he asked, why was it not necessary to make those resistances of particular values relatively to the resistance of the galvanometer. With regard to the point spoken of by Mr. Mordey, that if they altered the shunt connection they altered the resistance in the main circuit, that, of course, was an objection to all ordinary shunts. If they changed the shunt in an ordinary box they altered the resistance in the main circuit, and therefore they altered the current, unless they were dealing with very high resistances in the main circuits, testing the insulation of a cable or a condenser, or something of that kind. He had put in the proviso, "provided that the current in the main circuit remains constant," a condition which was assumed to be true in the ordinary use of shunts. With regard to Mr. Mordey's other point, the proof was given in the Paper, on slip 2. It made no difference what were the values of r and of q so long as they had fixed values for the time they were making the experiment. Whatever the resistance of the box or galvanometer, provided they remained constant, say for ten minutes, it did not matter what r was. They had also exactly the same relationship if they were measuring the capacities of condensers or submarine cables; they had exactly the same proportion, and might use exactly the same shunt boxes, without employing the correction which Mr. Hockin showed was necessary in the ordinary employment of shunts.

French Electric Coast Lights.—The Trinity yacht "Irene" has just returned from a visit to the French coast. The visit was made by a Committee of Trinity House with a view of obtaining full information respecting "*les feux éclairs.*" The Committee inspected the lighthouse of La Hève, on the extreme point of the northern bank of the estuary of the Seine, from which a light of the new type had been shown for some months. It was also desired to observe the system of gas-lighted buoys, by means of which the French authorities hope to avoid the necessity of maintaining costly lightships in certain positions. The Committee consisted of Captain G. R. Vyvyan, Admiral Sir Leopold M'Clintock, and Captain Slader, elder brethren of the Trinity House, who were accompanied by Mr. Charles A. Kent, the secretary, and Mr. Thomas Matthews, the engineer to the Corporation. At Havre the Committee were met by M. Bourdelles, the Inspector-General, M. Guirand, engineer for the Seine District, MM. Ribière and Vetillart, also engineers of the Lighthouse Department of the Ministry of Public Works, and by them were received with the greatest courtesy and good will. The party visited the lighthouse at La Hève, where the whole of the system was fully explained in detail, the quick flashes of the light being shown to be produced by rapid rotation of the lenses. The Committee subsequently, when crossing the Channel, made some comparisons of the quick flashes of La Hève lights with the slower characteristics of the St. Catherine's electric light.

ON CATHODE RAYS IN GASES UNDER ATMOSPHERIC PRESSURE AND IN EXTREME VACUA.*

BY PHILIPP LENARD.

(*Concluded from page 616.*)

17. Gases are less illuminated by the cathode rays the more they are attenuated. In measuring the radiation lengths in air and hydrogen the following was noticed:—The luminosity of the two gases at atmospheric pressure described above (3, 15) quickly loses in brightness and gains in extent as exhaustion proceeds, as might be expected from our conception of this luminosity as a consequence of the absorption of the rays in the gas. The lengths of the illuminated tracts are not to be exactly indicated, since the luminosity, faint in itself, always decreases gradually from the window, but they were comparable with the radiation lengths (Table III.). While the luminosity of the gases diminishes, the glass phosphorescence of the tube increases; already at 50mm. pressure, both in air and hydrogen, the glow is imperceptible in presence of the phosphorescence. The interior of the tube now appears dark, and remains so until the pressure has fallen to about 2mm. At this exhaustion the gases recommence to glow much brighter than before, and in a very different manner. The light no longer proceeds from the window, but from the two metallic clamps holding the observation tube. At first in their neighbourhood, and then after further exhaustion, along its whole length the tube is filled with a reddish (sometimes I find "bluish" noted) and fairly bright column of light. Conductors in the neighbourhood of the tube have some influence upon the distribution of this light. If the tube is, for instance, grasped in the hand in one place, the column of light usually ends at that point, and the remainder of the tube remains dark. This was utilised in the previous and also in the subsequent experiments (16, 18, 20), when the screen during observation had to be protected from extraneous light; the phosphorescence at the screen or the glass wall is not affected by the hand or other conductors. This light remains down to very small pressures: that it again disappears in extreme vacua has already been noticed above (12, 13). The glowing of the gas has no close connection with the cathode rays. For, on the one hand, it is not necessarily extinguished,† when the cathode rays are intercepted from the observing space, be it by moving the screen towards the window, or by a magnet near the discharge tube. On the other hand, the light column disappears always and completely when the observing tube is surrounded along its entire length by wire gauze, touching the window wall and the metal cap at the other end. The phosphorescence of the glass wall and the screen, as well as the luminosity of the window are, however, retained in the gauze envelope, as also the magnetic deflection of the rays picked out by a diaphragm (*see* 18 below). The gas, under low pressure is not, therefore, illuminated by the cathode rays, but by the same electric forces, due to the generating apparatus, which produced the small sparks (10) under ordinary pressures in the observing space. Thus the light column also appears when cathode rays are produced in an altogether different vacuum tube in the neighbourhood. That the first mentioned glowing of the gas, attributable to irradiation by the rays, persists after the exclusion of the electric forces, had already been shown before (10), at least for air at ordinary pressures.

In other gases also (*see* 18 below) essentially similar phenomena were observed, as in air and hydrogen.

The negative glow light in Geissler tubes is also to be regarded as gas illuminated by cathode rays.‡ Between that phenomenon and the glow observed here and attributed to irradiation there exists a correspondence, inasmuch as in both cases the light disappears at high exhaustions, appears fainter and larger when the pressure increases, and then becomes brighter and smaller. But whereas the glow in the Geissler tube has already become very bright and small at 0·5mm. pressure, the gas in our experiments remains much darker up to 760mm. pressure, and yet the illuminated space is much larger. This difference cannot, therefore, be attributed to an inferior intensity of the rays here used. But it will be explained as soon as we can show that at higher pressures cathode rays of a different kind are produced, which are much more strongly absorbed by gases than the rays investigated hitherto and produced at very low pressures.

18. Different gases are turbid media to very different degrees. With greater permeability we invariably find associated greater clearness. To study the manner of propagation of the cathode rays in different gaseous media we observe the course of pencils of rays separated out by a diaphragm, and traced in phosphorescent

* *Wiedemann's Annalen.*

† Sometimes it is. The cathode rays appear to support the formation of the light column. This may be connected with the fact that the cathode rays make the observing space conducting (11).

‡ Compare Hertz, *Wied. Ann.*, 19, p. 807, 1883.

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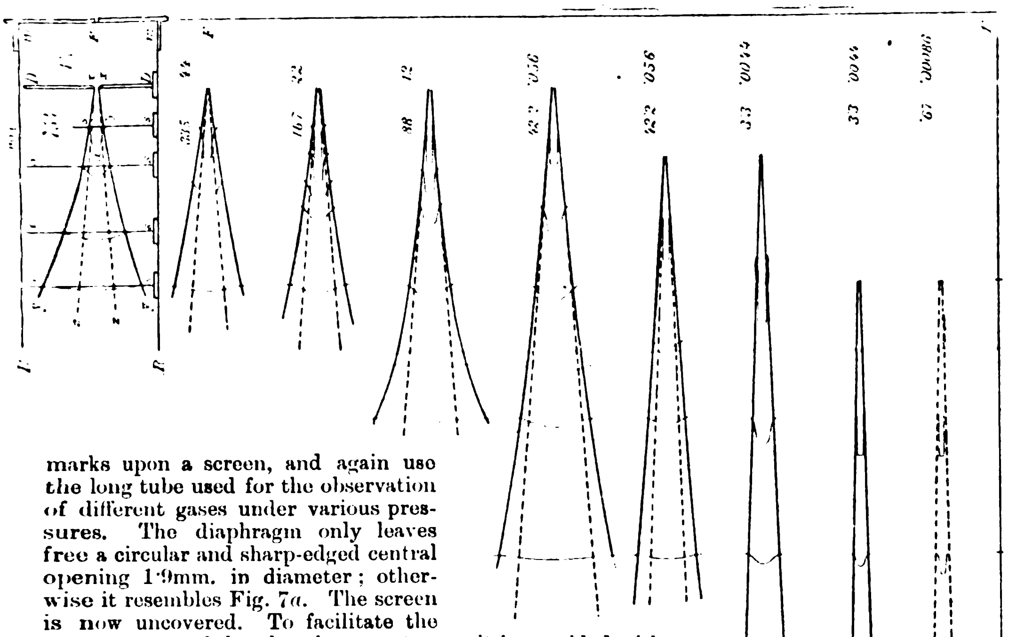
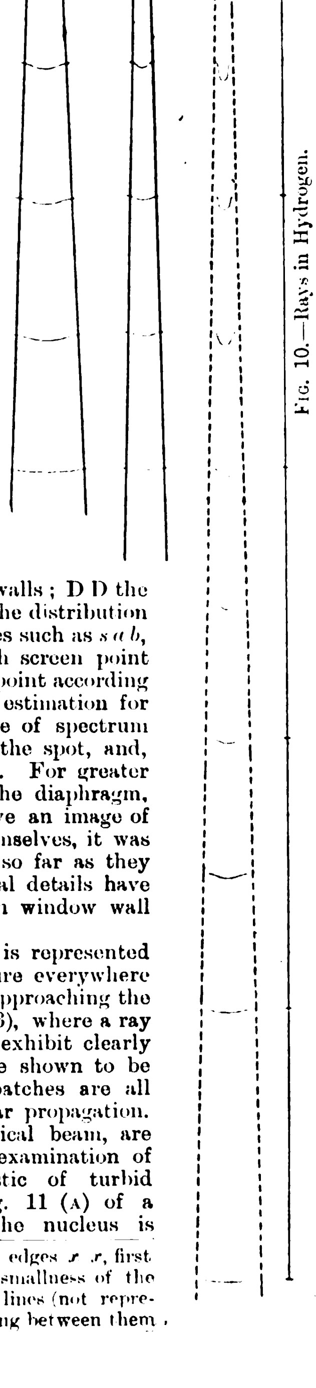

Fig. 10.—Rays in Hydrogen.

marks upon a screen, and again use the long tube used for the observation of different gases under various pressures. The diaphragm only leaves free a circular and sharp-edged central opening 1·9mm. in diameter; otherwise it resembles Fig. 7*a*. The screen is now uncovered. To facilitate the measurement of the phosphorescent spots it is provided with black paper strips (Fig. 9*b*) of measured sizes and distances on the side away from the window, from which it is observed. If the spot falls upon this scale in a manner unfavourable for measurement, it is displaced by approaching a magnet. This also offers the opportunity of making sure that all the rays observed are deflected in the manner characteristic of

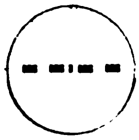

Fig. 9b. (Half Size.)

cathode rays. The ray passing through the diaphragm does not mark its course in the gas except at high pressures, as might be expected from the previous results; the glass wall also remains dark behind the diaphragm, only in front of it, up to the window, it glows green.

What was observed on the phosphorescent screen cannot be better exhibited than as graphically represented in Fig. 10. Each representation, such as Fig. 10, No. 1, is intended as a section through the axis of the rays and the observation tube. *m m* is the window wall with the window F; *m* R are the tube walls; D D the diaphragm; *s s* is in each case a tested position of the screen. The distribution of brightness in the phosphorescent spots is shown by small curves such as *s a b*, drawn in such a manner that the horizontal distance from each screen point to the curve gives the brightness of phosphorescence of that point according to an arbitrary scale, which is kept as uniform as possible by estimation for all the figures. The representation is that usual in the case of spectrum lines; it gives the distribution of light along a diameter of the spot, and, by rotation round the axis of the beam, over the whole spot. For greater clearness all the spots of a beam, together with the hole in the diaphragm, are joined by the horizontal curves, *x y*, which, therefore, give an image of the beam, although in most cases, as shown by the spots themselves, it was certainly not sharply defined. The beams are always drawn so far as they continued to give any well-marked spots at all. All unessential details have been omitted from the beams. F F always means the common window wall of different beams to be compared.

Let us now study the rays in hydrogen (Fig. 10). In No. 1 is represented a beam in hydrogen at ordinary pressure (compare the pressure everywhere indicated). It is fairly straight, the propagation much more approaching the rectilinear than in air of equal pressure (compare 8 and Fig. 3), where a ray proper never existed. This ray is, however, definite enough to exhibit clearly the deflection by a magnet. And yet hydrogen, which will be shown to be the clearest gas, is rather turbid, for the phosphorescent patches are all much larger than they could possibly be in the case of rectilinear propagation. The extreme limits of rectilinear propagation, of the geometrical beam, are given by the dotted line *x z*.* We further notice, on closer examination of the first phosphorescent spot another property characteristic of turbid media. This spot consists, as shown by the curve and Fig. 11 (A) of a very bright nucleus surrounded by a less bright halo. The nucleus is not yet sharply marked off from the halo, but still distinctly enough. Such a phenomenon is never witnessed in the case of rectilinear propagation. It is neither seen in cathode rays in a perfect vacuum in any position of the diaphragm or the screen, nor is it shown in the case of light. If we replace the window by an equally large illuminated aperture, the phosphorescent screen by a paper screen, we obtain with the same diaphragm under all circumstances nothing but more or less sharply-defined spots, in which we never find a nucleus distinct from a halo. The introduction of a glass trough with dilute milk between the window and the diaphragm, or between the latter and the screen, at once gives nuclei and halos. The nuclei are equal in size to the patches of light without milk, and therefore correspond to rectilinear rays, whilst the halos represent diffused rays. To complete the correspondence, the milk must in this experiment be diluted so far that besides diffused luminosity one can just perceive sharp images of bright objects through the trough. In the case of cathode rays in hydrogen, also, the nucleus of the phosphorescent patch is of the size corresponding to rectilinear propagation, only the halo overlaps beyond the geometrical shadow (*x z*). The diffused rays here only make up a small fraction of the total rays, for the halo is feeble in comparison with the nucleus. But if we now displace the phosphorescent screen further from the window we see that the nucleus becomes darker, the halo lighter, so that soon the limit between the two vanishes (compare the second patch in Fig. 10, No. 1); the nucleus is, so to speak, devoured by the halo. As the path through the turbid medium becomes longer, more and more rays are deflected from the straight path, and turned through larger and larger angles. Owing to this increasing diffusion the ray expands more and more (*see* the further phosphorescence patches), the limits of the patches become very ill-defined, and the screen appears almost uniformly illuminated.

On reducing the pressure down to 335mm (No. 2) a change at once takes place; all the patches become narrower, sharper, and brighter; all signs of increasing limpidity. The nucleus of the first patch is now separated very sharply and strikingly from the delicate halo, as seen in Fig. 7 (B). On further diminishing the pressure, down to 167mm. (No. 3), the halo round the first spot almost entirely disappears. In this figure it is specially well seen how, on displacing the screen, the halo is extended and increases in brightness at the expense of the nucleus. The beam is perceptible, but not very well, and is broader than the geometrical beam. Its front portion is even more contracted in the following diagram (No. 4), at 88mm. pressure. Here, for the first time, we meet with a sharp spot without any halo*, so that in hydrogen of 88mm. pressure no diffusion is observable along the path

* These lines would, therefore, if produced beyond the diaphragm edges *x x*, first intersect and then fall upon the frame of the window. Owing to the smallness of the scale they are not put in by construction, but by calculation. The lines (not represented) which join the window and the diaphragm without intersecting between them would run nearly parallel.

* Such spots might, doubtless, have been produced at higher pressures if it had been possible to approach the screen further than 1·5 cm. to the diaphragm; this was prevented by the iron feet.

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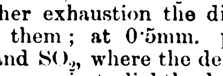
of 4cm. between the window and the screen; only at greater distances it becomes evident from halos, and then by a fan-like expansion of the beam. Hydrogen becomes even more limpid at 42mm. pressure (No. 5). Nuclei in the patches are now seen at greater distances from the window. The great breadth of the beam now only seems conditioned by small distance between diaphragm and window. If we now increase this distance from 2·5 to 5 cm. (No. 6) without changing the pressure, the ray becomes, in fact, correspondingly narrower. On exhausting further to 3mm. (No. 7), the beam does not perceptibly differ from the geometrical beam; the dotted lines in the figure coincide with the continuous ones, and are, therefore, invisible; the patches hardly show halos. If, in order further to test the rectilinear propagation, we increase the distance between window and diaphragm to 10cm. (No. 8), the ray becomes narrower in the same proportion as the geometrical one; the phosphorescent patches change in the same manner as would light patches under equal conditions. Finally, at 0·67mm. pressure, the increased transparency is the only thing noticed; the ray has increased in length, and the patches in brightness. On closer inspection it is seen, however, that all the spots are now somewhat smaller than would correspond to rectilinear propagation, as was seen in the perfect vacuum and in the case of light (13). The coincidence of the two previous beams (at 3mm., Nos. 7 and 8), with the geometrical beams must, therefore, be taken as a slight indication of residual turbidity.

In the other gases also turbidity is shown in the same way as in the case of hydrogen, by the extension of the rays and by halos. All gases become more limpid as exhaustion increases. Compared with the others at equal pressures hydrogen appears far and away the most limpid gas; nitrogen, air, and oxygen are about equally turbid; carbonic acid is more so, and sulphurous acid most of all. The denser gas, therefore, is always more turbid than the less dense; to large differences in density correspond large differences of turbidity, and *vice versâ*. It is evident that turbidity and absorption (15, 16) are inseparable.

At 180mm. pressure only hydrogen allows the formation of a regular beam. For the investigation of such turbid media as are the other gases in this case, the apparatus used was not suitable, inasmuch as the screen could not be brought close enough to the



A. B.

Fig. 11.

diaphragm; hence there is no very distinct difference noticeable between N_2, O_2, and CO_2; SO_2 alone appears perceptibly more turbid. At 40mm. pressure all gases have become clearer, the differences are more pronounced. CO_2 now is decidedly more turbid than O_2, SO_2 even more so. The differences are most decided at 10mm. pressure, where O_2 is distinctly more turbid than N_2. Upon further exhaustion the differences between the gases disappear with them; at 0·5mm. pressure, turbidity is only noticed at CO_2 and SO_2, where the delicate halos of the first phosphorescent patches project slightly beyond the geometrical beam, with which otherwise the cathode ray coincides.

All the observations not graphically reproduced confirm what has been said. In particular the rays in air are only slightly or not at all different from those in oxygen and nitrogen of equal pressure, as might be expected from the slight difference between the two last. A list of all rays fully observed and drawn is found in Table IV.; the positions of the diaphragm chosen were the most characteristic. When the diaphragm is placed close to the window the rays lose in definition, if only in consequence of the geometrical conditions; when it is further removed they lose in intensity and length in consequence of absorption. The essential differences, however, between the various media are always perceptible, though perhaps less distinct. All the gases were carefully prepared, washed, and dried. During the change from one gas to the next the observing space was emptied, filled with the new gas, again exhausted, and refilled. H_2 and CO_2 were derived directly from the producing apparatus, O_2 and N_2 from a gas-holder, SO_2 from the bottom of a very large and comparatively narrow glass cylinder out of which it had displaced air by gravity.

That the extension of the beam behind the diaphragm is in reality essentially limited to the space which we have described as the ray, and represented as such in the figures, could be proved by the interposition of the partition Fig. 9, between the diaphragm and the screen. The phosphorescent patches are in this case only changed (darkened at the edge) when the partition overlaps into the space described as the ray. Introduced between the window and the diaphragm the partition has no influence upon the phosphorescent spots. Such experiments were performed in air at various pressures.

19. The turbidity is only determined by the density of the gaseous medium. Different gases become equally turbid when they are brought to equal densities by variations of pressure. During the comparison of rays in various gases it appeared surprising that no single gas exhibited any specially characteristic property. Different gases behaved no more differently than the same gas at different pressures. If this applies all through, we must be able to find for any gas a pressure at which the propagation in it is exactly the same as in any other gas at a given pressure. Supposing we attenuate sulphurous acid, for instance, sufficiently, it must give exactly the same ray as hydrogen at ordinary pressure. Generally, all the rays observed must allow themselves to be ranged in a single series, from the most turbid gas to the clearest, as if they were all of them observed in one and the same gas, only at different pressures. This is, in fact, perfectly feasible. To compare easily and accurately any two rays I had copied each of them on to a strip of squared paper, and these strips were without difficulty arranged as required, so that all equally situated phosphorescent patches were smaller and sharper in each succeeding ray as compared with the preceding. Only I obtained, of course, three series instead of one, corresponding to the three positions of the diaphragm, since only such rays were comparable as were obtained with equal positions of the diaphragm. The following are the three series, always beginning with the most turbid medium (Table IV.)

Table IV.

1.—Diaphragm 2·5 cm. from the window.

Gas.	Pressure. mm.	Density. H_2 760mm. =1.
Air	385·0	7·3
SO_2	180·0	7·6
CO_2	180·0	5·2
O_2	180·0	3·8
N_2	180·0	3·3
SO_2	86·0	3·6
SO_2	42·0	1·8
CO_2	39·2	1·2
H_2	754·0	1·0
O_2	40·0	0·87
N_2	41·6	0·78
Air	40·0	0·76
H_2	335·0	0·14
SO_2	9·0	0·38
CO_2	10·2	0·30
H_2	167·0	0·22
Air	10·2	0·19
H_2	88·0	0·12
H_2	42·2	0·056

2.—Diaphragm 5cm. from the window.

Gas.	Pressure. mm.	Density. H_2 760mm. =1.
SO_2	3·8	0·16
CO_2	3·2	0·093
O_2	3·3	0·070
H_2	42·2	0·056
Air.........	2·9	0·055
N_2	3·0	0·055
H_2	3·3	0·0044

3.—Diaphragm 10cm. from the window.

Gas.	Pressure. mm.	Density. H_2 760mm. =1.
CO_2	0·50	0·015
SO_2	0·50	0·021
H_2	3·3	0·0044
O_2	0·65	0·014
N_2	0·45	0·0085
H_2	0·67	0·00086

It will be seen that the media thus arranged according to decreasing turbidity are also arranged according to decreasing density. Sporadic divergences only occur in the densest media, where the method of investigation makes the rays appear almost equal, and in the most attenuated, where the turbidity and the differences vanish together. The only property of any gaseous medium determining the turbidity is, therefore, its density; in other words, equal masses always bring about equal disturbance.

20. Cathode rays of various kinds are diffused to different extents. Up to the present we have always kept the conditions of production as constant as possible (15), and have only investigated cathode rays of a single definite kind. Thus especially the pressure in the discharge tube in the preceding radiation experiments was always such that sparks passed occasionally between the spheres, B (Fig. 1), kept at 2·8cm. distance. If we now diminish the pressure in the discharge-tube while the medium in the observing space remains the same, we have in the first place to expect an increased intensity of the rays (2), and a brightening of the phosphorescent spots. If their diameter increases at the same time this need not create surprise if we remember their blurred edges; the enlarging could only be apparent. But the reverse happens. While the brightness of the patches increases strongly at the centre, it diminishes at the edges, the patches contract in circumference, and become distinctly sharper. But on increasing the gas pressure in the discharge tube the spots not only become darker, but larger and more blurred; if nucleus and halo could be distinguished these may be completely fused. These appearances were often noticed when, during the preceding experiments (18) the vacuum in the discharge tube was brought to the correct amount. With special attention I have followed it in air of 13mm. pressure in hydrogen at 167mm., and carbonic acid at 39·2mm.,

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when the length of spark measuring the exhaustion of the discharge tube was varied between 2 and 4 cm.

I conclude that cathode rays produced at different pressures possess the property of diffuse propagation in gases to a different extent. Rays produced at lesser exhaustions are more diffused than those produced at greater exhaustions. That there are different kinds of cathode rays, the properties of which blend into each other in a manner corresponding to the colours of light, and which differ in their capacity of phosphorescence, absorption, and deflection by a magnet, has already been remarked by Hertz.* As in the case of the diffusion and propagation of cathode rays in gases generally, so the phenomenon observed here has its well-known optical analogue: Light of short wave-length is more dispersed in certain optically turbid media than light of greater wave-length.

21. To judge from the behaviour of the gases here observed, the occurrences in the ether, which make up the nature of the cathode rays, must be occurrences of such extraordinary delicacy that dimensions of molecular magnitude enter into consideration. Even to light of the smallest known wave-length matter behaves as if continuously filling space; but in the presence of cathode rays the behaviour of elementary gases even is that of non-homogeneous media; here each single molecule appears to act as a separate impediment. Gas molecules make the ether turbid, and it is very remarkable that in this case no other properties of the molecules are of any moment except their mass alone. The total mass of molecules contained in unit volume determines the turbidity of the medium. When the gas molecules are replaced by coarse suspended particles, and the cathode rays by light, equal appearances are presented, but in that case the behaviour of the medium is hardly determined by a single and equally simple problem.

M. HERMITE'S ELECTROLYTIC SEWAGE PROCESS AT WORTHING.

The report of Dr. Kelly, the Worthing Medical Officer of Health, on the results of the experimental treatment of sewage by the Hermite process at that town contains some valuable information as to the chemical and bacteriological actions of the Hermite electrolysed sea-water. A number of cottages have been supplied, each with (1) town water, (2) ordinary sea-water, and (3) electrolysed sea-water, for flushing purposes; and tests have been made on chemical and sterilising results obtained by these, as well as on the corrosive action of the last-named fluid. Chemically, the electrolysed sea-water was found to contain only one-sixtieth of the equivalent of chlorine that exists in a saturated solution of ordinary bleaching powder; while, after storage for only two days, as much as 5 per cent. of the strength of the solution disappeared. The solution does not contain free chlorine, as has been alleged, nor does it give an acid reaction. As compared with a strong solution of bleaching powder, the Hermite fluid will not act so powerfully, neither in reducing the offensive odour or breaking up the solidity of sewage, nor in corroding vessels in which it may be contained. Dr. Kelly finds that a few days' exposure to mortar produces slight flaking, while the metals copper, brass, bare iron, and galvanised iron are appreciably corroded. No effect was observed to take place with contact between the fluid and cements. The bacteriological experiments by Dr. Klein, F.R.S., which Dr. Kelly embodies in his report, are, it would seem, a striking proof that the Hermite process, as carried out under M. Hermite's direction at Worthing, is incapable of sterilising sewage—*i.e.*, of ridding it of either sporing or non-sporing bacilli. Cultures in gelatine of (1) the ordinary sea water, (2) the Hermite fluid, and (3) the freshly-treated sewage gave the following results:—Bacilli in immense numbers were found in the ordinary sea water, but the Hermite fluid proved to be perfectly sterile, showing that the direct electrolysis causes sterilisation. The freshly-treated sewage, however, produced an enormous number of colonies of microbes, after only 48 hours' culture. In fact, it was estimated that the original treated sewage, before culture, must have contained from 800 to 1,000 living microbes of various kinds per c.c., many of these being of the non-sporing varieties which it has been claimed are destroyed by the process.

Although, at the present time, the Hermite process appears to be but an imperfect success, we hope it will ultimately be improved sufficiently to compete on an equal footing with the chemical processes now commonly used.

* *Wied. Ann.* 19, p. 816. 1833.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, April 6th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting at 28, Victoria-street. The following paper will be read:—"Notes on Alternate Current Transformers," by A. F. Berry.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Students' Meeting. Paper to be read: "The River Humber," by W. H. Hamer, Stud. Inst. C.E.

ROYAL INSTITUTION.

9 p.m. Friday Evening Discourse. "Destructive Effects of Projectiles," by Prof. V. Horsley, F.R.S.

MONDAY, April 9th.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting at the Palatine Hotel, Hunt's Bank, Manchester. Continuation of Discussion on: (1) "Notes on Designing a system of Underground Electric Light Mains," by John H. Rider, (2) "The various Systems of Underground Mains and Methods of Laying Same," by S. V. Clirehugh. After which the following Paper will be read:—"Electricity Meters," by R. P. Wilson.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture. "Photometry," by Capt. W. de W. Abney, F.R.S.

TUESDAY, April 10th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "Electric Illumination," by Prof. J. A. Fleming, F.R.S.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. The following Paper will be further discussed: "The Construction of Gas Works," by Charles Hunt, M.Inst.C.E.

WEDNESDAY, April 11th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read: "London Coal Gas and its Enrichment," by Prof. Vivian Lewes.

THURSDAY, April 12th.

TRAMWAYS INSTITUTE.

11 a.m. Council Meeting at the Albion Hotel, Manchester. To be followed by (1) Report of Committee on the Board of Trade Regulations for Electric Traction; (2) Discussion on Mr. Schwann's Bill to Enable Local Authorities to work Tramways; (3) Paper on: "Mechanical Tramway Electric Traction," by Victor Popp; (4) Paper on: "The Heating of Railway and Tramway Carriages," by Frank Mellersh; (5) Paper on: "Vereker and Yeats' Car Starter," by H. L. Furlonge.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Ordinary Meeting at 25, Great George-street. Discussion on: "The Best Resistance for the Receiving Instrument with a Leaky Telegraph Line," by Prof. W. E. Ayrton, F.R.S., and C. S. Whitehead, M.A. After which the following Papers will be read: (1) "Transparent Conducting Screens for Electric and other Apparatus." (2) "An Astatic Station Voltmeter," by Prof. W. E. Ayrton, F.R.S., and T. Mather. (3) "Cost of Electrical Energy," by R. E. Crompton.

FRIDAY, April 13th.

INSTITUTION OF CIVIL ENGINEERS.

2 p.m. Students' visit to Barnes Bridge, London and South-Western Railway, to inspect the sinking of a Caisson; and subsequently to the new Lock and Weir at St. Margaret's, Richmond.

PHYSICAL SOCIETY.

5 p.m. Discussion on: "Calculating Machines," by Prof. O. Henrici. After which the following Papers will be read: (1) "The Minimum Temperature of Visibility," by P. V. Gray. (2) "The Mechanism of Electrical Conduction," by C. V. Burton.

JUNIOR ENGINEERING SOCIETY.

8 p.m. Ordinary Meeting at Westminster Palace Hotel. The following Paper will be read: "Lubricants: their Use, Testing, and Analysis," by William F. E. Seymour.

ROYAL INSTITUTION.

9 p.m. Evening Discourse on: "Some Properties of the Electric Discharge through Gases," by Prof. J. J. Thomson, F.R.S.

⁂ Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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LIGHT ELECTRIC RAILWAYS.

Alone almost amongst our daily contemporaries, *The Times* devotes an appreciable proportion of the space not occupied by political disquisitions and money matters, to such solid fare as India, the Colonies, and Agricultural Depression, and it is as a panacea for this national complaint that two long articles and a leader have recently been given over by *The Times* to the consideration of the subject of "Light Railways." Now Light Railways should possess peculiar interest for the electrical engineer, since it will be largely his own fault if he does not have the constructing of most of them. The connection between the building of light railways and the removal of agricultural depression is not, perhaps, immediately obvious, but may be established somewhat in this wise. At every turn the British farmer has to compete with the produce of more genial climes, brought to the home market from far afield cheaply, rapidly, and in large quantities. To restore equilibrium, if only the state of meteorological science permitted it, we might purge our own climate of its manifold defects or alloy that of our rivals. The imposition of that much-coveted small tax on foreign farm produce might effect something, but such a consummation is not just now particularly hopeful; there are too many people who still regard this modernised version of bringing in the New World to redress the balance of the Old as one of the greatest blessings of the century. Nor, again, would it be possible, humanly speaking, to impede the free flow of the fruits of the earth by depriving foreign producers of their transport facilities. British shipowners and others would have something to say to that. Remedies there still remain; rents still lower, more economical and scientific farming, better organisation would do much, but, according to *The Times,* light railways would do more. Since the British farmer cannot injure his enemies' means of communication, let him set to work to

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improve his own. Just so far as the suggestion leads to self-help and increased enterprise it will tend to do good; and just so far as it results in grants, subsidies, and such-like artificial stimulants, it will work mischief.

Up to the present it must be confessed that light railways have not, from the dividend-earning point of view, altogether justified their existence. In France, where there are over 2,000 miles of *chemins de fer d'intérêt local*, it is needless to say they are State-aided, but neither the system of lump-sum subsidies nor that of annual payments to make up the interest to 5 per cent. has been found to work well; the average cost per mile has, moreover, been about £7,000, not far short of the mileage cost of a country line built to the liking of the Board of Trade. The French have sunk no less than £15,000,000 in these local lines, the working expenses of which leave only £80,000 for interest, so that nearly £700,000 have to come out of the taxpayers' pockets to keep the interest up to the 5 per cent. level. In spite of this heavy direct loss to the State, the building of light railways, we are told, is being pushed on at this moment more energetically than ever; "the pressure of politicians anxious to secure a benefit to their constituents at the public expense" largely accounting, it is stated, for the strange phenomenon of the eager pushing on of an apparently unprofitable business. Italy, on the other hand, appears to have made a somewhat better job of its steam tramways, the average cost of which is given at under £2,000 per mile, though nothing is said about profits. In Belgium a continentally complicated mode of subscription of the necessary capital finds favour; 25 per cent. of the money is found by the ever-obliging State, 25 per cent. by the provincial authorities, 40 per cent. by the communes directly affected, and some 10 per cent. by private persons. The average cost per mile is under £3,000, and the average interest in 1891 was 2¾ per cent. In Holland the light railway idea, as we can testify by personal experience, is carried out in excellent style; the lines are almost invariably laid along the public roads, they pay some 8 per cent., and, pleasant to record, they receive no State subsidy, though the local authorities occasionally subscribe 10 per cent. of capital.

Such is the record of light railway enterprise on the Continent. What need have we in this country for any such lines? what chance have they of paying? by whom and in what style should they be carried out? Judging merely by the mileage statistics of similar countries, the need in which we in England stand of light railways is neither greater nor less than is the case on the Continent. Whilst we have more railways to the square mile than Germany or France, we have nothing like so many as Belgium or Saxony, and it must be remembered that there is an enormous concentration of railways in the manufacturing regions of the North, which has no parallel in any Continental country, and which makes the mileage of our agricultural districts considerably lower than the average. Again, English highways, whilst superior to most Continental ones, are undoubtedly inferior to some, notably those of France. On the other hand, seeing the admittedly high capital cost of our railways, it can scarcely be possible that the cost of carriage, even if we take into consideration the questions of superior speed, care in handling, and frequency of service, is as low at home as abroad. The need, therefore, for light railways does not seem to be such as would justify us in following the bad example of our Continental competitors and to dip into the Imperial Treasury, or even, for matter of that, into the ratepayers' pockets. We are constantly told, and there can be but little doubt about it, judging by the steady stream of English gold that flows into apparently bottomless foreign pockets, that there is a glut of capital in the country, so we may be perfectly certain that if it can be shown that light railways are likely to return even 3 or 4 per cent. on the capital outlay there will be no lack of funds. What Parliament and the local authorities can do to encourage such undertakings is, on the one part, to considerably simplify and cheapen the at present costly and cumbersome mode of procedure in obtaining statutory powers, and on the other, to refrain from squeezing all manner of small but expensive concessions out of the unfortunate individuals who are anxious to lend their money. Another necessary antecedent to the construction of light railways is undoubtedly the infusion of a little more "adaptivity" into the cast-iron rules of the Railway Department of the Board of Trade. It is a proud boast that we English have but one standard of railway construction and railway working—the best; but one very obvious result of our being satisfied with nothing but the best is that we often have to do without the good. These light railways must not be treated as anything more serious than long-distance tramways, to which it would be pure pedantry to apply the rules and regulations intended for quite other conditions. The Troon-Annbank line, instanced by Mr. ACWORTH in an article in a recent number of the *Engineering Magazine*, is a shocking example of the standard we are likely to have to live up to in the matter of light railway construction unless we are permitted to aim somewhat short of the admirable ideal of the Board of Trade. The Troon Harbour-Annbank Collieries line is only three miles long; it is single track throughout, there is no station on it, and no passenger trains are run; nevertheless, it has all the paraphernalia of a London and North-Western main line, and has cost £33,000 or £11,000 per mile, which is not surprising, considering that there are amongst many other unconsidered trifles no less than fifteen over and under bridges. In the same way that Dutch experience emphasises the fact that light lines of railway can be made to pay their way without any system of outdoor relief from the State, it points to the necessity of running these lines along the country roads; embankments, cuttings, viaducts, stations, signals, soon pile up the capital cost, which it is admitted on all sides must be kept low. Here, then, local authorities have an opportunity of benefiting the community by simply granting, on easy terms, the right to use the highways for tramway purposes. And it is this necessity for cheap construction, and the laying of the track along the high roads, which points, in our opinion, to the extensive use of electricity on our light railways, if ever they are built. By the use of motor cars, not only do we secure immensely greater tractive effort per ton of motive apparatus than is the case with steam locomotives, but the whole system gains a flexibility and an immunity from complete breakdown that can be obtained in no other way. Along quiet country roads, and past farmyards and hayricks, steam locomotives, with their sparks, smuts, and clatter, are altogether inadmissible. In Ireland, it seems, they run on the few lines already constructed only two *trains* a day, at almost impossible fares and rates, and the result, of course, is failure. To ensure success there should be light motor cars, with a reserve of motive power in order to pick up a "trailer" or two if need be, running at comparatively short intervals, and wherever the line feeds a railway, if not in every case, the gauge should be the normal 4ft. 8½in. gauge, to permit of trucks, &c., being run straight on to the local line. It is extremely difficult to tell beforehand whether there really exists a need for any given new thing, but it seems to us that there is a

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sufficiently good *primâ facie* case for light railways in our agricultural districts to make it advisable that all artificial impediments, such as the existing costly and cumbersome Parliamentary procedure and the blackmailing raids of our local authorities should be swept away; then, if there be really any money in the business, light railways will be built, largely, we hope, with local capital, not one single mile, we trust, under State or municipal patronage.

REVIEWS.

A Pocket-Book of Electrical Engineering Formulæ. By W. Geipel and M. Hamilton Kilgour. Published by *The Electrician* Printing and Publishing Company, Salisbury-court, Fleet-street, E.C.

"Although this pocket-book" (to quote the preface) "has been compiled to some extent on the lines of other pocket-books, yet an attempt has been made to supplement the rules and formulæ by brief descriptions of the various subjects treated." The book is published in two forms, one for the desk and one for the pocket. It may be said to consist of a set of very compressed treatises on the group of subjects, mathematical, engineering and electrical, which are usually included under the head of electrical engineering. It is divided into about forty-two sections. Of these, seventeen cover matters which are chiefly electrical, eleven the mathematical groups, and twelve are devoted to such subjects as engines, boilers, steam piping, &c. In a pocket-book designed on these lines, and which is not merely a collection of tables, the difficulty is to know what to put in and what to leave out; but the authors have succeeded in gathering together a considerable amount of information and arranging it in a fairly systematic way. The book begins with the usual definitions of terms, and we then have useful tables on the properties of materials, specific gravities, specific heats, electrochemical equivalents, &c. In the table of thermo-electric powers, we note the omission of the thermo-electric powers of antimony and bismuth. The tables of specific electrical resistances are given in "legal microhms," but it is not stated what this "legal microhm" is. If it is derived from the unit adopted by the Paris Congress, and which has never, in Great Britain at least, been "legalised," then the values should be altered so as to express them in terms of the unit of resistance recommended by the Board of Trade Electrical Standards Committee, and which will no doubt be generally adopted under the name of the international ohm. In the mathematical sections there are useful tables for aiding the student in trigonometrical transformations, also standard forms of differentials, integrals, and differential equations, tables of sines, cosines, &c., and also hyperbolic sines and cosines. A handy section on the use of the slide rule and logarithms is appended. The usual tables of squares, cubes, logarithms, &c., are not omitted. The mathematical section is, on the whole, very well written. The sections of the book which are purely on mechanical engineering, as above observed, are practically short treatises on engines, boilers, and steam and hydraulic work generally. The very compressed nature of these renders it impossible to find space to quote authorities or to enter into discussion of empirical formulæ, and there is, therefore, a risk of the inexperienced reader being led to place too much confidence in a formula or result. It will always be a matter of opinion how far in such highly technical subjects as these it is desirable in a pocket-book to go beyond tables of results. There is, however, an immense amount of highly concentrated information on steam engines, gas engines, oil engines, water motors, and on the subject of steam generation and use, which is presented in a very readable form. The electrical sections of the book cover the usual subjects of dynamos, transformers, batteries, arc and incandescence lamps, &c. There are also brief chapters on the above subjects, and are generally well written and arranged. The section on secondary batteries would bear amplification. The chapter on electrical testing, however, omits to mention several matters of practical importance. On page 572, sine should be cosine, or $E=E_0$ should be $E=0$, and so throughout the section.

In an electrical pocket-book it would, we think, have been better to sacrifice some of the space given to subjects of mechanical engineering and devoted it to more ample explanations in the section on electrical testing. This section would have been improved by the insertion of figures of the actual electrical instruments in addition to mere skeleton diagrams of connections. Considering the extremely simple and accurate methods of dynamo testing which are based on the use of the potentiometer, we think that a fuller account should have been given of that method of testing and of the precautions to be used. The favourite text-book methods for testing the internal resistance of a cell are in general perfectly useless, but the potentiometer enables an accurate and speedy test to be made of the behaviour of any primary and secondary cell when in action. This section will, we think, bear enlarging in another edition, because so much of what is given under the head of electrical testing in other similar books is limited to purely academic methods or to telegraphic work. The student requires to be told what are the precautions to be taken to obtain correct results, and to be warned on the sources of error. In spite, however, of some omissions, the electrical sections of the pocket-book are carefully written, and bring the information fairly up to date, and the book will prove useful to most of those engaged in any form of electrical work. J. A. F.

MAGNETIC QUALITIES OF IRON.*

BY J. A. EWING, F.R.S., AND MISS HELEN G. KLAASSEN.

Recent applications of electricity, and especially the extended use of transformers, have added particular interest to the study of cyclic magnetising processes in iron. It has become a matter of consequence to investigate, in various specimens of metal, not only the amount of the energy dissipated by hysteresis in a magnetic cycle, but the relative amounts under various degrees of magnetisation and various intensities of magnetising force. Other questions arise with regard to the dependence of this loss on the frequency of the cyclic process and on the manner in which it is performed. The experiments to be described in this Paper deal mainly with the effects of cyclic variations of magnetising force. They are intended to contribute some additions to existing data, to answer one or two specific questions, and to exemplify certain more or less novel methods of experimental inquiry. A section at the end of the Paper relates to the molecular theory of magnetisation, and its adequacy to explain some characteristic manifestations of magnetic hysteresis.

Experiments on Rings, by the Ballistic Method.

In a Paper published eight years ago by one of us,† experiments were described in which a piece of soft iron was carried through a numerous series of cycles of magnetisation, of graded amplitude, with the object of determining the form taken by the curve of magnetisation and magnetising force during the process of reversal between any assigned limits, and of comparing the work spent in the process with the amplitude of the magnetisation. A similar experiment was described for steel. Since then the importance of such information has been recognised by electrical engineers, and some experiments with a similar object have been made by Messrs. Evershed and Vignoles,‡ and by Mr. C. P. Steinmetz.§ Notwithstanding, however, the increased interest which now attaches to the matter in consequence of its practical bearing, the available data are still meagre. By way of adding to them, we have made a detailed examination of some ten samples of wire and sheet iron, arranged in the form of rings to be operated on by the ballistic method.

* Abstract of Paper read before the Royal Society.

† "Experimental Researches in Magnetism." *Phil. Trans.*, Part II., 1885, p. 523.

‡ Evershed and Vignoles. *The Electrician*, May 15, 1891.

§ Steinmetz, "Transactions of the American Institute of Electrical Engineers," Vol. 9, No 1.

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In the former tests, referred to above, the method used was to make direct observations with a magnetometer, the samples being then long, straight pieces of wire. When the metal to be examined is in the form of wire, which may be taken long enough to secure practical endlessness, or of rods or bars big enough to be turned down into ellipsoids, the direct magnetometric method is entirely suitable. Several of our samples, however, were to be cut out of plate or sheet metal, such as is now largely used in the manufacture of transformers; and for this reason, as well as because direct measurements were to be made of the heating effect of magnetic reversals (which made ring samples most eligible), the ballistic method was selected, and a somewhat novel form was given to it, to allow points on the cyclic curve to be accurately and conveniently determined by its means.

In the Paper already cited, some ballistic observations of magnetic cycles were described, in which the successive points on the cycle were determined by summing the ballistic effect of successive steps, in each of which the magnetic force underwent a small sudden change. This method is, at the best, laborious, and requires great care to avoid the carrying forward and accumulation of errors. The accuracy of each point depends on that of the points before it, though at the end of the process a check may be applied by comparing the ballistic effect of a sudden reversal with the sum of the effects of successive steps. There is an obvious advantage in making the determination of each point independent of the previous readings of the ballistic galvanometer, and, recognising this, Messrs. Evershed and Vignoles introduced, in their experiments, the plan of reading each point by a single step from the terminal condition of magnetisation represented by one or other extremity of the cycle. They wound their ring with two coils, through one of which a constant current was maintained; through the other coil a current, opposite in magnetising quality, could be passed, and its strength could be varied up to a maximum which made its ampere-turns just twice the ampere-turns of the other coil. Then, when current flowed in the first coil only, the magnetisation had its extreme positive value. By suddenly applying a current in the second coil, it was altered to any value between the positive and negative extremes. The use of two currents is an undesirable complication, especially as the symmetry of the resulting curves depends on the exactness with which the magnetising effect of the one is adjusted to be at its maximum, just twice that of the other. We have devised, and used throughout all these experiments, a method which, while requiring only one current and one magnetising coil, retains the advantage that each point in the cycle is reached by a single step from the end of the cycle.

The diagram (Fig. 1) shows the arrangement used.

The magnetising current passes from the battery through the adjustable resistance R_1 and the galvanometer G_1 to a key, K, and thence, through the resistance R_2, to a two-way plug, P, which allows it to be sent either into the magnetising coil of the ring A, which is the sample under test, or into the primary of a special induction coil, C, which is used for standardising the ballistic galvanometer. A and C each have a secondary coil; the two secondaries are kept in series with one another, and their circuit is completed through the ballistic galvanometer G_2. A Kelvin balance, B, which is short-circuited when it is not required, serves to determine the constant of the current galvanometer G_1. The key K is a rocker, working in mercury cups, which, when rocked to the left, connects *a* with *e* and *b* with *f*, and, when rocked to the right, connects *a* with *c* and *b* with *d*. In the latter position of the key, the full strength of the magnetising current is in action, and hence, if the plug P is set so as to send the current into A, the sample is magnetised to a degree which represents one extremity of a magnetic cycle. Between the cups *e* and *d* of the rocking key are a short-circuit plug and also an adjustable resistance, R_3. When this short-circuit plug is inserted, the key K is simply a reversing key, and then, when rocked to the left, it reverses the magnetisation of the ring, carrying it at once to the opposite end of the cycle. But when, instead of a short circuit between *e* and *d*, there is a resistance, the rocking of the key to the left applies to the sample a magnetising current opposite in sign to the primitive current, but less than it in amount, and consequently carries its magnetism not to the end of the cycle, but to a point which falls short of the end by an amount depending on the magnetism of the resistance R_3. The peculiarity of the method is that, by a single movement of the key, the magnetising current is at once reduced in amount and reversed in sign.* By giving R_3 a series of values, each movement of the key to the left determines a new point on the curve, while each movement to the right brings back the magnetisation to its extreme value. In this way as many points are found as may be required to define that part of the curve which lies between the zero of magnetising force and its extreme negative value. To find points lying between the positive extreme and the zero of magnetising force, a different process is adopted. The key is kept to the left, and a sudden reduction of the current (without change of sign) is effected by withdrawing a plug from the resistance box R_2. This gives a point in the first quadrant of the descending curve, and a series of such points are found by selecting successive values of R_2, the magnetisation of the sample being, however, restored to its initial full value before each such step.

To make the matter plainer, we may describe the operation of taking a cycle in detail. First, the strength of the magnetising current was adjusted by selecting a proper number of cells (a storage battery was used throughout) and by means of the resistance R_1, so that the limits of magnetisation should

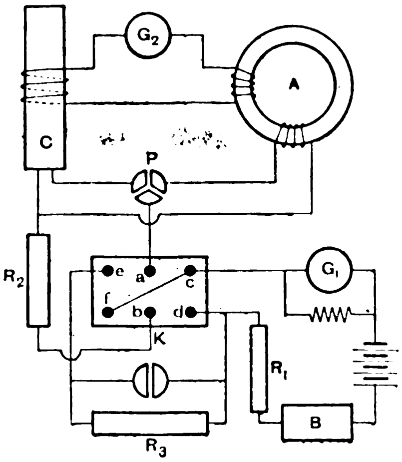

Fig. 1.

have the desired value. At this stage there was no resistance in R_2, and the short-circuit plug between *e* and *d* was in its place. The key K was now rocked back and forth many times to bring the magnetic changes into a thoroughly cyclic state—a precaution especially necessary when only a weak degree of magnetisation was in question. The ballistic effect of this reversal was observed, several times over. Then, with the key K leaning to the right, a small sudden reduction of current was made by removing a plug from R_2, and the ballistic effect of this was observed. The plug in R_2 was replaced, the key, K, rocked back and forth to put the metal through a cycle, and then a second resistance, larger than the first, was suddenly opened in R_2. Operating in this way, a series of points were found for values of the magnetising force H, lying between the positive maximum and zero. To continue the curve beyond the axis into the region of negative H, the resistance R_3 was adjusted to have, first, a rather high value. The key was then rocked from right to left, the ballistic effect being read; then this resistance was short-circuited; the specimen was taken through its full cycle by rocking the key; R_3 was set to be less than before, and its short-circuit plug was removed, the key was again rocked to the left, and so on. The curve determined by these successive operations

* Since this description was written, a Paper has been communicated to the Royal Society by Dr. John Hopkinson and Messrs. Lydall and Wilson, in which ballistic experiments are described where the method was essentially the same as that used by us. A single movement of a key reversed the magnetising current and introduced resistance (*Roy Soc. Proc.*, Vol. LIII., p. 352.)

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was the curve A B C D (Fig. 2), in which (ordinates being magnetisation and abscissæ magnetising force) A is the extreme state, always reverted to between each operation and the next; A B is the position determined by plugging out resistances in R_2, and B C D by rocking the key K with successive (lessening) values of R_3. This curve completely defines the magnetic cycle, inasmuch as the return limb is symmetrical with the one sketched. As a matter of convenience in exhibiting the results, the portion C D may be sketched as extending from a point C′ back to the starting point A, as in Fig. 3, O C′ being taken equal to O C, and in this way the relations of the rising and falling curve to one another are more clearly shown. There is, of course, no need to draw the other half of the cycle. The ordinate of A is taken as equal to half the magnetic change which occurs on reversal of the full strength of the magnetising current.

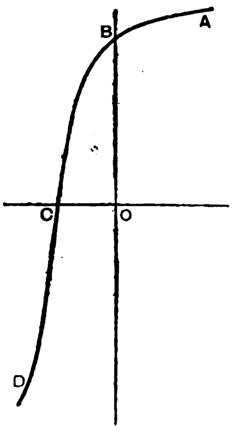

Fig. 2.

G_1, used in measuring the magnetising current, was a mirror galvanometer, strongly shunted and provided with a strong controlling field. Its constant in the shunted state was determined daily means of the Kelvin centi-ampere balance. The ballistic galvanometer was provided with a usual arrangement for applying electromagnetic impulses to stop the swing of the needle. Its readings were reduced to absolute measure by means of the coil C, an air induction coil, whose dimensions were accurately measured, and the coefficient of mutual induction of its coils calculated from them. Its induction was sufficient to give a ballistic deflection of the same order of magnitude as that given by the sample under test. The resistance of the

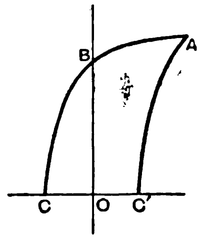

Fig. 3.

ballistic circuit was not altered throughout an experiment, and the two secondaries were permanently connected in series. The use of the coil C made the magnetic induction, as well as the magnetising force, depend for its interpretation in absolute measure on the standard furnished by the Kelvin balance. The resistance R_1 was a frame of platinoid wire, wound for these experiments; R_3 was, in the first instance, a liquid slide consisting of amalgamated zinc plates, immersed in a jar containing solution of zinc sulphate, but in the later experiments we found that a Varley carbon resistance, consisting of a pile of discs adjustable by compression, formed a very convenient substitute, especially when supplemented by short shunts of platinoid for the lower values of R_3.

All the samples tested in this set of experiments were arranged in the form of rings, with a mean diameter, generally, of about 10cm., and an area of cross-section of from one to two square centimetres. The magnetising coil was wound uniformly round the whole ring, in a single layer or in two layers. A few turns of wire, wound outside of that, formed the secondary or induction coil, the number of these turns being chosen so that reversal of the strongest magnetisation produced as large a throw as could conveniently be read on the ballistic galvanometer. In several instances pairs of rings were prepared, exactly alike in all respects, for the purpose of making certain special tests which will be described later.

With each sample a series of cycles were determined, generally ten or twelve, beginning with one in which the limiting magnetisation was strong, and working down to cycles on which the range was so small that the effects of hysteresis nearly disappeared. In the case of one or two samples a supplementary examination of the smaller cycles was made on a finer scale, by means of another secondary coil with a considerably larger number of turns, while the scale of the current galvanometer was at the same time altered by using a weaker shunt. We shall now give the results of the tests in detail.

Ring I.—In this ring the core was of fine iron wire, insulated by a winding of cotton. The diameter of the wire was 0·02475cm. It was supplied (by Messrs. Glover) as a specimen of soft iron, but the tests showed that it had either not been softened, or had been insufficiently softened after its last passage through the draw-plate, the curve of magnetisation presenting, to some extent, the characteristics of those for unannealed metal. Eleven cycles were examined; the results are shown by the curves of Fig. 4. The figures give the magnetic force **H** and the magnetic induction **B**, both in C.G.S units.

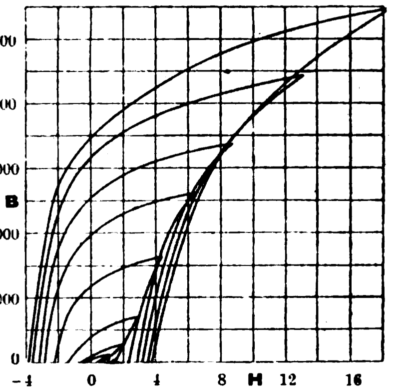

Fig. 4.—Ring 1. Fine Iron Wire.

In addition to these, three higher cycles were taken, with limiting values of **H** and **B**, as under :—

Limit of H.	Limit of B.
55·8	16,640
34·4	14.810
25·3	12,940

These, however, are omitted from the figure, as they would have required it to be drawn to an inconveniently small scale.

Inspection of Fig. 4 brings out one curious feature in the relation of the successive cycles to one another, which, however (as other figures will presently show), is of quite general occurrence. The extremity of each cycle lies outside of the rising curve of the immediately higher cycle, provided there is no very great difference in their ranges of magnetisation. It is only when we come down to the lowest cycles, where the steps by which **B** is reduced from cycle to cycle are relatively great, that this does not happen. It should be remembered that each of these cycles is taken only after a large number of reversals of that particular magnetising force which determines its range. During these reversals the range became somewhat reduced, especially when the magnetism does not approach saturation.

From these curves, by measuring the enclosed areas, values have been found of the energy dissipated in performing the magnetic cycle, namely, $\int H\, dI$ or, $\frac{1}{4\pi}\int H\, dB$.

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Ring I.—Fine iron wire. Energy dissipated in cyclic process of double reversal of magnetism. The results are given graphically in Figs. 7 and 8, along with corresponding ones for the next ring.

Ring II. was of steel wire, of nearly the same fineness as the iron wire of Ring I. The diameter was 0·0257 cm., and, like the last, it was insulated throughout with cotton. Eleven cycles were taken in the first instance.

These results are also shown in Fig. 5 (Plate 34), where, however, Cycle 2 and the extremity of Cycle 1 are omitted to avoid overloading the diagram. Cycles 10 and 11 are also omitted. In drawing the curves the points corresponding to the readings actually taken are marked by dots enclosed within circles. They give satisfactory evidence that the method of

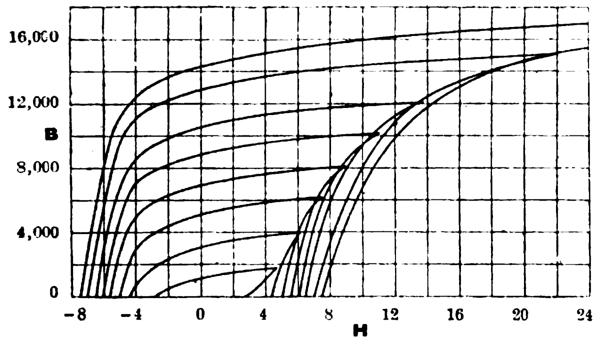


Fig. 5.—Ring 2. Fine Steel Wire.

observation we have used will yield a smooth curve. The curves here have the square-shouldered form, which is often found in steel as well as almost always in *annealed* soft iron. (The absence of this characteristic in Ring I., as well as its comparatively low permeability, was an indication of its being in a somewhat hard state.)

To test more particularly the action of weak magnetic forces Ring II. was further taken through a series of low cycles, the sensibility of the apparatus in regard both to ballistic and current measurements having been first increased in the manner already indicated. That is to say, an induction coil of a larger number of turns was now used, and the current galvanometer was less strongly shunted. Five small cycles were observed.

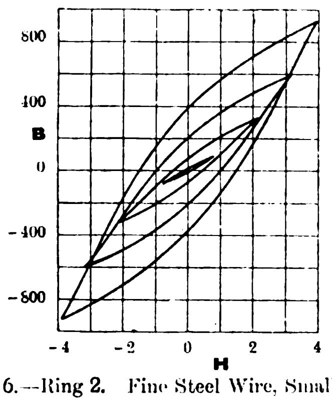


Fig. 6.—Ring 2. Fine Steel Wire, Small Cycles.

These, with the exception of No. 15, are drawn out in Fig. 6 (Plate 35). Measuring areas as before we find the energy dissipated in the cycles. Fig. 7 gives the value of $\int H\,dI$ for this ring and also for Ring I., in relation to H, and Fig. 8 (Plate 36) gives them in relation to B. Fig. 8*a* further shows to a larger scale the relation of $\int H\,dI$ to B in the low-cycle tests of Ring II. It is interesting, as an example of the growth of $\int H\,dI$ in the region of low magnetic force, when the effects of hysteresis are only beginning to be felt. The figures show in a striking way how small the loss of energy through hysteresis becomes when the limits of magnetisation or of magnetic force are restricted within certain values.

A characteristic of the curves of Fig. 5 is the remarkably uniform rate at which B changes with respect to H during a great part of the process of magnetic reversal. After the shoulder of the descending curve has been turned, by applying a sufficiently strong demagnetising force, the quantity dB/dH takes a large and nearly constant value, which it retains until a tolerably strong reversed magnetisation has been produced. The steep and nearly straight portion of the curve which corresponds to this part of the process has, moreover, nearly the same gradient in all except the smallest cycles. The same characteristic will be found in examples of annealed iron, to be given later, and the gradient in them is, of course, even steeper than it is here. In the present sample of steel wire (Ring II.), the maximum value of dB/dH is about 4,950; nearly half the whole magnetic change in the highest cycle

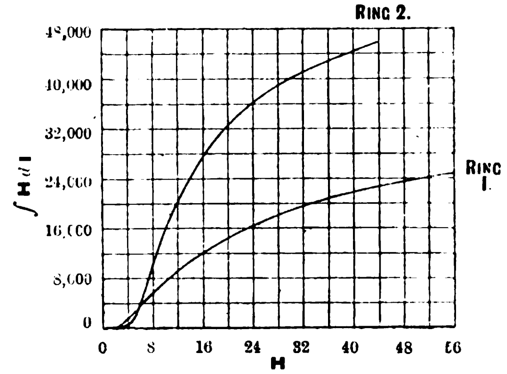


Fig. 7.—$\int H\,dI$ and H for Rings 1 and 2.

occurs at approximately this rate. In some of our soft iron samples dB/dH reaches a value nearly three times as great as this.

The amount of demagnetising force just sufficient to bring the magnetism to zero has been called by Hopkinson* the *coercive force*. It will be seen from these tests that the coercive force rises progressively as the magnetisation is increased. We have measured its values for the cycles of Rings I. and II., and these may conveniently be expressed in relation to the limits of H and of the intensity of magnetisation I.

In Fig. 9 the coercive force is plotted in relation to I. From this figure it is possible, by extrapolation of the curve, to arrive at a probable estimate of a definite physical constant of the

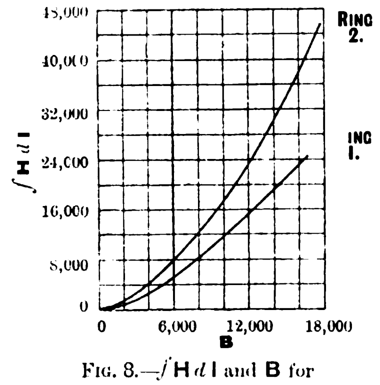


Fig. 8.—$\int H\,dI$ and B for Rings 1 and 2.

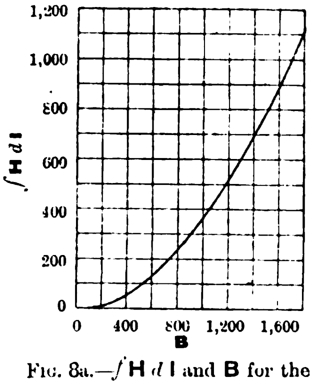


Fig. 8a.—$\int H\,dI$ and B for the Low Cycle Tests of Ring 2.

material which forms a good criterion of magnetic hardness, namely, the coercive force which would correspond to the state of magnetic saturation. This, in other words, is the demagnetising force which would be just sufficient to remove magnetism from a piece which had been magnetised to literal saturation. We know that the saturation value of I in wrought iron and steel is about 1,700.† A conjectural extension of the curves along the straight lines which they follow in the region of strong magnetisation shows that the coercive force of saturation is probably about 5·5 in the (rather hard) iron of Ring I., and 8·5 in the steel of Ring II.

* J. Hopkinson, "Magnetisation of Iron," *Phil. Trans.*, 1885, p. 460.

† *Phil. Trans.*, 1889, A, p. 221.

The next three rings had cores of sheet iron. Ring III. was made up of comparatively thick annular discs which were turned out of discs that had been supplied for the core of a dynamo armature. The mean thickness of the discs was 0·195cm.; the internal diameter of the annulus was 13·55cms. and its external diameter 1,545cms. Rings of paper were interposed to prevent the discs from touching one another. The tests showed that this iron compared well with most other specimens in the matter of magnetic softness.

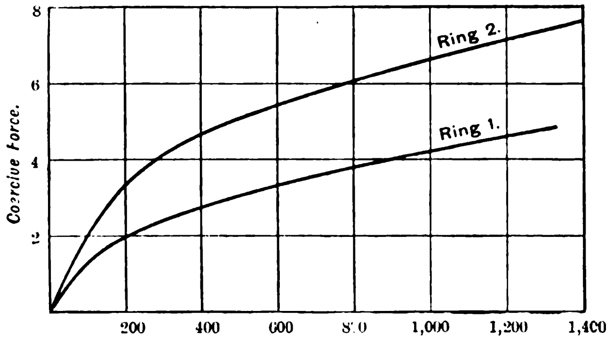
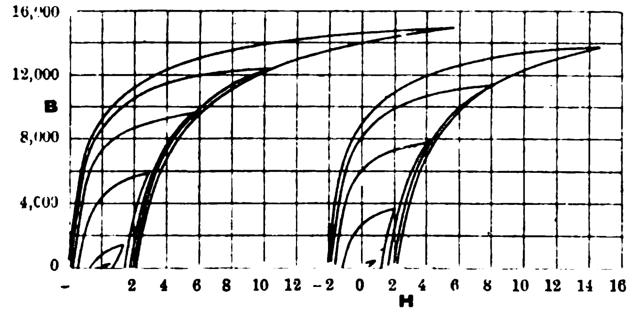


FIG. 9.—Coercive Force and I. Rings 1 and 2.



FIGS. 10 and 10a.—Ring 3. Thick Sheet Iron.

The cycles, with the exception of No. 1, are shown in Figs. 10 and 10a (Plate 37), where, to avoid confusion, the odd and even cycles are drawn separately. The values of $\int H\,dI$, in relation to B, will be found plotted in Fig. 21, along with corresponding results for other samples of sheet and wire iron.

(*To be continued.*)

POLYPHASE TRANSMISSION.*

BY CHARLES F. SCOTT.

Alternating Current Problems.

When the alternating current was introduced for lighting it presented many new problems to the electrical engineer. Numerous difficulties and dangers were predicted by the theorist, but in ordinary service most of these have fortunately lain dormant. These difficulties are apt to appear, however, when alternating current work is attempted on a large scale. The introduction of large units, heavier currents, higher potentials or power service, are apt to increase the effects of self-induction and capacity so that they demand careful consideration. The impetus which electrical engineering is receiving from the introduction of the polyphase system, which brings with it large units and long distances, naturally directs attention to the general problem of alternating current transmission and distribution. A complete and exhaustive solution of this problem is by no means a simple one, and the attempted solutions generally lead to formulæ and diagrams which are possibly even more perplexing than the phenomena.

The author then gives a number of explanatory diagrams, illustrating the effects of self induction. The important facts to be noted being—(1) that the sum of the alternating E.M.F.'s on the elements of an inductive series circuit is greater than that required on the terminals; (2) that the alternating E.M.F. for supplying glow lamps in series with a coil is greater than the continuous E.M.F.; and (3) that the difference between the two becomes greater as the number of lamps is increased. It is also to be noted (4) that if the same alternating current be supplied through a coil, first to a lamp alone and then to a combination including lamps and a coil, a higher E.M.F. is required when the combination is used. These relations, says the author, which seem rather perplexing, may be illustrated in a very simple way by diagrams. In

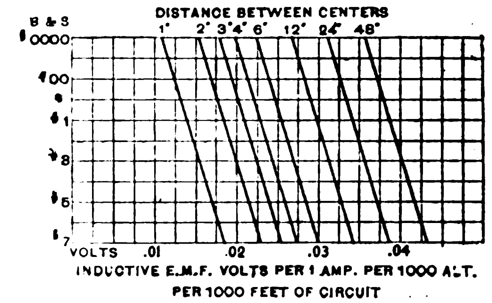


FIG. 1.

the case of a coil alone, in which 50 volts are required for producing one ampere alternating current, and 10 volts for one ampere continuous current, the two E.M.F.'s may be represented by the hypothenuse and one side of a right-angle triangle. The remaining side represents the counter E.M.F. in the coil.

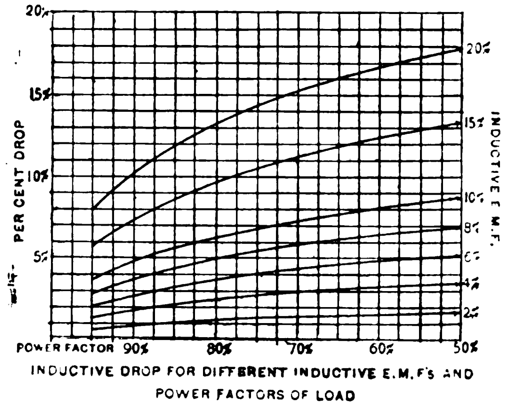


FIG. 2.

Calculation of Drop in Alternating Circuits.

The regulation of a circuit is in general determined by two elements; the counter E.M.F. of the circuit and the self-induction of the load. The counter E.M.F. of a line depends upon the size of wire and the distance between wires, and increases directly as

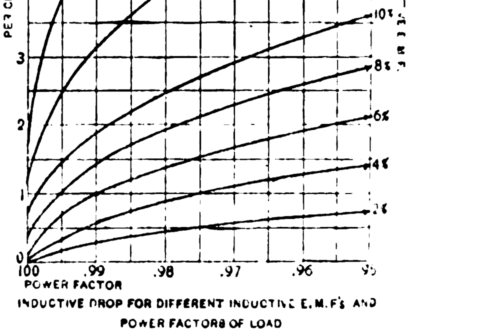


FIG. 3.

the length of the circuit, the current, and the alternations. The counter E.M.F. of a line has been calculated for a number of cases which are likely to occur in practice and the results are given in Fig. 1. The drop, or difference of potential between generator terminals and the load terminals due to the counter E.M.F. of the line

* Abstract of a Paper read before the National Electric Light Association, at Washington

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depends upon the self-induction of the load. The latter is best expressed by a power factor or a factor by which the product of the amperes and volts giving the apparent energy must be multiplied to give the true power in watts. The drop due to self-induction on the line (which, plus the ohmic drop, will give approximately the total drop) corresponding to various power factors of the load is given in Figs. 2 and 3.

These relations may be elegantly determined by a simple diagram on section paper ruled in tenths. Draw an arc through a quadrant with a radius of 100. At a distance from the centre on the horizontal, equal to the power factor of the load, erect a perpendicular and extend it to the arc. This line represents the counter E.M.F. of its loads and its value read directly on the scale gives the counter E.M.F. in per cent. of the E.M.F. upon the load. From the intersection of the arc draw a horizontal line outside the circle equal on the scale divisions to the per cent. in terms of the E.M.F. on the load which would be required for sending the normal amperes continuous current through the line resistance. From the end of this horizontal line draw an upward vertical equal to the counter E.M.F. of the line expressed in per cent. of the E.M.F. on the load. A line from the centre to the upper end of this vertical represents in direction and magnitude the E.M.F. must be impressed on the circuit. If from the same centre an arc be drawn though this point to the base, the scale divisions on the base between the two arcs measures the total drop caused by the lines in terms of the E.M.F. on the load (Fig. 4).

Self-induction in Transformers, &c.

Self-induction exists in line, generators, transformers, secondary wiring, and sometimes in the load. In each case the effect of the self-induction upon regulation depends largely upon the self-induction of the total load supplied. Thus, the regulation of a generator depends upon the total self-induction of the line, transformers and load. Again, the regulation of a line supplying converters depends both upon the self-induction of the converters as well as that of the useful load. An ordinary transformer has a primary self-induction, a secondary self-induction and a mutual induction, which becomes a ready source of a very complicated and perplexing analysis when the complete action is described in theoretical terms. Practically, however, the action of the self-induction in the transformer may be expressed in a very simple way, and it is readily seen that this self-induction has a very important bearing upon the regulation of the transformer. The load may be non-inductive, or it may be more or less inductive. Arc lamps or fan motors will produce a very much greater drop than incandescent lamps. The power factor of an alternating current arc lamp varies considerably, but in a number of cases has been found between 85 and 90 per cent.

A secondary line, if it carry a large current, may have a counte E.M.F. of several volts. This may not be enough to increase appreciably the drop in the line between the transformer terminals and incandescent lamps. The transformer, however, delivers current to the secondary circuit and to the lamps, so that the regulation of the transformer may be effected by the self-induction of the secondary circuit. Cases have occurred in which transformers of a very old type, possessing high self-induction, were supplying very large secondary currents, and the resulting drop in the transformers was increased several per cent. For example, a circuit of No. 0000 B. and S. wire supplying 100 amperes to 50 volt lamps at a distance of 100ft. has an ohmic drop of 2 per cent. The constant for counter E.M.F. of this circuit, if the wires be 6 in. apart, is 0·022. The volts at 16,000 alternations are $0{\cdot}22 \times 100 \times 0{\cdot}1 \times 16 = 3{\cdot}52$, or 7 per cent. of 50 volts. The inductive drop in the line corresponding to 7 per cent. is 0·25 per cent. The power factor of the aggregate service of the transformer is the second side of a right angle triangle of which 7 is one side and 100 is the hypothenuse. This is 99·7 which is the power factor of the total load on the transformer. If the self-induction of the converter be 10 per cent., the inductive drop is 1·2 per cent. ; if 20 per cent. the inductive drop is 3·4 per cent., and if 30 per cent. the inductive drop is 7 per cent. The aggregate drop in the converter and secondary circuit in the latter case would be, say, 2 per cent. for ohmic drop in transformer, 2 per cent. ohmic drop in line, 7 per cent. inductive drop in transformer and 0·25 per cent. inductive drop in line, or a total of 11·25 per cent. The necessary ohmic drop is 4 per cent., and the inductive drop resulting from self-induction in transformer and line is therefore 7·25 per cent. If the number of alternations be reduced to 7,200 the inductive drop would be reduced from 7·25 per cent. to $1\frac{1}{2}$ per cent.

Ordinary Tests upon Transformers.

The practical bearing of the self-induction of a transformer upon its regulation and the exact relation between the two does not seem to be clearly recognised, and even Dr. Hopkinson and Dr. Fleming, who have made very exhaustive tests upon transformers, comparing different methods of testing and different types of transformers, have not brought out this point. Attention is given to the exact form of the current wave, and measurements upon the iron losses are attempted within very close limits of error. Their measurements upon the regulation of the same transformer, however, vary from 2 per cent. to 2·4 per cent. or one measurement is one-fifth greater than the other. The presence of a light induction in the secondary load would have caused a very considerable increase, and it is probable that the difference in the measurements made were due to difference in the self-induction in the instruments used or in the load at the time the

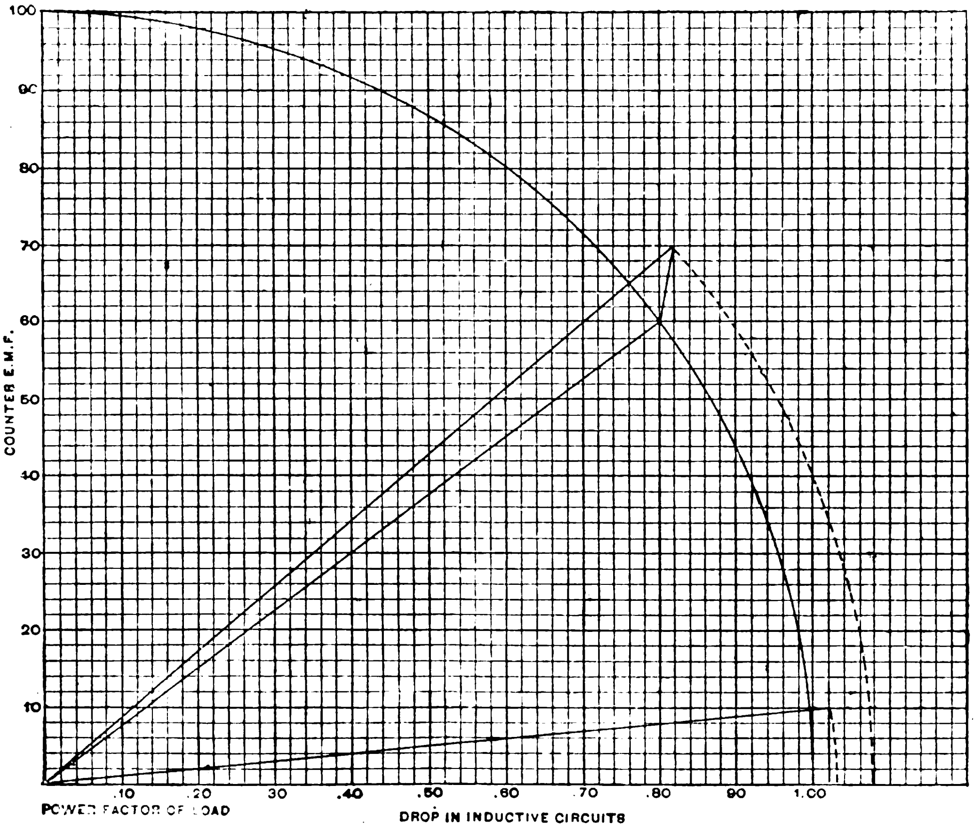

Fig. 4.

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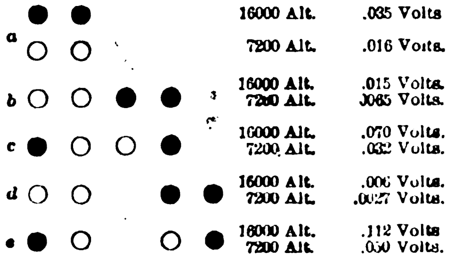
tests were made. No note is made of the effect of the self-induction of the load upon regulation, although regulation is one of the most vital points in the practical use of transformers. Even the temperature at which the drop was measured is not stated, although the resistance of a transformer when continuously working may be 20 per cent. greater than when cold. The elements of practical importance in a transformer are (1) the iron loss, in respect to the efficiency; (2) in the regulation, in respect to the satisfaction of service; and (3) the temperature to which the insulation is subjected, as affecting the life of the transformer. In the ordinary tests by theoretical men, the iron loss is measured to a very high degree of refinement, although the iron loss in transformers is the one thing which cannot be controlled, and is certain to vary 10 to 15 per cent. in commercial manufacture of transformers of the same size. The wave form of E.M.F. on different dynamos or the difference in form under different conditions of load on a circuit may make the loss under different commercial conditions vary several per cent. This renders more refined measurements of no practical use unless the conditions are stated. The temperature of the iron also affects the loss. The full load efficiency is usually given as if it had a great deal of importance, whereas the losses in copper during 24 hours ordinarily amount to but a trifling per cent. of the total losses. The regulation, and the temperature to which the insulation is subjected and which it is able to stand are generally not mentioned in reports of tests. The usual investigations and the papers published on the alternating current transformer may perhaps accurately express many facts in complicated formulæ, but the practical bearing of these points in every-day working seems to be totally ignored.

Mutual Induction.

If two circuits be run on the same pole line they act as a transformer in which one circuit carrying current may act as a primary and induce E.M.F. in the other as a secondary. If the two circuits be connected to different dynamos which are running at slightly different speeds, then the E.M.F. induced by one circuit



Volts in One Circuit Induced per 1,000 feet per Ampere in the Second Circuit.

FIG. 5.

upon the other will sometimes increase and at other times decrease the E.M.F. of the circuit, depending upon whether the two currents at a given moment are flowing in the same or in opposite directions. This fluctuation may cause variations in the intensity of the lights supplied. It is readily detected in the service of some central stations, and is, of course, more marked at time of full load, as the induction of one circuit upon another depends upon the strength of current carried. The fluctuation due to this action may be readily distinguished from that due to the slipping of belts or irregularity in engine speed. The fluctuation due to mutual induction of lines occurs only at the end of the line and is not observed in the station, while the other causes affect the station lights also. The number of volts E.M.F. set up in one circuit by a parallel circuit depends upon the current, the distance which the lines are parallel, and upon the relative positions of the four conductors. The distance between wires may be 6in. or 6ft. without affecting the mutual induction, provided the relative positions be unchanged. Several dispositions of circuits are shown in the diagrams (Fig. 5), and the number of volts per thousand feet at 7,200 and at 16,000 alternations, which are induced in either circuit by one ampere in the other, are given in connection with each diagram. The number of volts required for producing objectionable flickering in the light depends upon the voltage of the lamps in service, the efficiency at which they are run and the general surroundings in which they are placed, notably the relation of lamps to reflectors, white walls, &c., and the general disposition of the customer. An E.M.F. of ½ per cent. induced in one circuit by another can in some cases be detected, and usually more than 1 or 2 per cent. will cause objectionable flickering.

The mutual induction is reduced by bringing the wires in each circuit close together and separating the circuits.

Polyphase Circuits.

The subjects which have so far been considered apply to single-phase as well as to polyphase circuits. The effects of self-induction will be brought to the attention of the electrical engineer much more prominently in connection with polyphase work, however, because larger alternating-current enterprises will be carried out with the polyphase system, and power work involving variable power factors will be a large element in this system. There are, in addition, several problems which relate distinctively to polyphase working. One of these is the most suitable number of phases to be used. The two-phase system and the three-phase system are both in operation, and, while it is admitted by the adherents of each system that there is no fundamental difference between them, yet each has specific characteristics giving particular advantages.

Advantages of Three Phases.

In transmission it has been recently emphasised by a good many people that the single-phase system and the two-phase system require the same weight of copper, and that the three-phase three-wire system requires 25 per cent. less for transmitting power under similar conditions with the same maximum E.M.F. This places an advantage on the side of the three-phase system which in many cases is of very considerable importance. The aggregate advantage, however, is greater than 25 per cent. A two-phase system laid out for the greatest economy requires that the interest on the cost of conductors shall equal the cost of the power lost. If the three-phase system be substituted the loss may remain the same, and the copper will cost 25 per cent. less. This does not give the best relation between cost of copper and loss of power, so that a more economic adjustment is evidently possible.

It has also been shown that the self-induction of a three-phase three-wire circuit for transmitting under similar conditions of E.M.F. is only 57 per cent. of that which is incident to the two-phase four-wire circuit. When the power factor is high the effect of self-induction of line upon regulation varies approximately as the square of the counter E.M.F. The drop due to the self-induction of a three-phase circuit is, therefore, only about one-third of a single-phase or two-phase circuit. This is a second advantage for the three-phase system which is of great value. A further advantage of three instead of four wires is the reduced cost of insulators and pole construction, the reduced losses due to leakage, &c.

Advantages of Two Phases.

An important difference between the two systems is the effect of loading one branch of the system more heavily than the others, as is common in incandescent lighting. One of the statements which remain uncontroverted in Prof. Forbes' recent comprehensive and remarkable paper upon the electrical transmission of power at Niagara Falls is in reference to the difference of regulation in dynamos for two-phase and for three-phase alternating currents. He gives the result of tests showing that the circuits of a three-phase generator differ greatly in pressure if they are not equally loaded, and states that, having considered these points, the directors of the company determined to reject the three-phase system. These results agree fairly well with tests which I have made. The relative regulation of the two types of machine depends very largely of course upon the character of the construction. Although it is not just to condemn one system because a certain construction is bad, yet the theoretical and practical tendencies toward the evil are largely removed by discarding the three-phase type.

If independent regulation of circuits is necessary, one circuit can be given the proper pressure directly from the dynamo and the other circuits may be raised or lowered as may be required. This involves apparatus for regulating two circuits if the station be operated by the three-phase system, and only one circuit if the two-phase system is in use.

In a system where incandescent lighting is to be a prominent feature, or where load of any kind may be required upon one circuit and not on the other, the two-phase system has therefore a decided advantage in station regulation over the three-phase system. Another advantage of a two-phase circuit is that the load is separated into two divisions instead of three divisions, which is in general much simpler. A further advantage of the two-phase is in the reduction of potential for motors. Two transformers are sufficient in the two-phase system, whereas three transformers are commonly used in the three-phase system. The two transformers which would be required for small motors will cost considerably less than the three transformers which would be required on the three-phase system, and the loss in transformation will be much less, as there is not much difference in the cost of small transformers of slightly different sizes, and the large sizes are more efficient. The ease and simplicity of installation is also a gain for the two-phase arrangement.

A New System.

In considering the marked advantages of the two-phase system for distribution and of the two-phase system for transmission, it occurred to me that a combination of the two systems might secure the advantages of both in a combined system, and I have worked out a simple and effective method of accomplishing this

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result. It is well known that if two E.M.F.'s differing in phase be connected in series, the resulting E.M.F. will in general differ in value and in phase from either of its components. If two E.M.F.'s differing in phase 90deg. be connected in series, the resultant E.M.F. is represented in direction and magnitude by the hypothenuse of a right angle triangle, of which the two sides are the two com-

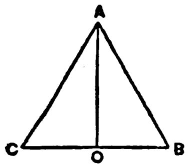

Fig. 6.

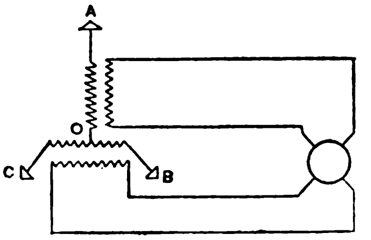

Fig. 7.

ponent E.M.F.'s. Thus in Fig. 6, if A O and O B are two E.M.F.'s at right angles, and these E.M.F.'s be connected in series, the resultant is the line A B, of different phase from either of the components. It is a simple matter to so proportion the components that O B is equal to one-half of A B, as shown in the diagram. In a similar manner it is readily seen that the same E.M.F., O A, may be combined with O C, which differs from it by 90 deg. (but is

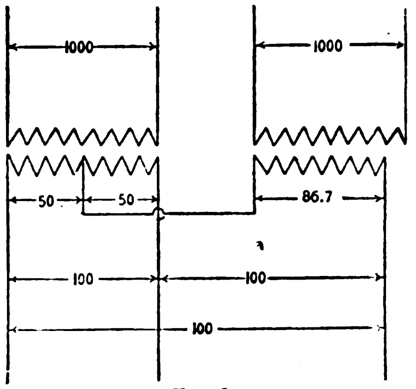

Fig. 8.

equal and opposite to O B) in such a way as to give A C equal to A B, but differing in direction. B O and O C added together give B C. The E.M.F., B C, may, therefore, be combined with the E.M.F., A O, at right angles to it in such a way as to give additional E.M.F.'s, A B and C A, which, in connection with B C, give three equal E.M.F.'s 120 deg. apart. This is the relation of E.M.F's in the three-phase system.

1,000 volts and on one secondary 100 volts and on the other 78 volts, then the E.M.F. measured between any two secondary terminals will be 100 volts. This three-phase circuit is adapted for operating three-phase motors. In a system of transmission two-phase currents at the generator may be converted into three-phase currents, as shown in Fig. 9, and the windings may be such that the E.M.F. is raised for transmission. The currents are then transmitted by three phases, effecting economy in copper. At the other end of the line a similar arrangement of transformers may be used for converting from the three-phase to the two-phase system. The two-phase currents may then be used for the operation of two-phase motors or the circuits may be independently loaded with lamps, or otherwise. If lamps be placed on the transformer which supplies directly from its two terminals the transmission is directly from the generator without affecting in any way the

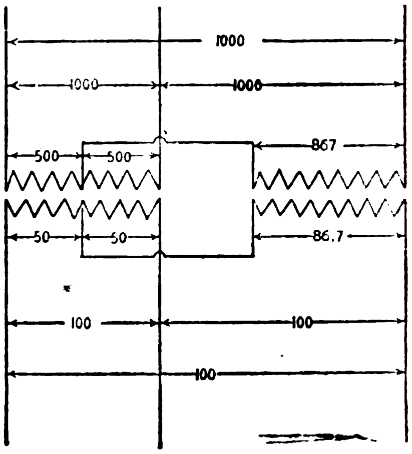

Fig. 10.

other circuit, as the generator terminals are connected directly to the first primaries, and the secondaries of the raising transformer are connected directly to the primaries of the lowering transformer and the current from this is taken directly to the load. On the other hand, if the other circuit be loaded the action here will also be on its own generator circuit without affecting the first. The current from the raising transformer in this circuit passes to the middle of the secondary of the other transformer, where it divides and flows in parallel through the two parts of the coil and two of the lines. As one-half of the current flows through each part of the secondary coil in opposite directions, the self-induction is completely neutralised and the transformers in this circuit are independent of the operation of the other circuit. It is to be noted that under this condition the line E.M.F. delivered by this transformer is only 87 per cent. of that delivered by the first transformer. The lower E.M.F., however, is compensated for by the fact that

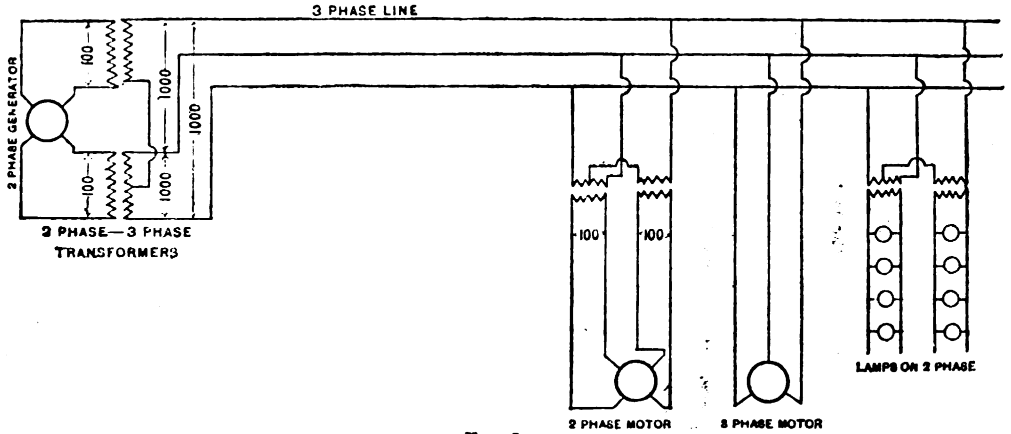

Fig. 9.

The application of this arrangement to transformers is illustrated in the accompanying Figs. 7 and 8. The primaries of two transformers are connected to a generator giving two-phase current. The secondary E.M.F.'s, therefore, differ 90 degrees. One secondary is made equal to 100 turns and a loop is brought out at its middle point giving 50 turns at each side. The second secondary has 87 turns, which is approximately equal to 50 multiplied by the square root of 3. One end of the secondary circuit is connected with the middle point of the secondary of the first transformer, as shown, and the three free terminals will then deliver E.M.F.'s differing in phase 120deg. If the E.M.F. on each primary be

the current on one side is passed through two of the lines in parallel, thus reducing the resistance of the circuit, and compensating for the slightly lower E.M.F.

The effect upon the regulation of the generator when two-phase circuits at the end of a three-phase transmission line are independently loaded is found, both by theory and test, to be the same that prevails when the load is placed directly upon the corresponding circuit of the generator. A modification of this system is found in the arrangement where the three-phase current is produced in the generator and transmitted over three wires to the reducing transformers. These transformers may be arranged

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as described for producing two phases. Loads may be placed upon either of the two-phase circuits and practically the same regulation in the generator will result that would have resulted if the generator itself had been wound for two phases and one of these circuits loaded. In this way it is possible to place a lighting load upon a three-phase generator in two instead of three units and to avoid the bad regulation in the generator due to unequal loading.

A similar arrangement of two transformers may be used for converting three phases of one potential into three phases of another potential. This arrangement is shown in the accompanying Fig. 10.

The efficiency of two transformers arranged for converting from two-phase to three-phase is reduced below that when working independently on ordinary loads by an insignificant amount. If the efficiency in ordinary working is, say, 97·5 per cent. it would be reduced to 97·4 per cent. in converting from one number of phases to the other.

The Tesla polyphase system in which the largest electrical enterprises are seeking a realisation, adapts itself with marvellous facility not only to all branches of electrical industry, but also by the transformation of its phases to the utilisation of three phases for gaining the highest economy in transmission, and of two phases for securing the maximum advantages in distribution.

DISCUSSION.

Prof. FORBES said he would like to say a few words simply to express the admiration he was sure everyone had felt for the great ingenuity which Mr. Scott had displayed in working out that beautiful arrangement of a combination of the two-phase and three-phase systems together. They must all admit that it was an extremely beautiful idea and appeared on the face of it to be a feasible method. He did not appreciate so much as Mr. Scott seemed to do the superior advantages of the three-phase system for transmission over long distances. The two systems, so far as they could find out in practice, as to their economy, &c., had little advantage one over the other. If the opinion be right that the three-phase system had a distinct advantage over the two-phase than such a scheme as Mr. Scott's ought to prove of great value. He particularly thanked Mr. Scott for the diagram, which showed the inductive electromotive force in volts per ampere per thousand alternations per thousand feet of circuit at different distances between circuits. With that Paper of Mr. Scott's, in conjunction with those which have been written by Mr. Kennelly on the same subject, any engineer had got before him all that was required for calculating the effects of self-induction and capacity upon the circuit. A little more had been done, however, and that was the effect of resonance. Mr. Scott had spoken of the interference of separate circuits upon each other. If he had considered the question of two different circuits, one circuit being a quarter of a period behind the other, then they had a very serious interference. It was most important in a large station where the polyphase system was employed to consider most carefully the arrangement of the conductors. This interference between the two circuits was of very great importance, far more important than the self-induction of one of the circuits upon itself. The lower the frequency the less the trouble from this cause, and hence the adoption of 20 periods per second at Niagara.

Prof. H. A. ROWLAND said that, so far as he could see, Mr. Scott's invention was one of the finest things that had come out in recent years. Very few of them expected that they would be soon able to transform a two-phase system into a three-phase, or any number of phases. The paper marked an era in the science of the polyphase systems. He had himself been working on a paper covering the same points, but his method, though a little broader, was not in any way so practical and simple as that of Mr. Scott's. By his method he could change the period of the current at the same time that the number of phases was changed. Although he quite agreed with Prof. Forbes that a low period was excellent in many respects, he was not able to agree with him as to the exact figures.

Mr. T. SPENCER inquired how Mr. Scott would apply that load factor when the load was distributed along the line, so that one could get an accurate idea of the size of the conductor or percentage of drop in the line.

Mr. SCOTT replied that in that case the problem became more complicated. It would be necessary then to take each part of the circuit and calculate the amount of electromotive force in it, and so on, for each part of the circuit. In practice, however, the counter electromotive force in primary circuits of one or two thousand volts extended over a small area—a mile or so—and with ordinary currents, up to one hundred amperes, was not such as to cause effects of very great practical importance. That was shown from the fact that in the circuits ordinarily operated these effects had not been very prominent. They had not interfered with the working of central stations of pretty large capacity, and the fact was fully demonstrated at the World's Fair Westinghouse incandescent lighting plant, which had been the largest ever installed. In general, the inductive drop in circuits for incandescent lighting was only a small percentage of the ohmic drop; and it was an extreme case when the drop due to induction equalled the drop due to the resistance of the conductor. He agreed with Prof. Forbes on the great value of Mr. Kennelly's Paper. In ordinary working, however, capacity would have very little effect. It was only when they got up to very high voltages or very low lines that the effect of capacity would enter in a marked degree. The so-called skin resistance, or increase of resistance of the conductor, due to the un-uniform distribution of electric currents in ordinary working might be very largely neglected.

Mr. L. B. STILLWELL complimented the Association in having had such a valuable Paper brought before it. He claimed that the plans at Niagara Falls were substantially those laid out by Mr. Tesla several years ago, and referred to the statement of the Westinghouse Company's position in the matter published in the *Electrical Engineer* of January 10, 1894. He also referred to the Westinghouse plant at the World's Fair as exemplifying the general type of the system adopted at Niagara.

ON PARALLEL WORKING, WITH SPECIAL REFERENCE TO LONG LINES.

The following is an abstract of the concluding discussion on Mr. Mordey's Paper, which took place at the Institution of Electrical Engineers on Thursday evening last week. Speakers whose remarks are prefaced by an asterisk have returned their proofs revised.

*Major-Gen. WEBBER said there was one matter which seemed to him to have been left out of the paper, and he thought it was to be regretted. If Mr. Mordey had been able to give them information on the condition of the parallel running which was going on, and which had been going on for a considerable time, under circumstances similar to those which he had described, the data might have been more interesting than those which had been given. They all knew that for two or three years Mordey-Victoria current alternators had been guaranteed to work in parallel with any other dynamo of the same make, irrespective of size. It was not so well known that for a considerable time the City Company had been running in parallel not only two Mordey-Victoria machines, but also one of that make and a Thomson-Houston machine of different size and capacity, supplied and fixed by Messrs. Laing, Wharton and Down, at the station known as the City of London Electric Lighting Company's Pioneer station at Wool Quay, which was close upon 2,500 yards away from their Bankside station on the Surrey side of the river. These machines differed not only essentially in construction, but also in the motors driving them. The Mordey-Victoria was a 100-kilowatt machine, driven by a Brush vertical inverted engine, the speed of which was about 167 revolutions, whilst the Laing, Wharton and Down, Thomson-Houston high-tension composite-field automatic self-regulating alternate-current dynamo had a capacity of 120 kilowatts, was driven by Marshall's engines with a speed of about 170 revolutions. These two machines were both serving the primary circuits of a transformer station in one bank of transformers. He hoped that the facilities obtained from the City Company for a laboratory experiment, as it might be termed, might also be given to Mr. Mordey in connection with this extremely exceptional circumstance which had been going on now for a twelvemonth, and so far as he was aware with success. He might mention that the original frequency of those two dynamos was different: that of the Mordey-Victoria was 100, and that of the Thomson-Houston 130.

*Capt. SANKEY said he would like to have an opportunity of confirming Mr. Mordey as to the ease with which Mordey alternators had been kept in parallel at Thames Ditton. There was not the slightest difficulty in getting them into step, nor was there any sign of their trying to get out of step, except when a brake having been put on the fly-wheel of one of the sets the speed of both sets was reduced to 25 revolutions from a speed of 500. Then they broke away; the set that had not the brake on went up to about 500, and the other, of course, remained at 25 until the plank used as a brake was removed. As regards the pulsation of the light in the Sunbeam lamps, he was inclined to think that it was due to oscillations in the load on the engines synchronising with the time period of the governors. He did not think it was due to hunting of the governors. The card shown in Mr. Mordey's Paper would, no doubt, be produced if the governor had been hunting, but it would also be produced if the governor were sensitive enough to follow up rapid changes of load. To put the matter beyond doubt he took some cards that morning. First of all he took a diagram holding the pencil down for half a minute, with a perfectly steady load of 240 volts, 340 amperes at 372 revolutions. The diagram was a thin line. Then the load was gradually changed by means of a shunt resistance, backwards and forwards from 240 to 234 volts, and from 350 to 240 amperes, and the card produced was indentical with the one in Mr. Mordey's Paper. The governor was then put out of adjustment so as to hunt, and the card produced was identical with the one due to a changing load. Having gone so far he thought he would like to know how sensitive the governor was, and, therefore, after readjusting the governor, he changed the load 10 times a minute, and the card produced was the same as that in Mr. Mordey's Paper. He then changed the load 30 and finally 192 times a minute, and even in the last case there was a distinct fluctuation on the card, showing that the governor was sensitive enough to follow these extremely rapid changes of load. He had measured the resistance of one of the Sunbeam lamps, it was 35 ohms cold, and it dropped to 17 with 4·7 amperes going through it, which just over-incandesced it. He was not present at the last meeting, but he understood that Mr. Raworth said the whole of this fluctuation was purely a mechanical effect due to hunting of the governors, and that so long as there was friction there must be hunting in governors. Now, it was quite certain there were governors that did not hunt, and it was also equally certain that those governors must have some amount of friction in them. The fact was it depended upon where the friction was, more than upon the amount. He was prepared, if Mr. Mordey would send down a couple of 30 kilowatt alternators to Thames-Ditton, to have them coupled up to two Willans' engines, and experiments might be tried until this matter was thoroughly threshed out.

Mr. MITCHELL read a communication from Prof. Forbes giving a mathematical examination of the parallel working of alternators having no self-induction.

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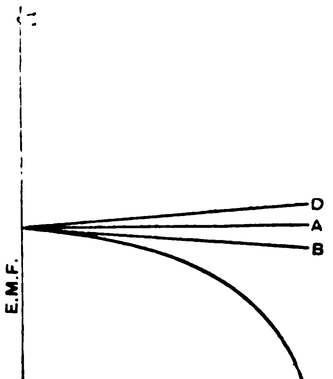
*Prof. AYRTON said at the last meeting the discussion seemed to turn upon methods of synchronising alternators, and he would say a word or two upon that subject. The ordinary elaborate method of synchronising alternators was really wholly unnecessary, if only electrical engineers would condescend to deal with the high-pressure circuit of their own alternators instead of always requiring to measure on the low-pressure circuit, and if they would also use electrostatic instruments rather than electromagnetic. Suppose they had two alternators which had to be synchronised: one of them, if they liked, was already attached to the omnibus mains supplying currents, and the other one had to be so attached. Then—as Mr. Mather and he proposed—let them join one terminal of each of the alternators together through a resistance, say, of 20 megohms (the very finest pencil line drawn on a piece of ebonite would do), and then connect the other terminals to any electrostatic voltmeter they liked—and he was using the word now in the most comprehensive form: an electroscope, a vacuum tube, anything which electrostatically indicated high difference of potentials. Imagine, for instance, an electroscope; they did not want gold leaves, tinfoil leaves would do, a foot-and-a-half long if they liked, the leaves being attached to one of the alternators and the outside case to the other. Then as one dynamo was speeded up the leaves would begin to oscillate backwards and forwards very rapidly, then more and more slowly, and finally, when they came together, the machines were exactly in step. They thus had an arrangement far more dead-beat than a glow-lamp; the luminosity remained for a sensible time in a glow-lamp. The apparatus was cheap—they might make it for a few shillings—and might be as large as they liked; they wanted no scale, no actual calibration; it might be as wrong as they liked looked at from the point of view of an accurate electrostatic voltmeter, and no specially doubly-wound transformer was needed with this direct method of synchronising. What they wanted was simply a thing giving a big divergence for 4,000 volts, and no divergence for zero P.D. They had thus a perfectly cheap method of synchronising dynamos, which did not need being metalically connected together, and there was no fear of one dynamo damaging the other. It was so simple that he should imagine it must have been tried, and, therefore, he should be glad to hear what was the experience of trying such a method. They had used it themselves in their laboratory with perfect success, but not with such large leaves as he had suggested.

Mr. W. M. MORDEY, in replying to the discussion, said his colleague, Mr. Raworth, opened the discussion and spoke of the question of pulsation. Mr. Raworth was under the disadvantage of not having read the Paper beforehand. He (Mr. Mordey) thought the pulsations might have been entirely mechanical, but it might also



have been electrical, as he had explained. But, for his part, he stopped at the pulleys of the dynamo, and he must leave Mr. Raworth and Capt. Sankey to settle whether governors could be made which did not hunt, or whether governors must hunt. Mr. Sparks followed Mr. Raworth, and emphasised the need for steady turning in engines driving alternators in parallel working. Mr. Kapp spoke at considerable length on the spur-wheel analogy. He (the speaker) was quite aware that all analogies must fail somewhere. All the same, he did not quite agree with Mr. Kapp's conclusions. Mr. Kapp argued in favour of spur gearing with yielding teeth. Prof. Thompson took the view which he (Mr. Mordey) had taken, in favour of the flexible teeth being weak teeth. Mr. Kapp interrupted, and said, "Not if you regulate the fields." That was to say, if the synchronism was going to give way, if the machines were likely to get out of step, then they must adjust the fields. Of course, that was really the whole question; it was a question between good regulation and bad. He quite agreed with what Prof. Thompson said, that the flexible tooth was really a weak tooth. A magnetic field that was twisted out of shape and pulled round by an armature must necessarily mean a weakened effect. Mr. Kapp said, "Yes; but you can avoid that by adjusting the field when the weakening is taking place." Unfortunately they could not always do that. In trying to make these analogies clear he pointed out that whilst an engine was going over the dead centre, and another engine was taking steam and accelerating a little, there was a tendency to a difference of speed which must be counteracted by very rapid interchange of power between the two machines. That meant that at each stroke of the engine, or perhaps twice at each stroke, or oftener, there was a weakening of the teeth taking place. Now, Mr. Kapp would, of course, acknowledge that he could not possibly regulate for that. Therefore he (Mr. Mordey) argued in favour of machines being designed which did not require this regulation, because they complied with what ought to be one of the principal conditions necessary to the good working of central station dynamos; he meant they had a constant electromotive force, or nearly constant. If they took a machine, such as Mr. Kapp thought was best, and excited it, say for full electromotive force, with no load, and then suddenly switched the load on, the volts would go right down. Let the abscissæ represent load and the ordinates electromotive force, then of course the perfect machine for parallel working for alternate current distribution would be one that gave a perfectly straight line A. Machines were made to give a perfectly straight line by hand regulation as a rule, sometimes by various methods of automatic regulation. In order to get it with any machine they had to increase the excitation of the field as the load came on. They might have to increase it a great deal or very little. In the case of a powerful synchroniser, if they did not increase the excitation at all and put the whole load on gradually, the line would fall a little bit, as shown by B. Taking the machine that Mr. Kapp advocated, the line would become a dropping curve, like C. Suppose they increased the excitation of the two machines to compensate for the drop: suppose that the fuses went: they then had no possible opportunity of regulating the fields. It was an instantaneous matter, and the field had just to take its chance. Well, the machine with the strong teeth would rise in volts about as much as it fell, as shown by line D. That was to say it might be about 4 per cent. each way on his (Mr. Mordey's) machine. Now, taking the machine, a type of machine which had been very successful in many ways, designed by Mr. Kapp and many engineers in different parts of the world. When the fuses went what happened? Well, the volts went somewhere up to E. They might say this large electromotive force was not on the mains, and therefore did not matter. Still, it was a risky thing. Imagine the electromotive force somewhere up there, and the engine running unsteadily, the governor sticking, or hunting—something of that kind happening. It had got pulsations of power alternately, the electromotive force was alternating between nothing whenever it tried to take a large current, and the point E up there whenever by reason of its not having steam the load was transferred to the other machine, so it was not merely in the parallel working qualities of the machines that the question was of importance. He was glad to have the information as to the resistance of the Sunbeam lamp in the Thames Ditton experiments. The change of resistance between the incandescent state and the cold state was even greater than he supposed. He thought that went a long way to support the contention he raised, that this marked change in the resistance joining the machines had to do with the pulsations.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March* 16, 1894.

Electrical Units.—At the meeting of the American Institute of Electrical Engineers on March 21st, the proposed names for the magnetic C.G.S. units will be brought up for provisional adoption. These, as your readers are doubtless aware, are the terms "Gilbert," "Weber," "Oersted," and "Gauss" for the C.G.S. units of magnetomotive force, magnetic flux, reluctance and flux density, respectively. It is urged that there is a practical necessity for the adoption of names for the magnetic units, and that their C.G.S. values are practical values. Objection has been made to the names proposed that they are not in conformity with the Greek names "erg" and "dyne" in the C.G.S. system, and are at variance with the practical system of other units in use as to their dimensions.

Personal.—Mr. O. T. Crosby, Manager of the street railway department of the General Electric Company will resign that position on May 1st to join the well-known firm of J. H. White and Co., constructing engineers. Mr. H. P. Parshall will continue with the General Electric Company as consulting engineer and will shortly sail for Europe on professional business.

BOOKS RECEIVED.

"Traité de Télégraphie Électrique." By H. Thomas. (Paris: Baudry et Cie.) 25fr.

"The Electric Lighting Acts, 1882 and 1888." By Francis Hastings Medhurst, M.I.E.E. Price 1s. (London: J. J. Keliher and Co.)

"Electro-Plating." By John W. Urquhart. Third Edition. (London: Crosby, Lockwood and Son. 1894.)

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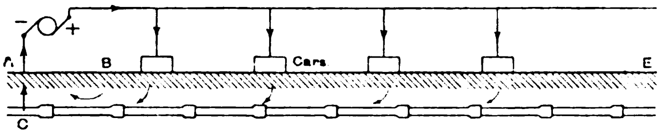
CORRESPONDENCE.

THE POLARITY OF THE EARTH RETURN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The discussion of the Board of Trade Draft Electric Traction Regulations having shown the considerable amount of importance given by the interested bodies to the subject of connecting the uninsulated return of traction circuits to *the negative* terminal of the generator, and some criticism having been directed some time ago against the arrangement adopted at the Marseilles Electric Tramway, where, for trial, I gave the *positive* polarity to the earth line, I ask for some space in your valuable paper to submit you the results of my personal experience and investigations on this subject.

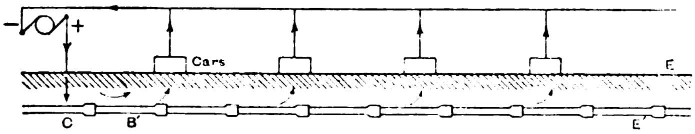
In a given plant, the track line of which is connected at one time to the negative and at another to the positive terminal of the generator, all other things being equal, the sum of all leakage earth currents will be exactly the same in both cases, depending only on the difference of potential between the point connected to the generator, and the other points along the track.



A gas or water pipe parallel to the track, and extending along its entire length, will become a conductor to these leakage currents, and, irrespective of the polarity of the track, the current density in this pipe will be greatest near the point of connection to the generator.

In case I., the track line being negative, the leakage currents leave the track at any points located between the end of line E, and a point B, generally very close to A, enter the pipe and leave it all together at C, in order to reach A through earth. The outflow of all elementary leakage currents being concentrated on C, the current-density at this point may become large enough to produce considerable electrolytic corrosion of the pipe in a very short time.

In case II. the track line being positive, the location of the leakage-currents is evidently the same, but they flow in opposite directions. The current inflow will be concentrated at point C, and no electrolytic action occurs there. The leakage currents then *leave* the pipe at any points between B′ and E′,



but the outflow being in this case divided over a very large surface of pipe the density at any point will not be large enough to produce any appreciable action on the pipe, unless after a relatively long time.

This assertion is fully confirmed by the results of a two years' working with case II. at the Marseilles Tramway, where no difficulty whatever has been found with electrolysis, although the station output often reaches as high as 350 to 400 amperes. The danger of this arrangement, however, lies in the fact that some special conditions, moist soil, branch pipes very close to the track, &c., may favour the concentration of current outflow to points that can only be detected by an accident itself, and the protection of which is, therefore, very difficult. With the *negative* terminal to earth, the danger being always concentrated principally at point C, protection of this point may be easily attained by a good, reliable, and *well-insulated* metallic connection to the negative terminal of the generator. Such a connection, with a current indicator in its circuit, and together with the regular "Board of Trade" earth connections, will prove very useful, as by it means a very reliable control over the return and the electrolytic dangers may be obtained.—Yours, &c.,

Marseilles, March 28, 1894. H. DUBS.

LEGAL INTELLIGENCE.

Dickenson v. Ronald A. Scott.

At the Stockton County Court last week, before Judge Turner, Mr. Thomas Dickinson, building contractor, of Middlesbrough, sued Ronald A. Scott, described as an electrical engineer and patentee, of Acton Hill, Middlesex, for £20. 10s. for work done.

The case for the plaintiff was that in May last the defendant arranged with his agent, Mr. W. C. Folchard, of Stockton, to have two displays at Middlesbrough of his patent electrical apparatus for advertising on the clouds with a view to selling the patent rights for the six northern counties to a syndicate, which Mr. Folchard and Mr. Fred Forster were to get up. The plaintiff put up the staging, &c., for the displays, and assisted to erect the machine and also take it down, but neither Mr. Folchard nor the defendant had paid him. An offer of £4,000 was made for the patent rights, and Mr. Folchard was to have 5 per cent. commission, but Captain Scott wanted, in addition, a royalty of £4 per lamp per annum, and the negotiations fell through.

The defence was that Mr. Folchard was liable, and the defendant, on a counter claim, sought to recover £50 damages for loss of profits arising from the wrongful detention of the machine by the plaintiff.

The JUDGE, after a long hearing, found for the plaintiff for £12 and costs, and against Mr. Ronald A. Scott on his counter-claim.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.—The Corporation of Edinburgh require tenders for the erection of the buildings, &c., of their central electric light station at Torphichen-street. Tenders have to be sent in to the Burgh Engineer, City Chambers, Edinburgh, not later than Wednesday next.

——— The proprietors of the Rhyl Pier and Pavilion invite tenders for lighting the same by electricity. Particulars can be obtained at 3, Bradshaw-street, Shudehill.

——— The Baden State Railway Authorities invite tenders for the supply and erection of plant, on the continuous-current system, for the lighting of the Carlsruhe Railway Station. Tenders have to be in by May 1st.

TENDERS ACCEPTED.—The tender of Messrs. Drew, Beard, Romson, and Parks, of 71A, Queen Victoria-street, E.C., has been accepted for the sum of £846. 18s. 10d., for the supply of steel lattice girders, rolled joists, cover plates, bolts, rivets, tie-rods, coupling-boxes, and rail struts, two traverse tables, and creosoted deal rail packings, for the Brighton and Rottingdean Seashore Electric Tramroad Company.

APPOINTMENTS.—Mr. A. B. Blackburn, M.I.C.E. (late with Messrs. Mather and Platt, Limited) has been appointed Chief Engineer of the Electric Construction Company (Limited).

——— Mr. L. Le Gros Horne has been appointed Electric Light and Telegraph Superintendent to the Great North of Scotland Railway Company, *vice* Mr. P. M. Barnett.

——— Mr. Joseph Shepherd has been appointed electrician to the Bolton Corporation, at a salary of £110 per annum.

——— The Dewsbury Board of Guardians, having considered the applications (22 in number) received for the post of "consulting electrical engineer," and to superintend the erection of the electric lighting plant at the workhouse, have decided to appoint Mr. Arnold Greener, of Dewsbury, at a salary of 30s. per week, provided the Dewsbury Corporation have no objection to his holding the appointment, or failing Mr. Greener, then Mr. Ernest Marples, of Liverpool.

LIQUIDATIONS.—The petition of General Sir R. J. Meade for the winding up of Elmore's Foreign and Colonial Copper Depositing Company (Limited) came before Mr. Justice Vaughan Williams in the Chancery Division on Wednesday. Counsel stated that the petition came up on the last day of last sitting, and it stood over till now. In the interval the petitioner had died, and the executors had not proved the will, and under these circumstances it was asked that it should stand adjourned for a month, to which his Lordship agreed.

——— A petition by shareholders for compulsorily winding up the South Staffordshire Tramways Company (Limited) came on Wednesday before Mr. Justice Vaughan Williams. It was directed to stand over till Wednesday next for the filing of further evidence in support of the petition.

DISSOLUTION OF PARTNERSHIP.—The partnership hitherto existing between William Winstanley Strode, Edward Phillip Williams, and George Edward Cockburn, of 67, St. Paul's Churchyard, London, gas and electric engineers, has been dissolved. The debts of the old firm will be paid by Mr. W. W. Strode.

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"ANTI-SULPHURIC ENAMEL."—This material is being used in the accumulator rooms of the Carnaby-street Electric Lighting Station of the Pall Mall Company, to protect the wood and metal work from the action of the fumes and spray from the batteries.

LOCAL GOVERNMENT ACT, 1894.—A pamphlet abstract of the new Local Government Act (being a reprint from the *Local Government Journal*) is issued by S. Edgecumbe Rogers, Dorset House, Dorset-street, London, E.C., price one penny.

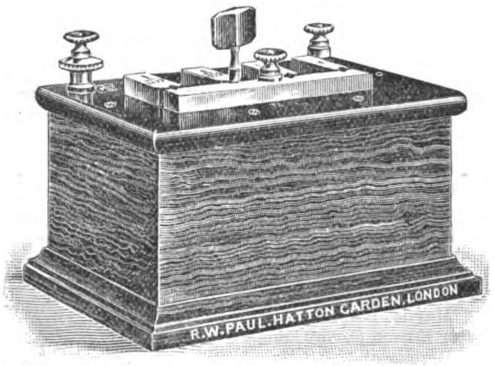
WORKS PREMISES.—The sale by auction, by Messrs. G. A. Wilkinson and Son, of the valuable freehold property, Cadby Hall, Hammersmith-road, West Kensington, recently in the occupation of Messrs. Woodhouse and Rawson United (Limited), is announced for Monday, the 23rd inst., at 2 o'clock, at the Mart, Tokenhouse-yard, London, E.C. Further particulars will be found in our advertisement columns.

ARTISTIC FITTINGS.—Messrs. Lea, Sons and Co. have just completed a set of elaborate electric light fittings for Lord Armstrong, of Cragside, Rothbury, N.B., consisting of two 17-light electroliers in oxydised silver and gilt, for the saloon and picture gallery, the ornamentation in beaten scroll and foliated work; a large octagonal shade light, 3ft. in diameter, the framework of dead bright steel in perforated and beaten panels, representing the rose, shamrock, and thistle; fittings for Lady Armstrong's boudoir, in gilt chased and beaten work, carrying a glass bowl, in which electric lamps are placed; and fittings for the studies, in black iron ribbon scroll work, with inverted opal shades.

TURRET LATHES AND SCREW MACHINES.—Mr. H. F. L. Orcutt, agent for Messrs. L. Loewe and Co., of Berlin, sends us a newly-issued illustrated sheet of turret lathes, screw and slotting machines, drills, &c.

DANISH PATENT LAW.—A new patent law for Denmark has been passed by both Chambers of the Legislature, and will probably become law in the course of a few days. The alteration effected by the new law assimilates Danish practice to that of Germany, Norway, and Sweden. Protection is given from date of filing application, the duration of the patent is 15 years, the importation of patented articles is prohibited, the examination as to novelty is prior to the grant, and opposition to the grant by parties interested is permitted. The new law is intended to come into operation about the middle of June.

THE AYRTON-MATHER UNIVERSAL SHUNT BOX.—On another page we give the Paper read by Prof. Ayrton and Mr. Mather on the 29th ult. before the Institution of Electrical Engineers on



"The Universal Shunt Box," and we give above an illustration of the box, which is manufactured by Mr. R. W. Paul, of 44, Hatton-garden, E C.

CHLORIDE ACCUMULATORS.—We have received from the Chloride Electrical Storage Syndicate (Limited) a well got-up catalogue and price list of chloride batteries. The pamphlet contains a description of the batteries, and details the advantages claimed from their use for traction purposes.

INTERNATIONAL ELECTRIC SUBWAY COMPANY (LIMITED).—This Company have just issued in convenient form a pamphlet describing the Johnstone system of conduits, the patents for which are owned by the Company. A number of illustrations and drawings show the method of laying the conduits. In the pamphlet is a price list, extracts from press notices, and favourable testimonials from large users of the Company's conduits.

MESSRS. DRAKE AND GORHAM.—This firm have obtained the contract for lighting two of the large new houses in Melbury-road, Kensington, with 115 incandescents, and are putting in a steam-engine plant for the lighting of the country house of Le Court for Mr. Heath Harrison.

"CLUBS."—This is the title given by Mr. E. C. Austen Leigh to a handy list of clubs frequented by the English in all parts of the world. This is the second year of publication, and the author has now been able to make up the total number to over 1,000 clubs in London, the provinces, and abroad. The price of the book, which is published by Messrs. Spottiswoode and Co., is 1s.

ACCRINGTON.—The Local and Parliamentary Committee of the Corporation have recommended that plant be put down for supplying electric current equivalent to 4,000 8-c.p., and that provision be made for extensions. It is further recommended that steam be selected as the motive power.

ABERDEEN.—The Gas Committee of the Corporation recommend that in future the committee be renamed the Gas and Electric Lighting Committee. Prof. Kennedy has appointed Mr. G. G. Clark as second engineer at the electric lighting station. At the last meeting the Gas Committee authorised the purchase of 50 electricity meters at an estimated cost of £320.

BEDFORD.—At the last meeting of the Town Council, the Mayor read a letter from the Board of Trade regarding the objections made by the Council to the application of the Bedford Electric Lighting Company for a Provisional Order, and suggested that a deputation representing all parties should appear before them to discuss the matter. It was agreed to appoint a deputation from the Council to wait upon the Board of Trade. The Town Council have obtained a Provisional Order, but so far have done nothing further in the matter, and the object of the Bedford Electric Lighting Company is to ask the Board of Trade to transfer the Order to them, but this proposal meets with the strong opposition of the local authorities.

BELFAST.—At a meeting of the Electric Lighting Committee, held on Tuesday, applications for the appointment of a resident electrical engineer were considered. There were nearly 60 applications, which were reduced to 10, and which will be further reduced to six, from which the Council will ultimately select.

BIRKENHEAD.—It has been decided to purchase a piece of land, 3,152½ square yards in extent, for the central lighting station, at a cost of £1,576. This will provide more room than is at present required, and will therefore allow for subsequent extensions to be made.

BRIDGEND.—The Local Chamber of Trade has decided to take legal advice as to the legality of the action of the Local Board in defraying the cost of the electric lighting Provisional Order out of the public rates.

BRISTOL.—Notwithstanding the local authorities of Bristol, St. George, and Kingswood, have given their sanction to the scheme for electric traction, it is stated that opposition is to be offered by several tradesmen in West-street, Kingswood, the grounds of opposition being the narrowness of thoroughfare. The tramways company are actively proceeding with the necessary plans and specifications, in order to be ready to commence work as soon as Royal assent is given to their bill. The threatened opposition comes as a surprise, and an effort is to be made by the influential local committee which originally supported the scheme to induce the opponents to re-consider their position.

CHATHAM.—A meeting of the Town Council was held last week, and, on the proposition of the Mayor, it was decided to ascertain the cost of constructing a tramway from the Luton Arch to the top of Star Hill, to be driven by electricity. If the Council decide to construct this tramway, the Chatham and Rochester Company are to be asked to supply the Corporation with current, and to prepare an estimate of probable cost.

CHELTENHAM.—With regard to the tenders received and accepted by the Town Council for electric lighting plant and machinery, it is noticeable that the amounts of the tenders are remarkably equal, especially when the highest and lowest tenders are eliminated. The second highest tender for the whole of the plant is £4,610, and the second lowest £4,100. As announced in our last issue, the tenders of Messrs. Siemens Bros. and Co. and Messrs. Galloways (Limited) have been finally accepted. The following is a complete list of the tenders :—

	For the whole.	For A.		For B.			For C.
	£	£	s.	£	s.	d.	£
Laing, Wharton and Down	4,964	380	0	4,002	0	0	682
Siemens Bros. and Co. (1)	4,360	365	0	3,450	0	0	590
Ditto (2)	4,610	365	0	*3,695	0	0	*590
John Fowler and Co.	4,500	377	0	3,612	0	0	575
Johnson and Phillips	4,307	345	0	3,280	0	0	682
Crompton and Co. (1)	4,100	430	0	3,060	0	0	660
Ditto (2)	4,125	430	0	3,100	0	0	660
Ditto (3)	4,180	430	0	3,165	0	0	660
Ditto (4)	4,170	430	0	3,160	0	0	660
Ditto (5)	4,470	430	0	3,460	0	0	660
Brush Company	3,840	340	0	3,006	0	0	521
Galloways	—	*438	15	—			—
Spurr, Inman and Co.	—	340	0	—			—
Electric Construction Company.	—	—		3,400	0	0	—
Mather and Platt	—	—		3,255	10	6	—
McLaren	—	—		3,322	10	0	—
Willans	—	—		3,963	0	0	—

* Accepted tenders. The engines in the successful tenders are Willans' direct driving.

A, boilers only ; B, engines and alternators ; C, condensing plant.

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Messrs. Laing, Wharton and Down's tender was for Browett and Lindley engines, as were also the tenders of Messrs. Johnson and Phillips (belt driving) and Crompton and Co. No. 1 (rope driving); Messrs. Siemens Brothers and Co.'s tender No. 1 was for Belliss engines (direct driving), as were also Messrs. Crompton and Co.'s tenders No. 3 (rope driving) and 4 (direct driving); Messrs. John Fowler and Co.'s tender was for Fowler engines (rope driving); Messrs. Crompton and Co.'s tender No. 2 for Davey Paxman engines (rope driving), and 5 for Willans' engines (direct driving); and the Brush Company for Brush engines (direct and rope driving).

The Local Government Board has given its sanction to a loan of £16,000 to be borrowed by the Cheltenham Town Council for the purposes of electric lighting, repayable in 25 years, and has further given its consent to the use of part of the site of the Destructor for the electric lighting station.

CHERRYHINTON.—It is proposed to form a company to light the Cherryhinton district by the electric light, and a meeting was held last week to discuss the subject. Lord Russell, who was present, said that the whole of the buildings, plant and machinery, mains and transformers, could be put down for about £2,500 or £3,000. His firm, as contractors to the scheme, were willing to take 50 per cent. of their contract in debentures, provided about £2,000 was subscribed. This sum would provide for about 500 lights, which was as much as they could expect to have taken up for the first few months. The Chairman of the meeting said, that doubtless if it could be shown that customers for the current would be forthcoming, people in Cambridge would assist Cherryhinton in providing the necessary capital. It was decided to adjourn the meeting for inquiries to be made as to the probability of obtaining the necessary capital and other support.

CHURCH LIGHTING.—The officials of the leading cathedrals and churches throughout the country are gradually adopting the electric light, and the authorities of the Methodist Free Church at Blackpool have entrusted Messrs. Maunsell Mercier and Co., of Manchester, to instal the light throughout the church, for the sum of £70, including electroliers. This is the first church in Blackpool to adopt the electric light.

CITY OF LONDON.—The gas standards have now been removed from all the principal thoroughfares, and the public lighting of the City is now almost entirely in the hands of the City of London Electric Lighting Company.

COLCHESTER.—A serious accident happened at the extensive works of Messrs. Davey, Paxman and Co. on Saturday last, causing the death of two of their employés and the injury of a third man, who were engaged in testing a cast-iron oil collector, part of a large plant being manufactured for a refrigerating company, when the massive tube burst. Several remarkable escapes from injury occurred.

COVENTRY.—The City Council have approved the plans for the proposed electric lighting station, with some slight alterations, and the Corporate Seal has been affixed to the contract with Messrs. John Fowler and Co., of Leeds, for the electrical equipment of the station.

DEWSBURY.—The Board of Guardians have decided to erect the necessary buildings and put down plant for lighting the workhouse and cottage homes belonging to the Union by electricity. They will ask for borrowing powers for £2,150 towards the cost. The Electric Lighting Committee having considered the application of the Collier-Marr Company for preparing plans and specifications amounting to £16. 11s., have recommended the offer of £11. 11s. in settlement, without prejudice.

DUBLIN.—At the meeting of the Corporation on Monday the report of the Electric Lighting Committee was taken into consideration, in which it was stated that though the contract for the additional plant was being placed with Messrs. Fowler and Co., an English firm, it had been arranged that the boilers and all other articles should, so far as possible, be made in Dublin. The increased plant was necessary to meet the growing demand for the current. An attempt was made to refer the matter back to the Committee, in order that further tenders might be obtained; but this was defeated by a majority of two; and ultimately it was referred back to the Committee for further consideration without any conditions.

DUNDEE.—A complaint having been made by local tradesmen concerning electricity meters put in by the Corporation, the Police Commission have agreed that Major Cardew, the electrical adviser to the Board of Trade, should make a test, on condition that if the meters are found correct, the consumer shall pay all expenses.

EDINBURGH.—The principal proprietors and tenants of the property in George-street, St. Andrew's-square, Charlotte-street, and the streets leading into these important thoroughfares from Princes-street, have determined to energetically memorialise the Local Authorities to have these streets included in the electric lighting scheme. If this movement is successful a considerable extension of the Council's original scheme will be necessary.

ELECTRIC ORGANS.—Mornington-road Wesleyan Church, Southport, has been furnished with an electric organ, comprising great swell, choir, solo, echo, and pedal organs with couplers, and 53 stops, besides accessories. The first rehearsal took place last week, and proved highly successful.

EXHIBITIONS.—An Exhibition of British Industries is to be held at Earl's Court, London, W., from May to October, the object being to illustrate the various industries of Great Britain, with special reference to the advances made in methods of production and new inventions during recent years. The buildings are to be lighted throughout by electricity, and the exhibits will be divided into seven sections—manufactures, mechanical engineering, machinery and electricity, agricultural, mining and metallurgy, science, and fine arts.

GUILDFORD.—Since the resolution adopted by the Town Council, as previously reported, a meeting has been held, at which a spirit of conciliation was evinced, and the Mayor and Town Clerk have been appointed to discuss with the promoters the possibility of the Council giving its sanction to the application made by the local Company for a Provisional Order, on condition that terms can be arranged so that the Local Authority can take over the Order any time after ten years by giving six months' notice. It is, therefore, more than likely that the present deadlock will be satisfactorily arranged. A motion that the Council undertake to themselves promote an electric lighting scheme in five years time was discussed, but was negatived, it being pointed out that several public works of considerable magnitude were already being undertaken by the Council.

GLASGOW.—The Kelvinside Electricity Company have decided to reduce the price per Board of Trade unit for electric current on and after May 15th next to 6d. This is a reduction of 2d. on the present price, and is 1d. less than the Corporation charge.

HANLEY.—The following is the complete list of tenders received by the Corporation for electric light wiring and fittings to the Corporation buildings:—1. Town Hall, including Victoria Hall. 2. Free Library and Boys' Reading Room. 3. Museum and Technical Schools. 4. Baths. 5. Market Hall and Fish Market. 6. Butchers' Market. 7. Electricity Works. (Mr. Joseph Lobley, Borough Engineer and Surveyor.)

C. A. Hemingway, Richmond	£5,681
Crompton and Co., London	4,925
Charles Smith and Sons, Birmingham	4,159
Laing, Wharton and Down, London	4,152
A. H. Wood, London	4,121
E. M. Evans, Manchester	4,086
Bourne and Grant, London	3,986
Brush Electrical Engineering Company, London	3,980
Paterson and Cooper, London	3,915
W. A. Shaw and Co., Stockport	3,897
Graham and Priddle, London	3,873
R. Barnett and Co., Newcastle	3,865
Sharp and Kent, London	3,859
A. F. Joel and Co., London	3,789
Fowler, Lancaster and Co., Birmingham	3,733
Marryat, Lillywhite, and Co., London	3,726
J. C. Collum and Co., Leicester	3,657
Walsall Electrical Company, Walsall	3,657
Johnson and Phillips, London	3,651
New and Mayne, London	3,651
Manchester Edison Swan Company, Manchester	3,585
Maunsell Mercier and Co., Manchester	3,527
Baxendale and Co., Manchester	3,445
S. H. Heywood, Manchester	3,061
Spagnoletti and Crookes, London (accepted)	3,034

In addition to the above, tenders were received from Messrs. Harry South (London), Joseph Blackburn (Nottingham), J. Defries and Sons (London), Thomas Barton (Blackburn), Lea, Sons and Co. (Shrewsbury), B. Verity and Sons (Manchester), and Donnison, Parmiter and Barber (Manchester), for wiring and fittings to a portion of the buildings, and from Messrs. J. D. F. Andrews and Co., to a different specification. Messrs. Spagnoletti and Crookes' tender has been, by modification of some of the items, reduced to the round figure of £3,000.

HULL.—It has been decided by the Lighting Committee of the Corporation to reduce the charge for electric current from 7d. to 6½d. per unit. A member of the Council pointed out that, with only a small balance on the right side from last year's working, the reduction would probably result in a considerable deficit at the end of the current year, but the Chairman of the Committee replied that last year 75,000 units were sold, and if with the reduced charge the consumption was much increased, as might reasonably be expected, there would be no deficit. As showing the appreciation in which the electric light is held by the leading firms in the district, the following letter was read from Messrs. Thomas Bach and Co.:—"We have now been users of the electric light for thirteen months, and are quite satisfied with it. It has never failed us a second, and not a penny has been expended upon it since its first installation. When it was

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first put in we had our premises painted and papered, and for the first time find that at the end of the year no outlay is necessary to keep our premises clean and wholesome; our stock is now undamaged, the health of our employés is far better, and danger from fire is minimised, as neither taper nor matches are required." An amendment to reduce the cost to 6d. per unit was lost, and the Committee's proposals adopted. The Committee also decided to recommend that the price of current for power purposes be reduced to 5d. per unit.

LARNE.—The agreement between the Town Commissioners and the liquidator of Messrs. J. E. H. Gordon and Co. for the lighting of the town by electricity for three years has been approved.

LLANELLY.—At a meeting of the Llanelly Local Board a communication was read from the Electrical Installation Company (replying to a letter from the Board), in which the Company stated they hope to complete the agreement to proceed with the electric lighting of Llanelly in a fornight's time. The Board were, however, of opinion that sufficient time had already been given, and on the initiative of Mr. Trubshaw the Board's agreement with the Company was terminated.—*South Wales Daily News.*

MANCHESTER.—The Electric Light Sub-Committee of the City Council having recommended the appointment of Mr. C. H. Wordingham, as resident electrical engineer, at a salary of £500 per annum (as stated in our issue of the 16th ult.), Alderman Sir John Harwood, in reply to an inquiry at the last meeting of the City Council, said that the committee had found the electric light supply was not working with that smoothness which was necessary if they wanted to obtain public confidence, and they had asked Dr. Hopkinson to supply them temporarily with an engineer. Mr. Wordingham came and took charge, and everything had since then worked smoothly. The committee, therefore, proposed to make the appointment a permanent one, which was unanimously confirmed.

NEWCASTLE.—The firm of Rowland Barnett and Co., which has just been registered as a joint-stock company, contemplate considerable extension and development of their present works at Walker Gate.

PLYMOUTH.—The local gas company has incurred the displeasure of the Corporation, and this body has determined to bring about a reduction in the price of gas. The Company have a bill before Parliament to many of the clauses of which the Corporation take severe exception. The Corporation submit that the highest standard price of gas authorised by the Companies Act of 1879, and which it is proposed to re-enact by the present bill, is unsatisfactory, and that this state of affairs is largely due to the very large profits which the Company under its Act has power to divide amongst its shareholders. The Corporation in particular object to the provisions of the bill authorising the gas company to supply electricity for lighting and other purposes in the district. In 1879 the Company applied for these powers, but were unsuccessful. The Corporation are applying for a Provisional Order, which, it is anticipated will be shortly granted.

PORTSMOUTH.—The progress of the electric lighting works is sufficiently forward to justify the Electric Lighting Committee of the Corporation in giving the machinery a trial in about a week's time, and advertisements are to be issued for permanent officials.

ST. PAUL'S CATHEDRAL.—It is stated that it is the intention of the Lord Mayor to call a great meeting, to be held at the Mansion House, London, on May 25th, with the object of raising a quarter of a million of money to carry out the new decorations and other improvements at St. Paul's Cathedral, including the electric light, for which it is proposed to use 200 large candle-power incandescents.

SCARBOROUGH.—At a meeting of the Cliff Bridge Company, at which the Mayor presided, a report was presented from a committee appointed to consider the question of lighting the Spa by electricity. This committee recommended the adoption of the electric light for the theatre only at present, leaving for future consideration the question of its introduction into other portions of the buildings and grounds. The current is to be taken from the local company's mains, but provision is to be made while laying the mains to provide for probable extensions in the near future. The theatre lighting is estimated to cost £300.

SOUTHAMPTON.—At the last meeting of the Harbour Board it was resolved, on the recommendation of the Works Committee, to allow Mr. Kerbey Bowen to place on the Royal pier a charging box for the supply of electric power for launches, subject to the payment of 8d. per unit for current supplied by meter, and a rent of £5 for the charging box. The electrical works at the pier and the quay being near completion, it was also resolved to appoint Mr. J. G. W. Aldridge as consulting electrical engineer for twelve months, with a retaining fee of £10.

STIRLING.—The points of difference between the Town Council and the Caledonian Electric Supply Company are not yet settled. The Electric Lighting Committee have recommended, and the Council agree, to decline to withdraw their opposition to the order of the Company, and have further resolved to request the Board of Trade to withhold their consent to the order, on the ground that the Company now refuse to grant to the Council the terms which had been previously offered.

STRASBURG.—It is reported that the Strasburg tramways are to be converted into electric lines under a concession which extends to 1926.

THEFT.—Thomas Stevenson was charged at the County Court, Belfast, with stealing moneys from his employer, Mr. J. H. Greenhill, of New King-street, Belfast, the amount being made up of small sums taken weekly out of the moneys which the prisoner was given to pay the workmen's wages. Mr. Greenhill was anxious to get back the good character which he had given the prisoner on leaving.

TUNBRIDGE WELLS.—It has been under consideration to put down gas-engine plant in lieu of steam-engine plant for the central station here, but a report from Mr. A. H. Preece, who has advised the Town Council on the subject, recommends that steam plant be put down with a gas engine for the light load, and this recommendation has been adopted, the local gas company being asked to allow a discount of 10 per cent. on the gas used at the station for power purposes. The Electric Lighting Committee have been invited by Sir David Salomons to visit the new City of London electric light buildings when completed, and Sir David also advises the consumption of the town refuse in producing the electric light.

WEYBRIDGE.—The Lighting Inspectors of the Chertsey Rural Sanitary Authority having expressed a desire to renew the contract for lighting the village by electricity, the Authority has sanctioned the proposal. It was pointed out that the lighting company were under a daily penalty for not removing the overhead wires, but the Authority have undertaken not to bring any action in the matter until after September 29, 1895.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by* MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.

APPLICATIONS FOR PATENTS.

March 17, 1894.

5,619. H. BARTELS. London. Improved construction or arrangement of bridge or support for electric wires and in appliances for fixing or holding such wires in place therein.

5,631. E. J. PRESTON and A. B. GILL. London. Improvements in and connected with the electric lighting of trains and other vehicles.

5,637. J. CHAVANNE. London. Improvements in electric accumulators.

5,643. Sir C. S. FORBES and THE DOMESTIC TELEPHONE COMPANY (LIMITED). London. An improved telephone combination.

5,647. A. SCHNELLER and W. J. WISSE. London. Improvements in the manufacture of secondary coils for transformers.

5,650. R. PEARSON. London. A thermometric circuit-closer.

March 19, 1894.

5,690. H. OPPENHEIMER. London. Improvements in connection with microphones.

5,721. C. SMITH. London. New or improved process and apparatus for the electrolytic decomposition of common salt. (G. Jorgensen, Norway).

RECENT FRENCH PATENTS AND CERTIFICATES OF ADDITION.

The following list of French Patents and Certificates of Addition is specially prepared for THE ELECTRICIAN. *A list of these Patents will be given from time to time, and arrangements have been made for supplying MS. Abstracts of the Patent Specifications (with Drawings), of which further particulars will be found in an advertisement on page xv. The advantage of this arrangement is that our readers will be able to obtain the earliest information regarding French Patents, which can be obtained (in most cases) many months earlier than similar information regarding English or American Patents.*

233,105. GOULD & CIE. Automatic hydraulic winding-up apparatus, especially applicable to the Hughes telegraph apparatus. (September 23, 1893.)

233,117. SOCIÉTÉ ANONYME DES ANCIENNES SALINES DOMANIALES DE L'ETAT. Electrolytic diaphragm. (September 29, 1893.)

233,185. RAHNER. Improved armature for dynamos and electric motors. (October 3, 1893.)

233,271. BRUNS. Improvements in indicators specially used in telephone posts and in annunciators. (October 7, 1893.)

233,363. MILLAUD. Automatic commutator for reducing the cost of electric lighting, electro-deposition and all electrical purposes. (October 12, 1893.)

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233,371. PICARD. System of transformation of alternate currents into continuous currents. (October 13, 1893.)

233,468. CHAUVET. Coin-actuated machine for stereoscopic apparatus. (October 16, 1893.)

233,579. SOCIÉTÉ ANONYME DES ANCIENS ETABLISSEMENTS CAIL. Improvements in cut-outs for high-tension electric conductors; system Cail-Grosselin. (October 23, 1893.)

233,604. ELECTRIC SELECTOR AND SIGNAL COMPANY. Apparatus for choosing and putting in motion mechanism by employing an instrument of electrical transmission called an Electric Selector. (October 24, 1893.)

233,654. PIGANEAU. Improvements in accumulators. (October 26, 1893).

233,719. PÉCOUL. New electric accumulator with porous and oblique troughs. (October 30, 1893.)

233,743. UNIVERSAL ELECTRIC PULL-SOCKET AND SWITCH COMPANY. Improved combined switch and cut-out for electric brackets and pendants. (October 31, 1893.)

233,931. POGNEAUX. New fastening, called "Junius" fastening. (November 13, 1893.)

233,945. DE SEGUNDO AND DERHAM. Electric heating apparatus. (November 9, 1893.)

233,998. KINNIBURGH. Ear-trumpet for telephone receivers. (November 11, 1893.)

234,091. NABER. Voltameter. (November 15, 1893.)

234,103. LE DANTEC. A system of setting up electric batteries to effect complete depolarisation. (November 16, 1893.)

234,178. MILLAUD. Multiple-filament incandescent lamps. (November 20, 1893.)

234,191. LUC COURT & CIE. New dynamo brush-holder. (November 24, 1893.)

234,373. SOCIÉTÉ HILLAIRET-HUGUET. Apparatus for starting and stopping a dynamo at a distance by means of an electric detent. November, 30, 1893.

234,569. WOODRUFF. Improvements in electric incandescent lamps. (December 5, 1893.)

234,606. SOCIÉTÉ L'ACCUMULATEUR FULMEN. Improvements in electric accumulators. (December 6, 1893.)

CERTIFICATES OF ADDITION.

225,916. DION. Certificate of addition to patent taken out November 25, 1892, for an improved thermo-electric pile and process of manufacture. (October 5, 1893.)

230,889. DUJARDIN. Certificate of addition to patent taken out June 16, 1893, for improvements in electric accumulators. (November 25, 1893.)

COMPANIES' MEETINGS AND REPORTS.

Telephone Company of Egypt (Limited).

The eleventh ordinary annual general meeting of this Company was held on Tuesday, at the offices of the Company, 14, Austin Friars, Gen. Alexander Fraser, C.B., R.E., presiding.

The SECRETARY (Mr. Alexander B. Chalmers) read the notice convening the meeting and the report of the Directors and statement of accounts were taken as read.

The CHAIRMAN moved the adoption of the report and accounts, and said that the revenue account showed a credit of £4,192, which, with the £1,446 carried forward from 1892, brought up the balance for disposal to £5,638, out of which the Directors proposed to pay a dividend of 6 per cent. on the Preferred shares, tax free, to write off £69 for depreciation of stores, and to carry forward £1,948. He considered that for a small Company their affairs were advancing most satisfactorily. The management and control of the business in Egypt referred to in the previous year's report had involved an increased expenditure, which, with a considerable outlay incurred at Alexandria, Cairo, and Port Said, for re-construction, had been charged against the revenue of the year. The falling off in the net revenue, as compared with that of 1892, had been more than made good from profits from other sources.

Mr. HENRY GREWING seconded the motion, which was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. THOMAS LLOYD, the retiring Director, Mr. Grewing was re-elected.

The auditors, Messrs. Price, Waterhouse and Co., were also re-appointed, and the proceedings ended.

The following is the report of the Directors referred to above:—

After providing for debenture interest, the revenue account shows a credit of £4,192. 12s., and, including £1,446. 7s. brought forward from 1892, the balance for disposal is £5,638. 19s. The Directors propose to deal with this balance as follows:—To pay a dividend of 6 per cent. on the Preferred shares, free of income tax, to write off £69. 8s. 3d. for depreciation of stores, and to carry forward £1,948. 4s. 9d.

The arrangements in connection with the management and control of the business in Egypt referred to in last year's report have necessarily involved an increase in the expenses, which, with a considerable outlay incurred at Alexandria, Cairo, and Port Said for re-construction, has been charged against the revenue of the year. The net profit from the ordinary business of the Company for 1893 shows, therefore, a falling-off as compared with 1892, but this has been more than made good from profits realised from other sources. The business continues to develop, and the increase in the number of exchange and private lines during the year has been fairly satisfactory; the full effect of such increase will, however, only become apparent on the presentation of the accounts for the current year. The gross revenue of the Company from exchange and private lines, &c., on January 1st last was £13,100, as against £12,225 on the corresponding date in the previous year.

Bournemouth and District Electric Supply Company (Limited).

The third annual general meeting of this Company was held on Friday, under the presidency of Mr. Leveson Scarth. The Chairman, in moving the adoption of the report, which showed a net balance of profit of £964 on the year's working, said that the business was progressing with reasonable rapidity, and had now reached the stage of being a dividend-earning concern, the Directors having decided to recommend the payment out of profits of two-thirds of a 5 per cent. dividend on Ordinary shares, the Brush Company paying the remaining one-third under their guarantee, which does not expire till June next. The telephone difficulties are, the Directors trust, nearly at an end, as the Telephone Company are now adopting the system of complete metallic circuits for their currents, a method which, supplementing the continued efforts of the Company, will obviate all future trouble. The Directors had devoted much attention to mains and cables, and were incurring considerable expense in accelerating the policy of laying down concentric cables throughout the system. The plant at the central station has been and is still fully adequate to the load, as stated in the report, but the Directors anticipate an increase of at least 30 per cent. in the output during the ensuing year, and this would necessitate additional engines and alternators. During the last two months Mr. A. J. Lawson, M.I.E.E., London, has been acting as consulting engineer, and the Directors had appointed as resident engineer Mr. H. M. Sayers, at present engineer to the Electric Lighting Company in Oporto. Mr. Sayers will take technical charge of the Company's system as from April 20th. Mr. Shepherd's connection with the Company, for which he has done much work since its formation, has now terminated.

The report was adopted, and the retiring Directors and auditors were re-elected.

Southampton Electric Light and Power Company (Limited).

The following is the Directors' report presented at the annual meeting of this Company, held at the offices, Southampton, on Wednesday:—

The anticipations of your directors of steady and continuous progress in the business of the company have been realised. The increased revenue for 1893 amounts to £553. 9s. 10d. over 1892, but a satisfactory feature is that the expenses are practically the same, thus making the whole of the increase net gain.

Statement of Revenue and Expenses.

	Lamps (8 c.p.), 31st Decr.	Units Sold.	Revenue. £ s. d.	Expenses. £ s. d.
1891 (part only) ...	— ...	5,469 ...	350 5 11 ...	535 2 1
1892	2,200 ...	35,537 ...	1,153 4 10 ...	1,152 0 4
1893	3,162 ...	53,848 ...	1,606 14 8 ...	1,121 4 8

This statement is doubly gratifying inasmuch as the Directors reduced the maximum price of the current to 8d. from January 1, 1893. With the view of placing the Company upon a dividend-paying footing, your Directors have resolved to relinquish the fees already debited in the two previous balance-sheets, namely £400, and to take no fees for the year 1893. After debiting interest on debentures and overdraft and depreciation, a net profit of £170. 1s. 11d. is shown. This sum, together with £400 re-credited for Directors' fees, reduces the loss brought forward of £754. 19s. 9d. to £184. 17s. 10d.

As the sales of current for January and February of this year have shown an increase of 50 per cent. over the corresponding period of the previous year, your Directors feel justified in expressing the opinion that they will be able to declare a dividend at their next annual meeting.

To enable the Directors to cope with the new applications, it is highly essential that more capital should be forthcoming, and in view of the favourable showing of the Company's working, the Directors hope for the support of the shareholders in bringing fresh capital into the business.

The Directors who retire from office are Mr. J. F. Obree and Mr. G. J. Tilling, who, being eligible, offer themselves for re-election. The auditor, Mr. C. Cox, also offers himself for re-election.

CITY NOTES.

ALTRINCHAM ELECTRIC SUPPLY (LIMITED).—The Directors of this Company have issued a prospectus inviting subscriptions for 25,000 Ordinary shares of £1 each, payable 2s. 6d. on application, 2s. 6d. on allotment, and the balance in instalments of 5s. The prospectus states that the Company is formed to undertake the private and public supply of electricity in Altrincham and district. Subject to approval of the Local Authorities and the Board of Trade to the transfer, the Company has undertaken to purchase (at a sum expected not to exceed £900) a Provisional Order which has been incorporated into an Act of Parliament. Messrs.

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Kincaid, Waller, and Manville have verified an estimated necessary expenditure of £22,000 to provide for an installation capable of supplying current to 15,000 8-c.p. lamps, and, it is estimated that the capital of £25,000 will be sufficient to meet the present requirements of the Company, whose total share capital is £50,000, in £1 shares. The list of applications closes on Tuesday next.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—This Company's traffic returns for the week ended April 1st amounted to £844, as against £744 in the corresponding period of last year, being an increase of £100. The total receipts for the half-year amount to £12,035, as against £12,015 for the corresponding period of last year, an increase of £20.

CUBA SUBMARINE TELEGRAPH COMPANY (LIMITED).—The estimated traffic receipts of this Company for the month of March are £4,200, as compared with £4,275 in the corresponding month of last year.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—This Company's estimated traffic receipts for the month of March amounted to £1,800, as against £2,015 in the corresponding period of last year.

DIRECT UNITED STATES CABLE COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend of 2s. per share, free of income tax (being at the rate of 2 per cent. per annum), for the quarter ended March 31st, which will be payable on and after the 24th inst.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the month of March amounted to £57,677, as against £55,786 in the corresponding period of last year, an increase of £1,891.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY (LIMITED).—The list will be found elsewhere of the drawing of 371 Five per Cent. Australian Government Subsidy Debentures of £100 each in this Company, which will be paid off at par, on July 2nd next, by Messrs. Barclay, Bevan and Co., bankers, 54, Lombard-street, E.C., after which date interest on these debentures will cease.——The accounts of the Company to December 31st last shows, subject to audit, a balance of profit of £189,080. 10s. 11d., after the payment of three interim dividends. The Directors propose to distribute, on the 19th inst., the usual dividend of 2s. 6d. per share, making a total dividend of 5 per cent. for the year 1893, together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year. The share register will be closed from April 11th to 13th inclusive.——The traffic receipts of this Company for the month of March amounted to £38,923, as against £46,204 for the corresponding period of 1893.

EDISON GOWER-BELL TELEPHONE COMPANY (LIMITED).—A brief notice of the meeting of this Company appeared in our last issue. Sir Alexander Armstrong, who presided, moved the adoption of the report and accounts. The Directors did not anticipate any return of capital on the 1,000 Ordinary shares in the Telephone Company of Austria, that concern having been placed in liquidation. An early decision was expected in the action against infringers of the patent in Belgium, the case being now before the Court of Appeal at Liége. With regard to the sum of £393,611 appearing in the accounts as expenditure on patent rights, concessions and exchanges, those relating to the Portuguese properties were represented by 37,400 fully-paid shares of £1 each in the Anglo-Portuguese Telephone Company, while similar rights in Austria-Hungary were represented by the 1,000 fully-paid Ordinary shares of £5 each in the Austrian Company already alluded to. There were no Directors' fees, and the expenses of management had been kept down to £230. 14s. Dividends for two years, amounting to £2,000, had been paid on the 20,000 Preference shares issued to the Consolidated Telephone Construction Company, and the dividend received as dividend on Anglo-Portuguese shares, less income-tax, £1,823. 5s. The reserve stood at £2,293. The motion to adopt the report was agreed to.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this Company for March, 1894, amounted to £22,000, and from January 1st to March 31, 1894, to £63,000. In the corresponding months of 1892 and 1893 the amounts were £62,800 and £63,200 respectively.

GLOBE TELEGRAPH AND TRUST COMPANY.—The Directors have declared an interim dividend of 3s. per share on the Preference shares, less tax, and 2s. 6d. on the Ordinary, from which the tax has already been deducted.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY (LIMITED).—This Company announce that warrants have been posted to the shareholders for dividends at the rate of 7 per cent. per annum on the Preference shares (free of income tax) for the half-year ended December 31st last, and 5 per cent. per annum on the Ordinary shares (free of income tax) for the year ended same date.

INTERNATIONAL ELECTRIC STORAGE (LIMITED).—Elsewhere will be found an abridged prospectus of this Company, which is formed to purchase and work the British rights in the invention of Messrs. Theryc and Oblasser for electric accumulators. Subscriptions are invited for the issue of £150,000 out of a total capital of £200,000, in £5 shares, of which the vendors and patentees take 9,000. On the present issue £1 is payable on application, £2 on allotment, and the balance as required. The Company also acquires by contract (the prospectus states) the right for 18 months to purchase the patents which have been obtained or applied for, for the same invention, in the United States, several of the British Colonies, India, and many of the principal European States. The Directors think the battery supplies a long-felt want, and that, in addition to the profits likely to be derived from working the business in the United Kingdom, further considerable profits will be obtained by dealing with the foreign patents. Private experiments have been made with the battery by the Paris, Lyons, and Mediterranean Railway Company, whose engineers have nearly completed a locomotive to produce nominally 700 H.P., which, it is stated, will run at a constant speed of 67½ miles per hour on the level, and 50 miles on gradients. It is further stated that the result of the trials of the accumulators on the tramway lines at Liége has proved sufficiently satisfactory for the tramways company to have obtained permission to run a tramcar equipped with these accumulators over its system. The prospectus contains extracts from a report by Dr. J. A. Fleming, which is favourable, as is also the report of Mr. A. Schanschieff, extracts from which are also given. The Company takes over a licence giving the exclusive right to use the invention for the lighting of road vehicles, and the business now carried on at Euston-buildings, London, W.C., and at High-street, Camden Town, for the working of this licence. It is stated that negotiations are nearly completed with the London Road Car, and other passenger-carrying companies for lighting their vehicles by electricity. The price to be paid for the British patent, and the right to purchase the Foreign and Colonial patents referred to, is £40,000 in cash and 8,000 fully-paid shares. The only contracts in which the Company are directly concerned are set out in the prospectus, complete copies of which, and forms of application, can be obtained at the offices of the Company, 73-75, Gresham House, Old Broad-street, E.C., or from the brokers, auditors, bankers, or solicitors. The Chairman of Directors is Major S. Flood Page, the consulting electrical engineer Dr. J. A. Fleming, the engineer Mr. A. Schanschieff, and the secretary Mr. J. G. B. Elliot. M. Ch. Theryc joins the Board after allotment. The prospectus is accompanied by a circular from the Universal Electric Lighting Company (Limited), who are the vendors, in which it is stated that "the invention of Messrs. Theryc and Oblasser constitutes one of the greatest, if not the greatest, advance which has yet been made in the application of electricity to practical uses," and "for a given weight this Company's battery has at least double the capacity of any other practical electrical accumulator in the market." It is further stated that "the important question of the validity of the patent has had the most serious attention."

ISLE OF MAN TRAMWAYS AND ELECTRIC POWER COMPANY (LIMITED).—Applications are invited for £125,000, in £1 shares, of the above Company, 50,000 of which are Six per Cent. Preference shares, and the remaining 75,000 Ordinary shares; 5s. is payable on application, 10s. on allotment, and the balance on May 1st next. £50,000 Debentures in bonds of £20 will also be issued, payable 10 per cent. on application, and the remainder on allotment. These Debentures are redeemable at par on May 1, 1914, and bear interest at 5 per cent., and form a first charge on the property of the Company, conveyed in security to the trustees for the debenture holders, and duly registered. The Directorate includes Dr. E. Hopkinson, who is also consulting electrical engineer to the Company. Dr. Hopkinson joins the Board after the completion of the works now in construction by Messrs. Mather and Platt. The Company is formed for the purpose of purchasing and working under one management the following tramway undertakings:—The Isle of Man Tramways, the Tramway over the Douglas Bay Estate, an extension now in course of construction from Groudle Glen to Baldromma, and an extension of the lines from Baldromma to Laxey. The Douglas Bay Estate line is expected to be open for traffic at Whitsuntide; the line from Groudle Glen to Baldromma about July 1st. The whole of the tram lines and property are to be conveyed to this Company under the agreements entered into, with the exception of about three miles, will be held by the Company in perpetuity, the tramways so held consisting of about 14 miles. There is a further three miles which the Douglas Town Commissioners have power to acquire by purchase. The purchase is made by the Company, including the whole of the property of the Isle of Man Tramways (Limited), and a quantity of valuable land, the electric generating station at Douglas, &c. In 1893 the number of passengers carried by the Isle of Man Tramways which the Company acquired was 911,410, an increase of about 100,000 over 1892, and the receipts show a profit of £3,784. It is estimated that the new lines and feeders will realise a total of £14,525, which, after paying interest on Debentures and Preference shares, will leave over £9,000 available for dividend, equal to about 12 per cent. on the £75,000 Ordinary shares. Additional revenue is expected from the sale of electric current in the neighbourhood of the Douglas generating station. The lists open on Monday next, and close on Saturday, the 14th inst., for town and country. Forms of application can be obtained from the Secretary, Mr. W. E. Young, Athol-street, Douglas; or of the Company's bankers and brokers. An abridged prospectus will be found on page xvi. of our present issue.

"JOINT-STOCK ELECTRICITY."—Under this title the *Financial Times* of Wednesday last contains a critical article dealing with the financial aspect of electrical industry and supply, from which it appears that the 14 supply companies operating in London and its suburbs have a paid-up share capital of £3,250,141, in addition to an issued loan capital of £604,600, making a total of nearly £4,000,000 embarked in the electrical supply business in the metropolis alone. The paid-up capital of 20 provincial companies amounts to £721,030, and the loan capital to £160,484. Nine of the principal manufacturing companies have a paid-up share capital of £2,051,654, and a loan issue of £365,130, or a gross total of £7,153,039.

MEDICAL BATTERY COMPANY (LIMITED).—A meeting of creditors in this concern has been held under the presidency of the Deputy Official Receiver, Mr. Warley, for the purpose of considering a draft scheme of reconstruction which has been put forward by the debenture shareholders, shareholders, and creditors of the Company. Apparently the last has not been heard of Mr. Harness and his so-called "electrical" dodges.

READING ELECTRIC SUPPLY COMPANY (LIMITED).—A prospectus is issued inviting applications in this Company for £45,000, in 9,000 shares of £5 each, payable 10s. on application, £2. 10s. on allotment, and the remainder at intervals. The list closes on Tuesday, the 17th inst. The Company is formed to work a Provisional Order for supplying the borough with electric current, which Order has been obtained in amity with the Reading Corporation, and has been duly confirmed by Act.

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WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended March 30th (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,659.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the two weeks ending March 31st were £2,822, as compared with £3,357 for the corresponding period of last year.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share.	Last Dividend.	Name.	Previous Week's Price, Mar. 28.		Price Wednesday, April 4.		Rate per Cent. Yielded. £ s. d.	Dividend Due.	Business Done During Week Ending April 4. Highest	Lowest.
			TELEGRAPHS.								
£1,134,640	Stock	13/6	Anglo-American	42	44	42	44	5 13 8	Jan., Apr., July, Oct.	44	..
£2,932,680	Stock	27/0	Do. Preferred	78½	79½	79	80	6 5 0	" "	82	79½
£2,932,680	Stock	5/0	Do. Deferred	7¼	7¾	7½	7¾	..	.. ..	8⅜	7 9/16
£184,500	100	4%	African Direct Telegraph 4% Deb. (Reg. & Bearer)	100	103	100	103	3 17 8	January and July ..	..	..
130,000	£10	3/0	Brazilian Submarine	11¾	12¼	11¾	12¼	5 4 0	Mar., June, Oct., Dec.	12⅛	11 15/16
£18,700	£100	5%	Do. 5 per Cent. Bonds	99	102	99	102	4 18 0	January and July ..	..	–
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	..	–
10,000,000	$100	$1¾	Commercial Cable Capital Stock	146	150	146	150	4 13 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12	13	12	13	6 3 1	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	19	–
12,931	5	1/7½	Direct Spanish (£4 paid) xd	2¼	3½	2½	3	5 6 8	April and October	..	..
6,000	5	10%	Do. Preference 10 per Cent. xd	8½	9½	8½	9	5 11 1	" "	–	..
60,710	20	3/0	Direct United States Cable, 1877	10½	10¾	9¾	10¼	6 13 4	Jan., Apr., July, Oct.	10¾	9⅞
400,000	10	2/6	Eastern	14¾	15	15	15½	4 5 3	" "	15⅛	14⅞
70,000	10	6%	Do. 6 per Cent. Preference	16	16½	16	16½	3 12 9	" "	16⅜	16¼
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	115½	114¼
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	107	110	107	110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	15¼	15½	15½	15¾	4 8 11	Jan., Apr., July, Oct.	15⅞	15¼
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113	116	113	116	3 9 0	February & August	..	..
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103	106	103	106	4 14 4	January and July ..	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	103	106	103	106	4 14 4	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	104	107	104	107	3 14 9	February & August	..	..
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	107%	110%	107%	110%	3 12 9	May and November	..	..
180,227	10	1/3	Globe Telegraph and Trust	8⅝	8⅞	8¾	9	5 0 0	Jan., Apr., July, Oct.	9	8 11/16
180,042	10	6%	Do. 6 per Cent. Preference	15	15½	15¼	15⅝	3 18 1	" "	15 1/16	15 1/16
150,000	10	5/0	Great Northern	21½	22	21¾	22¼	3 16 4	Jan., April, and July	21⅞	..
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 13 6	March & September	..	..
17,000	25	12/6	Indo-European	43	45	43	45	5 11 1	May and November	..	..
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	..	" "	..	–
£100,000	100	6%	Do. 6 per Cent. Debentures	106	109	106	109	5 10 1	March & September	..	–
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red." 1942	102	105	102	105	3 16 2	..	..	–
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	–	–
3,381	£100 Cert.	25/0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	" "	–	..
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July ..	..	–
£249,900	100	5%	Do. 5 per Cent. Debentures	98	101	99	102	4 18 0	March & September	101½	..
30,000	10	2/0	West Coast of America	2¼	2¾	2½	3	..	January and July ..	2¾	2⅝
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	99	103	101	105	7 12 5	June and December	–	–
88,321	10	1/0	West India and Panama	1⅛	1⅜	1¼	1½	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10	10½	10½	10¾	5 11 7	May and November	10⅝	10 9/16
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	8½	9½	9	10	6 0 0	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	106	109	107	110	4 10 11	June and December	..	–
64,242	15	4/6	Western and Brazilian	7¾	8¼	7½	8	..	May and November	8	7 11/16
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	6	6½	6	6½	..	..	6½	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	2	2½	2	2½	..	..	2⅛	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105	108	105	108	5 11 1	February & August	–	–
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	105	108	105	108	5 11 1	" "	..	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	..
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	100	104	100	104	5 15 5	March & September	..	..
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	1½	2½	1½	2½		–	..	–
224,850	10/0	3½d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
220,000	£1	6d.	Oriental Telephone and Electric	..		..		..	Yearly	..	–
484,597	5	2/6	National	4½	4¾	4⅝	4⅞	5 2 7	June and December	4¾	4⅝
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½	15½	14½	15½	3 17 5	" "	15⅜	..
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	14	15	14	15	4 0 0	" "	14 11/16	14⅝
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅝	5⅞	5⅝	5⅞	4 8 11	..	5½	..
925,017	£100	4½%	Do. Deb. Stk. 4½%	115	117	115	117	3 16 11	January and July	117	115½
58,000	5	1/0	United River Plate	1½	2	1½	2	–	" "	..	–
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	–	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11½	12½	11½	12½	–	–	12½	..
20,000	10	6/0	Do. 6 per Cent. Cumulative Pref. (fully paid)	13¼	13¾	13¼	13¾	..	–	13 7/16	13¼
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	–	–
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	–	–	–
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		–	–	–	–
8,322	£5	..	House to House Electric	..		..		–	–	–	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		–	–	–	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	–	–
30,000	£5	1/9	Liverpool Electric Supply (£4 10s. paid)	5⅞	6⅛	5⅞	6⅛	..	–	–	–
15,000	£5	2/6	Do. (fully paid)	6 7/16	6 9/16	6 7/16	6 9/16	..	–	..	–
111,000	5	..	London Electric Supply	¼	¾	¼	¾		..	..	–
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	8¼	8¾	8	8½	2 7 0	..	8⅜	8¼
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	106	109	106	109	4 11 9	June and December	..	–
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	–	–	..	–
19,980	£5	4/6	St. James' and Pall Mall	6¼	6¾	6¼	6¾	..	–	6½	..
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	–	8⅜	8⅛
59,900	5	2/6	Westminster Electric Supply (fully paid)	5¾	6¼	5¾	6¼	3 4 0	–	6	5 15/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅞	3⅛	3	3¼	5 10 10	–	3 1/16	3
90,000		6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	–	2 1/16	..
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	108	111	108	111	4 1 1	March & September	110½	109½
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	3½	4	3½	4	..	January and July	..	–
12,139	5	..	Edison and Swan United	–		–		–	–	–	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	–	..	–
120,000	2	..	Electric Construction	¼	¾	¼	¾	..	–	½	7/16
12,845	2	..	Do. 7% Cumulative Pref.	1½	2	1¼	1¾	..	..	..	–
91,195	2	10/0	Elmore's Patent Copper Depositing	½	¾	½	¾	–	–	..	–
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	–	..	..
50,000	10	15/0	India Rubber, Gutta Percha &c., Works	23	24	23	24	5 4 2	February & August	23¾	23¼
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896 xd	101	103	101	103	4 7 5	March & September	..	..
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	–	–	–	–
16,000	£10	..	Do. 8 per Cent. Preference	–		..		..	December and June	–	–
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	—	⅛	—	⅛	..	–	–	..
78,949	5	3/6	Swan United (£3. 10s. paid)	2	2½	2	2½	7 0 4	May and November	..	..
87,350	12	36/0	Telegraph Construction and Maintenance	39	41	39	41	4 7 10	March and July	40½	39½
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	–		..		..	January and July	..	..
37,514	£5	–	Woodhouse and Rawson Ordinary (£3. 15s. paid)	–		..		..	–	–	–
41,098	£5	–	Do. Preference (fully paid)	–		–		–	–	..	..
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	3%	City and South London Railway	27	32	27	32	4 5 11	May and November	..	..
87,500	£10	1%	Liverpool Overhead Railway	6⅞	7⅛	6⅞	7⅛	–	–	–	–

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THE ELECTRICIAN:

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NOTES.

The decision of the Court of Appeal has been given in favour of the London County Council in its dispute with the London Street Tramways Company as to the terms upon which that undertaking shall be purchased; in other words, the contention of the referee, Sir Frederick Bramwell, that he was precluded by the terms of the Tramways Act of 1877 from taking profits into consideration when assessing "the then value of the tramway," has been upheld. As we pointed out a week or so ago, this decision, although of some indirect interest to the electrical industry, does not immediately affect it, since the purchase clause of the Electric Lighting Act of 1888 is as explicit as that of the Tramways Act was vague.

The research of Prof. Ewing and Miss Helen Klaassen on the magnetic qualities of iron, which is appearing in our columns, being abstracted from the *Transactions* of the Royal Society, is the most important contribution to our knowledge of the actual material used by dynamo and transformer makers that has yet been published. Not only have practical samples been used, but they have been tested under practical conditions. Tests of iron without number have been made and published, but, either from nervousness or delicate feeling, the names of manufacturers and of users have been suppressed. Sometimes authors have feared to advertise a manufacturer, or to show up his poor work, and at other times tests have been made of iron which never has and never will be used by dynamo builders. Again, iron has been tortured through high inductions which give excellent lecture-room curves, but which give no useful information to transformer makers, and in other cases attention has been directed to the effect of extremely small magnetising forces. Some of these researches have formed valuable contributions to pure science, but every dynamo builder has not time to keep abreast with pure science, and, if such tests as those of Prof. Ewing and Miss Klaassen are not published, manufacturers must undertake them in their own testing rooms, and no one can complain if they decline to publish them.

Besides test of the samples, the effect of bending them to form rings for testing has been considered, and the effect of annealing on the various magnetic properties has been examined. One consideration seems to deserve more attention, namely, the frequency. To be thoroughly practical, without sacrificing a jot of science, the frequencies should be in the range of practical periodicities. The authors express "a doubt whether all that is possible has yet been done by manufacturers of iron to produce a quality specially suitable for such uses as the construction of transformer cores." The strangled discussion at the Institution of Electrical Engineers seven weeks ago was quite sufficient to show that this is more than doubtful.

Those of our readers who are desirous of obtaining information on the economy of steam pumps used for feeding boilers will do well to peruse a Paper on "The Working of Steam Pumps on the Russian South-Western Railways," by Mr. A. Borodin, published in the *Proceedings* of the Institute of Mechanical Engineers, No. 4, 1893. The author of this interesting Paper has made extensive trials of a large variety of steam pumps, some of which are well known within the walls of our electric supply stations. The quantity of steam consumed by these pumps, per effective horse-power hour, varied from 860lb. down to as low as 50lb., the former figure representing the economy of a pulsometer, and the latter that of a Worthington compound pump. From these figures it will be seen that the steam consumption by the feed pumps will generally be a by no means insignificant percentage of the total. Take, for example, a feed pump supplying a boiler with 2,000lb. of water per hour, under a pressure of 100lb. per square inch. The effective useful horse-power will be about 1·5 h.p.; and if we assume an average value for steam consumption, as given by Mr. Borodin, say 100lb. per horse-power per hour, there will be 150lb. of feed water per hour used solely for the pumping. This amounts to as much as 0·75 per cent.; and it is quite within the limits of practice for this consumption to rise to one or even two per cent.

The way out of the difficulty does not appear to lie in the design of more economical pumps; for, above all things, simplicity of working parts and ease of repair are the essentials in a power station feed-pumping plant. In many stations the heat of the exhaust steam from the pumps is utilised for heating the feed water; and by this practice there is no doubt that almost the whole of the exhaust heat can be restored to the boilers. This, in fact, is the very reason why the steam injector is such an efficient device, notwithstanding that it may require an enormous weight of steam per effective horse-power per hour. In the experiments recorded by Mr. Borodin an injector required no less than 1,440lb. of steam per effective

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horse-power hour! Without doubt this is a very bad case, even for injectors; but if all the heat gets back to the boiler—who cares?

The recent recommendation of a Committee of the Worcester City Council, that the power developed at their new electric supply station should be utilised for pumping purposes at their water works (instead of steam as originally arranged), is one which shows that the Council has grasped the fact that work must be found for the supply station during the daytime. It has been decided to fix two sets of electric pumping plant, consisting of two 30-B.H.P. alternate-current motors having a guaranteed efficiency of 90 per cent., and two three-throw pumps capable of delivering 10,000 gallons per hour to an elevation of 300ft., through 5,000 yards of 10in. main. Electrical engineers will, we are sure, await with considerable interest the publication of the load factor and economy of the electric power station, after it has been working for a year or so under such favourable conditions. Whatever economy may ultimately be obtained, we are, at any rate, justified in saying that it ought to be a very high one; and we heartily commend to the notice of municipalities this very practical mode of giving steady work to their electric supply plant during the daytime.

Some further information on the new adiathermanous glass will be found in another column. Alum solution has long ago been shown to be little or no better than water as a heat screen, although alum crystals are good absorbers of radiant heat. It should be observed that while the first table relates to screens of one uniform thickness, so that the results are at once comparable, the second set in which the thicknesses differ cannot be directly compared, for the absorption is not proportional to the thickness. The effect of ferrous salts in solution is so remarkable that we hope further experiments will be made.

The general question of the screening of radiation is at present but little developed. In the present case it would seem to be due to resonance of the molecules either directly or by their action on the interstitial ether. A red-hot poker emits waves of all lengths down to about one forty-thousandth of an inch. Abney and Langley have made observations on waves of about one ten-thousandth of an inch, and between these and waves of half an inch there are some twelve octaves of completely unknown radiations. We cannot study them because we cannot generate them separately, though all are generated uselessly when light is produced. It is conceivable that some of these vibrations might be sifted out by means of suitable screens, and having been separated, they might be studied.

A man with a mission is commonly reputed to be a danger to the commonwealth; how much more dangerous, then, must be a Government Department with a mission, seeing that it is even more of an intangibility than a limited liability company. The Directors of the latter can occasionally be brought to book, and made to testify by their presence in the witness-box that a limited liability concern possesses a simulacrum of body and soul. But in dealing with a Government Department even this approximation to evidence of a bodily and spiritual existence is denied us, though the permanent officials are generally admitted to be its life and soul, and it has been averred, but never proven, that they have their departments under their thumb.

It is on account of this departmental elusiveness and the characteristic thoroughness with which the Board of Trade entered upon the mission, assigned to it by Parliament, of municipalising electric lighting, that we are glad to learn that the vagaries of one town council at any rate have received a check. For years past the corporation of a certain little town, not a hundred miles from London, has been "thinking of going in for electric lighting," and by judiciously-timed debates and reports has managed to do nothing itself, and at the same time keep everyone else from doing anything. Finally, the advent of a *bonâ fide* locally-supported company obliged the Corporation to state its readiness to give its consent, though only on condition that the promoters accepted a clause involving municipal purchase on an old-iron basis within 10 years. This was too much even for a department with a mission, and the Corporation was told that the Provisional Order Confirmation Bill would go forward notwithstanding its non-assent. Thus irreverently dealt with, the municipality now proposes to try and secure the reduction of the 42 years' period to 30 years. We wish it all ill-success in this venture: it is bad even for local authorities to be encouraged in the belief that they can eat the cake and have it.

An Alternate-Current Tramway.—The Creusot Works will exhibit an electric tramway on the alternate-current system at the Lyons' Exhibition.

The City Lighting.—The City of London Electric Lighting Company announce that they are now prepared to supply current in 406 streets, courts, lanes, &c., within the City, and that current will be laid on by the end of next month in most of the remaining streets.

Electric Traction in Switzerland.—The Bernese Oberland Railway Company is contemplating the substitution of electric traction for steam. The scheme is a very important one, comprising 200-H.P. locomotives, with 10 trains on the line simultaneously. Water power is plentiful.

Bristol University College.—Courses of lectures will shortly commence at this college, on civil, mining, and electrical engineering. The electrical engineering courses will comprise electric lighting, dynamo-electric machinery, and transmission of power.

Folkestone.—Last Friday, the Folkestone Corporation, after a sitting extending over four hours—the last of several meetings on the subject—approved of a scheme of electric lighting, at a cost of £35,000. There was considerable opposition, and several members of the Corporation who are shareholders in the Gas Company were not allowed to vote on the question.

Cable Interruptions:

	Date of Interruption.
Cayenne-Paramaribo	Oct. 15th, 1893.
Bissao-Bolama	Nov. 24th "
Garachico-Santa Cruz de Palma	Dec. 27th "
Fao-Bushire	Mar. 20th, 1894.
Bonny-Cameroons	Mar. 21st "
Brest-St. Pierre (P.Q. Co.)	Mar. 29th "

Rigidity.—This is the oracular manner in which a semi-scientific American contemporary announces the fact that no known substance is perfectly rigid:—"The form of no solid

matter or metal can be said to be fixed, under the possibilities of pressure equal to the flow of its atoms toward a readjustment of an equilibrium necessary to maintain a permanent form, by equalising or transferring pressures from a single direction to the multiple directions required for stability."

Death by Electric Current.—On March 16th last at Innsbruck a lamentable accident occurred. A high pressure circuit is carried on poles from the Mühlauerklamm to the town, and the telephone wire on the same poles being broken in several places by the weight of the snow, came into contact with the high-pressure circuit, and was hanging down to the ground. A young man named Würtemberger, passing the spot, went to clear the wire out of the way, and immediately fell dead. His companion and a neighbouring innkeeper, who tried to remove and restore him, thinking they saw signs of life, received severe shocks, but were not injured.

Electrical Bills in Parliament.—Amongst the Bills referred to Sir J. Kennaway's Committee, which will commence work on Thursday next, are the Charing Cross, Euston and Hampstead Railway Bill, and the London, Walthamstow and Epping Forest Railway Bill. It is stated that more petitions have been presented against the London, Walthamstow, and Epping Forest Railway Bill than against any other Bill before Parliament, with the exception of the Thames Conservancy Bill, against which 99 petitions have been presented. The Charing Cross and Hampstead Railway Bill is to confer further powers upon the Company, and enable them to acquire additional lands.

Electrolytic Sterilisation of Tetanus Filtrates.—The current number of the *Istituto d'Igiene sperimentale di Roma* contains an exhaustive and very important memoir "Sul veleno del Tetano," by Dr. Fermi and Dr. Pernossi. It covers close upon 60 pages, and records numerous experiments on the behaviour of the toxic soluble products of tetanus cultures under various conditions. Amongst these the action of heat was investigated, and it was ascertained that the tetanus-filtrate diluted with water was deprived of all pathogenic properties when exposed for one hour to 55° C., but when completely desiccated it was still toxic after being exposed for one hour to 120°C. The action of an electric current on its pathogenic properties was also examined, and they were found to be destroyed after exposure for about two hours to a current of about 0·5 amperes.

Lightning.—On Monday week during a thunderstorm at Thirsk, a large tree was struck by lightning. The tree was split, and the clothes of a youth sheltering under it at the time were burned off his back. The young man himself was seriously injured. On the following day a house situated in Oakes' Row, near Codnor Park, was struck by lightning.—The thunderstorm which occurred on Wednesday last was accompanied in the Luton district by a heavy downpour of rain and hailstones of an extraordinarily large size. The lightning near the town set fire to a barn and destroyed some outbuildings. About two miles from Harpenden the lightning killed three cows, and other damage is reported. During the storm, at Lampeter South Wales, a farmer's son was struck by lightning and killed instantly. The man was engaged in ploughing at the time.

Electrical Communication with Lighthouses and Lightships.—The Royal Commission on Electrical Communication with Lighthouses and Light-vessels have presented their second report, which recommends the establishment without delay of electrical communication by aerial wires between the telegraphic system of the country and a number of shore lighthouses and lighthouse stations. The Commissioners state that it is with regret that they have decided to confine their recommendations in this report to shore lighthouses; but until more has been done towards perfecting the communication of those light-vessels and lighthouses which were mentioned in the previous report as having the strongest claim to immediate attention, the Commissioners hesitate to add to the list of light-vessels and rock lighthouses with which they consider that electrical communication should be made. The report also recommends that the general lighthouse authorities should be invited to consider the general question of signalling with a view to institute a universal system of visual and sound signals at all the various light stations on the coast of Great Britain and Ireland.

Iron and Steel Institute.—The annual meeting of this Institute will be held, by kind permission, at the Institution of Civil Engineers, 25, Great George-street, on Wednesday and Thursday, May 2nd and 3rd, commencing each day at 10:30 o'clock a.m. On Wednesday, May 2nd, there will be a general meeting of members, the Council will present their report for the year 1893, and the President will deliver an address. On Thursday, May 3rd, the following Papers are expected to be read and discussed:—(1) "On the Physical Influence of Certain Elements upon Iron," by Prof. A. O. Arnold; (2) "On the Analysis of Steel," by H. K. Bamber, F.I.C.; (3) "On the Capacity and Form of Blast Furnaces," by William Hawdon; (4) "On Scandinavia as a Source of Iron Ore Supply," by Jeremiah Head, M.Inst.C.E.; (5) "On the Application of Electricity as a Motive Power in the Iron and Steel Industries," by D. Selby-Bigge; (6) "On the Walrand Process," by G. J. Snelus, F.R.S. (Vice-President); (7) "On Methods of Preparing Surfaces of Iron and Steel for Microscopic Examination," by J. E. Stead, F.I.C.; (8) "On the Relations between the Chemical Constitution and Ultimate Strength of Steel," by W. R. Webster.

Post Office Telegraphs.—The following figures from a Parliamentary paper ordered to be printed by the House of Commons last Session are of interest if only as showing exactly where we are in the matter of the telegraph deficit. The net telegraph revenue for the year ending March 31, 1893, amounted to £2,486,791. 5s. 1½d., and the "value of telegraph services performed for other public departments without remuneration" is stated to be £39,520. 18s. 1d. The total outgoings for the same period were £2,692,994. 11s. 2¼d., so that the year's operations resulted, if we consider the work done for public departments as having been paid for in hard cash, in a deficit of £166,682. 7s. 11¾d., which, if the interest on capital for the same period be added, is converted into a deficit of £465,570. 13s. The total deficit up to March 31, 1893, interest on capital being taken into consideration, was £4,929,257. 1s. 4d. On the other hand, if we only consider actual income and actual outgoings, this deficit is converted into an excess of receipts over expenditure of no less than £2,127,276. The capital expenditure on behalf of the telegraph service as shown by Government stock created now amounts to £10,868,663. 14s. 5d. In connection with this return it must be remembered, firstly, that extensions have almost entirely been paid for out of revenue, and secondly, that until the exact allocation of expenses as between the postal and telegraph departments is known, it is impossible to say whether the above big deficit is an actual fact or a mere matter of bookkeeping.

The Paris Bourse and Long-Distance Telephony.—The fussiness of officialdom, says the *Standard*, was amusingly illustrated and frustrated on the Paris Bourse last week. "It had hitherto been the practice for members who made use of the long-distance telephone there to run up a little account, which they settled before they went home for the night. The arrangement worked well; it must, therefore, be reformed. An order was issued that in future all messages must be prepaid, and that before entering the speaking chamber everybody was to state how many he intended to despatch. But neither in London nor in Paris is the stockbroker a person whom it is safe to trifle with. The complicated laws and customs of his own profession he obeys, and, in some cases, understands; but he is always ready to fight against rules and regulations imposed by outsiders—even her Majesty's judges. No sooner was the new edict promulgated on the Bourse than the members decided that it must be promptly withdrawn—like an Address in reply to a Queen's Speech or a General Strike Manifesto. With one consent they dispensed with the telephone, and the result of this boycotting was that the Post Office authorities, early in the afternoon, agreed to cancel the offensive order. The credit system being thus re-established, business was resumed, and the Central Administration began to earn their fees again. It is difficult to see what object was aimed at in the novel demand, since the amount of bad debts incurred under the old plan must have been infinitesimal. Nor is it quite obvious why the members

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of the Bourse felt such a strong objection to the ready-money system, unless it be that men who habitually deal in large sums of money are generally reluctant to pay out small ones. A substantial cheque they will draw without wincing, but they do not like to part with their petty cash."

Small Arc Lamps.—A discussion on the potential possibilities of small arc lamps has been started in the *Electrical Engineer* of New York. Prof. Elihu Thomson writes that as far back as 1882 and 1883 he experimented with arcs using 2 to 3 amperes, and with a potential between the carbons of about 50 volts. An arc with 2½ to 3 amperes was readily obtained, and the mechanism for feeding, accurately, the carbon of small diameter was worked out, but the great difficulty at that time was that no carbons could be had pure enough or uniform enough in structure to permit such arcs to run steadily. Subsequently enclosing short-plate carbons in a chamber of glass with limited air supply or none at all was tried. This gave better results, but the carbons gave out enough impurities to obscure the glass in a moderate time. The actual waste of the carbon was very slow, and with a good arc length the light was quite steady. Very small arcs, says Prof. Thomson, when burned in the air with ordinary carbons, have a woeful tendency to rotation. Referring to the early difficulties of arc lighting, due to flickering caused by the use of inferior carbons, Prof. Thomson says, "There was, of course, an added prejudice against the light itself because it was a white light, or appeared bluish in relation to flames, torches, and such other 'hereditary' night lights. It is easy to account for such prejudice, and it is difficult to see how it could have been avoided. For countless ages the human race had relied for night light on fires, torches, lamps burning fats or oils—and the sensorium had come to expect a night light to be orange or yellowish in quality, and to be able to recognise no other to be in correspondence with hereditary expectation. Hence the sudden appearance of a white light at night was a sort of shock which could only be assimilated in the consciousness as something uncanny, inspiring dread or distaste rather than the reverse sentiment."

Electric Discharges.—At a recent meeting of the Académie des Sciences M. Lippmann presented a Paper by M. N. Piltchikoff, on a new method of studying the electric discharge. This method consists in joining one pole of a Voss electric machine to a metallic point which is held over a layer of castor oil contained in a copper dish, connected to the other pole of the machine. If the point is positively charged a large depression is formed, at the centre of which a secondary depression is seen if the distance between the point and the oil is diminished. If a small screen is placed between the point and the oil, an elevation is produced at the centre of the depression; the shape of this elevation being the same as that of the shadow that would be formed if the electrified point were luminous. The level inside this shadow is the same as that of the unaffected liquid, so that it appears that the screen stops the action and produced an electric shadow. The curious effect is shown in a very striking manner by the employment of mica screens cut into various geometrical forms; in every case the "shadow" formed on the depression was an exact reproduction of the screen. One cannot help being struck, says *Nature*, with the resemblance of the above experiment to some of those of Prof. Crookes. The same phenomena are produced with the negative discharge. The discharge acts in a very powerful manner, and the phenomena show themselves even when a strong blast of air is caused to play between the point and the oil. Using different gases the author finds that at the ordinary atmospheric pressure the electric shadows are in all cases the same; the only differences obtained were in the secondary depressions which appear when the electrified point is very near the surface of the oil. With very low pressures, however, the shadows are not formed. The author has succeeded in photographing the depressions and the shadows, and has obtained sharp and well-defined negatives with an exposure of about twenty seconds, showing that, at any rate for this length of time, the phenomenon does not change appreciably.

The Trans-African Telegraph Line.—From information furnished by the British South Africa Company, it appears that the telegraph company which Mr. Rhodes formed last year in London shipped to South Africa 400 miles of telegraphic plant, with iron poles and insulators of the same pattern as used for the wire connecting Cape Town with Fort Salisbury. Of this plant 200 miles were sent to Beira, and thence, *viâ* the Beira Railway and by ox-wagon, transported to Salisbury for the section of the line between that place and Tete, on the Zambesi, traversing the auriferous Mazoe district. The other 200 miles of plant was sent to the Chinde mouth of the Zambesi, and thence carried by steamers to Tschekwawa, a place about 140 miles up the Shiré river. Of this 200 miles 80 miles is being constructed backwards in a westerly direction to connect Tschekwawa with the Zambesi at Tete. The remaining 120 miles is to be erected northwards to Blantyre and Zomba, the British Consulate in the Shiré highlands of Lake Nyassa. Some months ago constructors were sent to Tschekwawa, and they have already constructed some 50 miles of the 80 miles connecting the Shiré with the Zambesi. Of this, 20 miles, completed and in working order, is in the Portuguese territory. The task of cutting the road from Tschekwawa to Tete has been an extremely difficult one owing to the denseness of the forests, but in three months of hard work the officials employed by Mr. H. H. Johnston, Her Majesty's Commissioner and Consul-General for British Central Africa, have made rapid progress. So thick is the growth of timber in this region, that the broad track cut for the telegraph poles resembles in many places a tunnel through the forest. The southern section of 220 miles between Salisbury and Tete is being erected under the superintendence of Mr. Gordon, a nephew of the late General Gordon. This section crosses the Zambesi to join the Shiré section at Tete, where, the river being broad, it was proposed to erect a lofty iron pole on an island in mid-stream. It was here that the recent collision with the Portuguese is said to have occurred.

Capt. Abney on Photometry.—At his second lecture at the Society of Arts, Capt. Abney dealt with the amyl acetate, Dibdin-Sugg-pentane, and Methven standards. Different chemical amyl compounds gave a light differing no more than 3 per cent. from that of the pure acetate, some being in excess and others deficient, the light even of impure amyl acetate was likely therefore to closely approximate to that of the pure substance. Photographic records were exhibited, showing that a slight difference in the actinic power of screened standards of the Methven type was caused by varying the height of the flame. Capt. Abney spoke highly of the Rumford or so-called shadow photometer which is not in favour among gas testers. The two disadvantages were, that with wide flames the junction of the shadows is ill-defined, in such a case a white band rather than an overlapping of the shadows is preferable; the other was that errors might arise if the screen were not perpendicular to the light; but, as Capt. Abney observed, a man must be a fool to allow such errors to occur. An inclination of 10deg. would give an error of 1½ per cent., and 5deg. only 0·4 per cent. Bunsen discs are likely to get out of order, and are therefore likely to lead to errors unless in the hands of an expert. The Methven standard is liable to error if used at short distances, since the thickness of the flame, as seen through the slot, must vary. A flat flame used behind a slot would give no such error. Capt. Abney went very fully into the question of scintillation produced by revolving sectors, and showed that the appreciation of a sensation of continuous or of scintillating light depended on the degree of illumination as well as on the frequency of extinctions. Similary, the appreciation of slight differences of illumination depend largely on the degree of the illumination. A strip of paper with a gradated series of tints from black to white showed each step clearly when brightly illuminated, but in a feeble light not only were the steps indistinguishable, but the gradation of the whole was much less marked. Text-books stated that the eye was able to detect certain small differences, and this value, whatever it was, was repeated, as errors are wont to be, in text-book after text-book. The fixed degree of accuracy of a photometer is quite illusory. With a feeble light, a difference of 2 per cent. or more is not appreciable, but with stronger lights, everything else being the same, one half per cent. or less can be detected.

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REVIEWS.

Electric Waves: being Researches on the Propagation of Electric Action with Finite Velocity through Space. By Dr. HEINRICH HERTZ. Authorised English Translation: By D. E. JONES, B.Sc.; with a Preface by Lord KELVIN, P.R.S. (London: Macmillan and Co. 1893.)

The discovery of the Rosetta stone did not more completely solve the meaning of the hieroglyphic formulæ graven in the stones of Egypt, till then mere symbols devoid of physical significance, than have the researches of the late Dr. Hertz into the phenomena of the propagation of electromagnetic waves solved the physical meaning of the Maxwellian formulæ. Many had gazed at those algebraic signs in wonder at their true meaning; and, like Maxwell himself, had made isolated attempts with detached experiments to build upon them some physical basis. But it was not until the long line of careful research by Hertz had been well-nigh completed, that the inductive method of reasoning could safely be applied to their physical interpretation, and the medium of electromagnetic action could be defined. The observed inter-dependence of certain optical and magnetic phenomena had already given rise to a well-grounded theory of the mutual relationship between the two classes of physical action; but it was impossible to go much farther, or to say in what exact way the phenomena of light resembled the phenomena of electromagnetic action. Then Hertz struck the true key-note; and lo! electromagnetic waves were observed to have the same velocity as that of light, and to follow the same laws of refraction, reflection, and other modification of their paths. This was the grand solution; and onward from this point the studies of light and of electromagnetic waves proceeded in parallel, in regard to any attempt to investigate their inner nature or the nature of the medium of their propagation.

"To fully appreciate the work now offered to the English reading public," writes Lord Kelvin, in his most interesting Preface, "we must carry our minds back 200 years, to the time when Newton made known to the world the law of universal gravitation." Here, in the struggle between Newtonianism and the dying Cartesian doctrine, we have the battle-royal between the rival theories of action-at-a-distance and action-by-contact. The victory was to the former, for a time; and in the hands of Bernouilli, and subsequently of Boscovich, the doctrines of Newtonianism were carried far beyond the doctrines of the individual Newton. In fact, Newton expressed himself as being opposed to the notion of matter acting where it is not; though, as we see by his support of the emission theory of light, he was not prepared to accept the notion of a luminiferous ether. Newton, however, suggested, that gravitation might be explained as being due to a diminution of pressure in a fluid filling space. Thus the doctrine of an empty space, requiring the infinitely rapid propagation of a distance-action, held the field, and was recognised by scientists of the eighteenth century as the only plausible hypothesis. History repeats itself; and again the battle-royal was fought, this time, early in the nineteenth century, in favour of the ether hypothesis; and action-at-a-distance was mortally wounded. Before the phenomena of interference of light and the magnetic and electrostatic researches of Faraday, both the idea of empty space action and that of emission light propagation failed; and the propagation of force through the ether, and of light by vibratory conditions of the ether, came to be held as necessary doctrines. Later still, Maxwell assumed the existence of and investigated the state of stress in a medium through which electromagnetic action is propagated. The mathematical theory which he deduced gives a set of equations which are identical in form with the equations of motion of an infinite elastic solid; and, on this theory, the rate of propagation of a disturbance is equal to the ratio of the electromagnetic and electrostatic units. The experimental determination, by Maxwell and others, that this ratio is a number equal to the velocity of light in ether in centimetres per second, is a fact which gave immense strength to the Maxwellian hypothesis of identity of the light and electromagnetic media. But, although this is the case, the Maxwellian hypothesis, even when taken in conjunction with the experimental support which he educed for it, fell far short of being a complete demonstration of the identity of luminous and electromagnetic propagation.

It is a popular belief that the greatest scientific discoveries and inventions have been the result of pure accident. The belief is only supported by flimsy and superficial evidence. Nevertheless, it is worth noticing that Dr. Hertz was led to commence his series of researches into the propagation of electromagnetic action by what may, perhaps, be styled an accident. In other words, he was engaged upon quite a distinct line of research when certain unlooked-for phenomena attending the discharge of Leyden jars attracted his attention. Thus were initiated the researches which are recorded in the present volume; but it is safe to say that, in thus stumbling upon the problem, Hertz made the only stumble in connection with it. For there is not in the entire annals of scientific research a more completely logical and philosophical method recorded than that which has been rigidly adhered to by Hertz from start to finish. We can conceive of no more delightful intellectual treat than following up the charming orderliness of the records in the pages before us. Setting out with a definite purpose, Hertz took the measure of its length and breadth and gauged its relations to known facts; then proceeded, with infinite patience, to explore. Nothing could be more remotely removed from accident, stumbling or haphazard groping in the dark.

The progress of Dr. Hertz's researches was recorded from time to time in Papers contributed by him to *Wiedemann's Annalen* and other journals; and translations of these have appeared in the columns of *The Electrician*. The publishers of *Wiedemann's Annalen*, however, being unable to comply with the numerous applications made for copies of these researches, invited Dr. Hertz to prepare his Papers for publication in a collected form. It was felt to be best to reprint the Papers in the form in which they originally appeared, an explanatory introduction being written by their author, in which he describes the manner in which the investigations were undertaken, and discusses their bearing upon electrical theory and the criticisms to which they have been subjected. The collected researches were published early in 1892, under the title of "*Untersuchungen über die Ausbreitung der Elektrischen Kraft.*" The work before us is an admirable translation of the German original, by Prof. D. E. Jones, with a change in the title, suggested by Lord Kelvin, and with one or two slight alterations in the original notes. The researches themselves, as we have already said, are a splendid consummation of the efforts which have been made since the time of Maxwell to establish the doctrine of one ether for all energy and force propagation—light, heat, electricity, and magnetism. The original Papers, with their introduction, form a lasting monument of the work thus achieved. The able translation before us, in which we have a skilful blend of the original meaning with the English idiom, and which is copiously illustrated, places the record of these researches within the reach of the English reading public, and enables it to study this important and epoch-making landmark in the progress of physical science.

ELECTRIC MOTIVE POWER.*

BY ALBION T. SNELL.

(Continued from page 604.)

Relative Merits of Two-phase and Three-phase Currents.

Experts differ as to the relative merits of two and three phase currents. As regards the alternators and motors there is, perhaps, not much to choose between them. Machines designed for similar outputs, whether synchronous or non-synchronous, are found to have about the same efficiencies, starting torque, weight, and apparent watt consumption, the three-phase machines, however, being the better, according to

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experiments made by Mr. Kolbein, the chief engineer of the Oerlikon Works. As regards the winding details, perhaps the two-phase type is the simpler. The main difference between the two systems lies in the relative weights of copper required in the conductors for given conditions, and the ease with which the currents may be handled, regulated and controlled.

The first experiments with three-phase working brought to light difficulties in the regulation of pressure between the three mains at the points of supply, when the currents in the three circuits were not approximately the same, which though since overcome to some extent, are greater than those obtaining with two-phase currents—they lie chiefly with the design of alternators and transformers. Two-phase currents, if worked

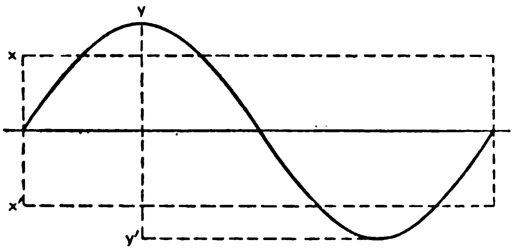

FIG. 96.—Single-Phase System.

xx' = Effective Pressure of 3,550 volts (*see* Table).

yy' = Maximum Pressure of 5,000 volts.

with *two separate circuits* are as easily dealt with as single-phase currents, and serve readily most purposes to which single or poly-phase currents are usually applied. They are specially convenient for distribution. It may be safely inferred that two-phase are better adapted for a combined service of light and power work; while three-phase currents are specially useful for running with equally loaded circuits, and therefore are not generally so suitable for lighting work.

For simple transmission of power between two distant points, however, the requirements are different, and the three-phase currents system is generally cheaper than either a continuous-current or a one- or two-phase alternate-current system.

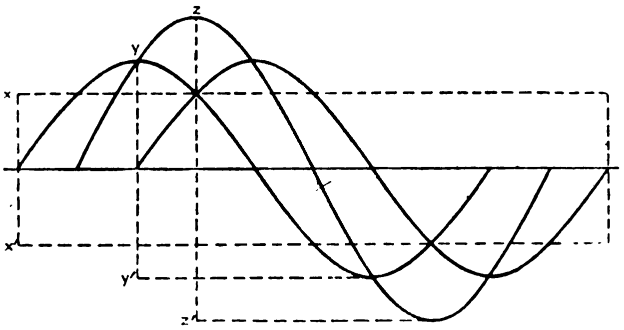

FIG. 97.—Two-Phase System. Three Wires.

xx' = Effective Working Pressure of 3,550 volts.

yy' = Maximum Working Pressure of 5,000 volts.

zz' = Maximum Component Pressure of 7,100 volts.

This interesting and important problem may be considered from three points of view, each of practical value :—

(1) On the basis of effective pressure at the distributing station (or motor terminals, perhaps).

(2) On the basis of maximum difference of pressure between conductors.

(3) When the economic law is considered.

The ratios of the weights of copper under these conditions are stated in tabulated form in the accompanying Table, in which, to give a practical character to the figures, a definite power has been selected for transmission to the receiving station. Constant line loss and constant fall of pressure have also been considered.

In the final column the economic law has been considered to the exclusion of either a definite line loss or drop, the equivalent current being taken as in column 3. In practice, the weights would be modified by local considerations; but the main ratios would hold good, and the figures given form, therefore, a reliable guide between the relative merits of the systems as affected by the weight of copper.

The significance of the difference between effective and maximum pressure is at once apparent if Figs. 96, 97, 98 and 99 are examined.

In these figures the *electrical centre of gravity* is shown graphically. In any electrical circuit of good or bad insulation there is a datum pressure with reference to the variations of pressure in the circuit. For example, in a continuous-current circuit the absolute pressure of the negative pole of the dynamo will have a constant ratio to that of the earth's surface at the particular site, and the difference of pressure

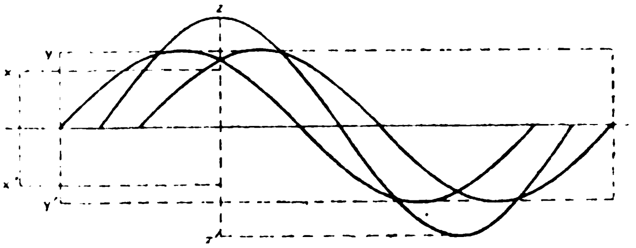

FIG. 98.—Two-Phase System. Three Wires.

xx' = Effective Working Pressure of 2,500 volts.

yy' = Effective Component Pressure of 3,550 volts.

zz' = Maximum Component Pressure of 5,000 volts.

between it and the positive pole will simply affect the absolute pressure of the positive pole. And if the negative pole be grounded, the datum pressure will be that of the earth's surface.

Again, with an alternate-current circuit, with both poles insulated, the cyclical changes will alternately raise and lower the absolute pressure above and below zero pressure, which corresponds to that of the earth's surface. Thus in a circuit carrying a current of 5,000 effective volts pressure the maximum pressure between any two points of the circuit will be $5{,}000\ \sqrt{2} = 7{,}050$ volts, while the absolute pressure, *i.e.*, *that* above the earth, will be only 3,525, positive or negative. The stress through the insulation to earth will, therefore, be only 3,525 volts.

But if the circuit be grounded, say, at one of the main terminals, the absolute pressure between the other terminal and

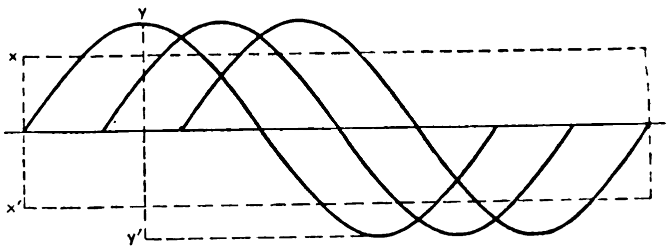

FIG. 99.—Three-Phase System.

xx' = Effective Pressure of 3,550 volts.

yy' = Maximum Pressure of 5,000 volts.

earth will be 7,050 volts, and therefore the insulation all over the high-pressure circuit will be subjected to this stress, although the effective working pressure will remain as before.

This possible change in the stress upon the insulation of a circuit carrying an alternate current has led to the general practice of earthing one of the primary mains, usually at both the generating and distributing circuits. The maximum stress is thus accepted and suitable precaution adopted to safeguard against accidents; and additional security is gained because a fault in the other main at any point at once blows the fuses and disconnects the faulty section.

With two-phase three-wire circuits it is permissible to earth the middle wire, at the generating station, which then is at zero pressure. The same precaution is observed with the "star" coupled three-phase system. With the "triangle" three-phase system it is not permissible to earth either of the mains, since the earth would then form part of the circuit.

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Table.

Comparative Table of Ratios of Weights of Copper required with different systems to deliver 50,000 watts at Receiving Station under the conditions of Constant Maximum Pressure and Constant Effective Pressure at Receiving Station, with constant line loss of 5,000 watts, or constant drop of 500 volts.

System.	Conditions. M.P. = Maximum Pressure. E.P. = Effective Pressure.	Current in amperes.	Effective volts at motor.	Effective volts at power station.	Line loss in watts.	Drop in volts.	Resistance of each main in ohms.	Ratio of weights of copper.	Weight of copper when the economic law is considered.
Continuous current, 2 wires	M.P. 5,000 volts, line loss 5,000 watts	10·0	5,000	5,500	5,000	2 × 250 = 500	25·0	1·0	1·0
	E.P. ditto ditto	10·0	5,000	5,500	5,000	2 × 250 = 500	25·0	1·0	1·0
	M.P. 5,000 volts, drop 500 volts	10·0	5,000	5,500	5,000	2 × 250 = 500	25·0	1·0	1·0
	E.P. ditto ditto	10·0	5,000	5,500	5,000	2 × 250 = 500	25·0	1·0	1·0
Single-phase alternate-current, 2 wires	M.P. 5,000 volts, line loss 5,000 watts	14·12	3,550	3,906	5,000	2 × 178 = 356	12·5	2·0	1·411
	E.P. ditto ditto	10·0	5,000	5,500	5,000	2 × 250 = 500	25·0	1·0	1·0
	M.P. 5,000 volts, drop 500 volts	14·12	3,550	4,050	7,100	2 × 250 = 500	17·8	1·41	1·411
	E.P. ditto ditto	10·0	5,000	5,500	7,100	2 × 250 = 500	25·0	1·0	1·0
Two-phase alternate-current, 4 wires		Each circuit.							
	M.P. 5,000 volts, line loss 5,000 watts	7·06	3,550	3,906	5,000	2 × 178 = 356	25·0	2·0	1·411
	E.P. ditto ditto	5·0	5,000	5,500	5,000	2 × 250 = 500	50·0	1·0	1·0
	M.P. 5,000 volts, drop 500 volts	7·06	3,550	4,050	7,100	2 × 250 = 500	35·6	1·41	1·411
	E.P. ditto ditto	5·0	5,000	5,500	7,100	2 × 250 = 500	50·0	1·0	1·0
Two-phase alternate-current, 3 wires		Outers. / Return.			Two outers. / Return.		Each outer. / Return.		
	M.P. 5,000 volts, line loss 5,000 watts	10·0 / 14·12	2,500	2,794	2,940 / 2,060	2 × 147 = 294	14·7 / 10·3	2·91	1·706
	E.P. ditto ditto*	*a* 7·06 / 10·0	3,550	3,962	2,940 / 2,060	2 × 206 = 412	29·4 / 20·6	1·478	1·205
		b 5·0 / 7·06	5,000	5,590	2,940 / 2,060	2 × 295 = 590	59·0 / 41·25	0·737	0·853
	M.P. 5,000 volts, drop 500 volts	10·0 / 14·12	2,500	3,000	5,000 / 3,550	2 × 250 = 500	25·0 / 17·75	1·704	1·706
	E.P. ditto ditto*	*a* 7·06 / 10·0	3,550	4,050	3,550 / 2,500	2 × 250 = 500	35·5 / 25·0	1·204	1·205
		b 5·0 / 7·06	5,000	5,500	2,500 / 1,770	2 × 250 = 500	50·0 / 35·4	0·853	0·853
Three-phase alternate-current, 3 wires	M.P. 5,000 volts, line loss 5,000 watts	8·1	3,550	3,752	5,000	1 × 202	25·0	1·5	1·212
	E.P. ditto ditto	5·78	5,000	5,288	5,000	1 × 288	49·8	0·755	0·866
	M.P. 5,000 volts, drop 500 volts	8·1	3,550	4,050	12,200	1 × 500	61·8	0·610	1·212
	E.P. ditto ditto	5·78	5,000	5,500	8,700	1 × 500	86·5	0·435	0·866

* Effective pressure measured (*a*) with respect to the working pressure in each circuit, (*b*) with respect to the component pressure.

In the final column is given the necessary weights of copper, when the economic law is considered to the exclusion of either a definite line loss or drop, the equivalent current being taken as in column 3.

It appears, then, that from consideration affecting prime cost of line the three-phase system is cheaper for long-distance transmission than either single-phase or double-phase alternate currents. Continuous currents are the cheapest of all, but are not admissible for extra high pressures.

The selection of a system for a long distance transmission of power plant will mainly depend upon the maximum permissible pressure. If it be possible to work at such pressures as are feasible, in the engineer's judgment, for continuous-current dynamos (coupled in series or otherwise), then there can be no doubt from considerations affecting the line that this will be the cheapest and best system. But if extra high pressure be deemed advisable, then the three-phase system will generally prove the cheapest.*

In connection with this question it is important to notice that the engineers responsible for the electric transmission of power plant being laid down at Niagara, have finally, after mature consideration, decided upon a four-wire two-phase system. The reasons for their choice are given by Prof. G. Forbes, in a Paper entitled "The Electrical Transmission of Power from Niagara Falls," read before the Institution of Electrical Engineers on November 9, 1893. The details of the scheme have been strongly criticised by English experts, and the choice of two-phase currents is open to doubt. When it is considered that Buffalo, the nearest large city, is fifteen miles distant, it is clear that the weight of copper will be a very important item in the cost of the whole plant, and in the author's judgment a three-phase system would prove more economical in first cost, and give as good pressure regulation as the two-phase. For it must be recollected that there is a line difference of pressure of 20,000 volts, and hence step-down transformers will have to be used at every point from which power is taken. The *main line* drop will, therefore, be as difficult to regulate with two-phase as with three-phase currents; and variation of pressure of submains of the distributing systems can be as readily controlled by using *independent* secondary circuits from three-phase transformers as from *separate* secondary circuits of single or two-phase transformers, Prof. Forbes's argument that two-phase currents are more easily *redressed* than three-phase currents is probably sound, but the fact that no form of alternate current has yet been made unidirectional in a practical manner cannot be ignored.

* The generating plant may perhaps be a two-phase one, with suitable step-up transformers, as proposed by Mr. Scott, of the Westinghouse Company. And it may also prove economical to transform the phase again at the receiving station. The ingenious proposals of Mr. Scott, however, have not yet been verified in practice; but there seems to be no doubt of their feasibility and usefulness.

(To be continued.)

THE IMPORTANCE OF COMPLETE METALLIC CIRCUITS FOR ELECTRIC RAILWAYS.*

BY J. H. VAIL.

In the early days of electric railway construction two distinctly different systems were devised and competed for public favour. The one being the overhead double trolley system, affording a complete metallic circuit for the out-going and return of all the electric current required to move the motor cars, and the other being the single trolley system, using the track and earth as a common conductor for one side of the circuit, and the trolley wire and parallel mains for the opposite side.

The double trolley system was found impracticable of operation in many of its details, and the single trolley, because of its simplicity and convenience, has made rapid advances in public favour. The single trolley system has depended largely upon the earth and buried pipe systems for completing the circuit. Many devices for making the track and earth combined a more complete and low resistance circuit have been resorted to, such as burying copper or iron plates, old rails or old car wheels, and connecting same to the track; or, at frequent intervals, driving iron rod down in the earth and connecting by wires to track; or by making actual connection with wire from tracks to gas and water pipe systems.

* Abstract of a Paper read before the National Electric Light Association at Washington.

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Also, for supposed reinforcement of the track, we have used a bare wire of iron or copper, buried in the earth, laid parallel to the track, and connected at frequent intervals; also the supposed electrical connection of rails at joints, by bond wires of iron or copper, only having a small fractional part of the capacity of the rail as a conductor. In the early days of electric railway construction it was assumed by experts that the earth and the buried pipe systems would, when combined, form an ample return for the electric current. At that age of the art experts did not fully appreciate the immense quantities of current that would require to be carried, and therefore did not foresee that these currents when disseminated would produce the serious results that have been caused by electrolytic action on systems of pipes buried in the earth and owned by other companies. Frequent tests prove that the earth itself cannot afford the free path for the current that was anticipated. Earth conductivity has been over-estimated. Iron and lead pipes, being better conductors than earth, must of necessity carry the current, if no superior path is offered by the method of construction. The natural moisture of the earth hastens the destructive electrolytic action of the current on these pipes In some soils electrolysis is more rapid than in others. The rapidity of action depends upon the chemical constituents of the soil. It has been found that illuminating gas leakage held in such soils as underlie the cities of New York, Brooklyn, Boston, Philadelphia and elsewhere, hasten electrolytic action. Abundance of substantial evidence can be produced. These serve to prove the case, which cannot longer be successfully denied nor assigned to other causes. It has been stated that in an electric railway system where a connection has been made to water pipes, the pipes have carried as much as 28 per cent. of the total current. Instances are known where as much as 40 per cent. is carried on the pipe systems. It is the opinion of the writer that any gas or water-pipe system used as a carrier of electric currents will not only be corroded through the body of the pipes, but will surely in due time show defects at joints, as here will occur higher resistance than in any other portions of the pipe system. It has been proven by test that the electrolytic action of even five amperes of current on an iron pipe is considerable, and that much damage will result in one year. The rapidity of action depends upon character of soil, amount of moisture, and quantity of current; the destructive action is constant and sure. Any system using ground plates, ground rods, or substitutes therefor, or bare return track wire buried in the earth, is constructed primarily to utilise the earth as return circuit; when the earth does not afford good return the current is sure to follow the water pipes, gas pipes, or other buried conductors offering the path of least resistance. We now see that these prove to have been only makeshift methods to reduce the cost of construction. We find that the evidence thus produced and the troubles constantly occuring in existing street railway systems are sufficient to show that all methods of grounding the track circuit or connecting to pipe systems should be entirely discontinued; it, therefore, becomes of vital importance to so construct the electrical railway system as to avoid all electrolytic action on buried systems of metal work that are the property of other concerns.

Having produced the evidence and established the case, let us briefly analyse the matter and ascertain the reason for these results. What was intended to be good has proved to be defective electrical work executed in connection with track systems, has not given to that side of the system a perfect path for the travel of the current; the conductivity of the rail circuit being impaired to such an extent that the electric current must force itself through the earth or through metal pipe lines buried therein.

A further examination into other features of construction requires some consideration of the bonding of rail joints. The existing methods of utilising railway tracks for conducting large quantities of current are faulty in at least three particulars—first, restricted conductivity at joint, due to insufficiency of the rail bonds; second, neglecting to properly utilise the track as a conducting medium; third, failure to provide a complete circuit of low resistance. For electrical purposes we cannot regard the joint plates and bolts as of any permanent value; the contact is electrically imperfect, the metal surfaces are oxydised and under constant movement, due to passing cars pounding the rail joints. The rail sections are in many systems of ample conductivity to carry more than the requisite current, provided they are perfectly bonded and properly connected by feeders with the dynamos. We must, therefore, bond the rail joint in such a *mechanical* manner as to maintain perfect *electrical* contact, and with sufficient metal to restore at the joint nearly the full conductivity as of the rail itself; and at the same time to give the existing joint plates their present freedom of motion.

It has been found that a system of track with faulty rail bonds will give a shock to animals and, possibly, to human beings, should the same be brought into actual contact in such a manner as to complete through them the broken circuit. It will be readily understood how difficult it is to maintain proper inspection of the electric bonding where the bonds are covered up by the street pavement. Under such conditions the ground circuit and the bonding escapes inspection until excessive coal consumption, loss of current, and other troubles, force themselves upon the attention of the street railway management. Observation proves that a faulty rail bond will show its location in winter by heating, due to high resistance, and if snow be present on the ground around the joints the snow is partially melted, thus indicating location of fault. Let us turn our attention for a few moments to the question of the conductivity of the rails.

According to statement of G. F. Sandt, which the author believes correct, the area in square inches of a single track of two 56lb. rails is 10·9748, and a single track of two 70lb. rails is 13·7186, while the safe carrying capacity, recorded at one-third that of copper in amperes, is respectively 780 and 976 amperes. The carrying capacity of copper wire between No. 10 B. and S. gauge and 1in. varies between 16 amperes and 302 amperes.

These figures serve to show how utterly absurd it is to bond a track of 70lb. T rails with iron rail bonds No. 4 or No. 0 in size, and to pretend to reinforce their conductivity with a No. 0 iron or even a No. 0 copper wire. It is laying a 12in. water main and then putting a ½in. pipe alongside to help it out. The No. 0 B.W.G copper wire has a resistance of over 20 times the single track of 56lb. T rails per foot, and the No. 0 B.W.G. iron wire over 112 times the resistance per foot of the same track. How, then, can either of these be of any adequate assistance for conducting current?

The writer knows personally of several instances where the copper supplementary wire has absolutely disappeared. The writer believes that 99 per cent. of the money expended for so-called supplementary wire is absolutely thrown away. The same money expended in other directions will give more adequate return. Does not this show conclusively that we should give our attention to the more perfect bonding of the rail joints, and also to apply track feeders in such a manner as to fully utilise the conductivity of the track, and thereby make it fulfil the service of which it is capable when properly treated? We are in error when the track system is named as a return circuit. The track system of all electric railways should really be the positive side or outgoing circuit.

It is also important that existing systems of operating electric railways should be promptly taken in hand and the proper remedies intelligently applied. The three-wire system has been mentioned by some engineers as a possible solution. I will here diverge for a minute to state that a trial was made four years ago under favourable conditions—not to avoid electrolysis, but to save copper. We developed physical difficulties of operation which warned us to avoid the three-wire system in future electric railway work. I believe I am safe in stating that 90 per cent. of the electric railways have their systems so constructed as to largely restrict the conductivity of the rail circuit. A one-sided system is fundamentally wrong. The quantity of current to be controlled is so enormous that ordinary make-shift methods will not answer. Having carefully analysed the whole matter, I feel justified in recommending that we must adopt the complete metallic circuit as the standard for the best electric railway practice. This can best be obtained by the following method—first, by so bonding the track as to render the rail joints of as low resistance and nearly equal conductivity to the rails, and to execute this work so as to maintain this improved condition; and, second, the track system must be supplied with insulated feeders leading direct from the bus bars in the station to predetermined points of the track system, and thus offer a perfect low resistance path for this side of the electric circuit, the some as is obtained with the trolley line and the overhead system. All of these features and improved methods have been put in practice by the writer.

The only proper system is one that affords a well insulated and complete metallic circuit of low resistance, that will give an ample path for the complete unrestricted circulation of the entire current from pole to pole of the dynamo, thus offering no inducement for the current to follow such conductors as gas or water pipes. I am not recommending extravagant methods, but only such as are deemed essential for economy, and of a practical nature for reducing expenses and augmenting dividends. The item of cost cannot properly be urged as an objection, because where the whole construction requires a large investment, every detail of the work should be so executed as to be permanent and enduring. If the details are carefully analysed it will be found that the cost of frequent reconstruction, maintenance and renewals of rail bonds and bare wire amount to an excessive rate of interest on original investment, and would soon pay the small additional cost to build a complete metallic circuit. The superior service obtained from a complete metallic system of low resistance with the proper application of insulated track feeders will, within a brief period, more than refund a reasonable interest on the investment through the saving of fuel alone, not counting other economies in renewals and maintenance. The tract feeder system will be far less costly than the double trolley system.

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Whether track feeders should be laid underground or erected overhead is a question largely controlled by local conditions and capital available. I express a preference for underground work as being more permanent and subject to the least cost for repairs. The original construction is certainly more costly for underground. The actual cost of copper is the same in either. The necessity of constant repairs under existing methods, and the damage to water and gas pipes by electrolytic action, simply proves that it is but a question of time as to how long before electric railway companies will be forced to adopt the complete metallic circuit. Where experience and practical knowledge is applied the cost will not be excessive. It is not difficult to arrive at an exact method of doing the work, and an accurate estimate of its cost. The writer has observed on some roads that large quantities of copper for return circuits have been placed at great expense, apparently without a proper conception of how to obtain the best results. Frequently a far less amount of copper, judiciously applied for improved distribution by the feeder system, would give superior equalisation of pressure at reduced cost. If for the movement of cars singly or in quantities at a high speed the electric current is to be distributed uniformly over an electric railway system, the subject must be handled with as much scientific accuracy as is always used for a perfect system of incandescent lighting, in order to obtain equal distribution and free flow of current in both sides of the system.

The conductivity of the rails should be calculated with as much care as the overhead system, and when the track needs reinforcing the purpose should be accomplished by laying a thoroughly insulated main line (not a bare line) and making frequent sub-feeder connections bonded to the track. If used at all this main will be of large size. Such a system, accurately worked out, will show by actual test with instruments on the cars a surprising equality of electromotive force throughout a large territory.

A very careful test has been made with instruments on moving cars, throughout a system covering 40 miles of streets, with double tracks, equal to 80 miles single track. The readings showed—maximum volts, 512; minimum volts, 420. Average of electromotive force over entire system, 460 volts, the electro-motive force in station, at bus bars, being 520 volts. The feeders were calculated for 10 per cent. drop. The actual average drop from dynamo to motor does not exceed 12 per cent. This will be found to result in reduced fuel consumption, better working of the motors, a most satisfactory reduction in repair accounts, and an improved general economy of the entire system. In the system of distribution secured by the above method, the use of ground plates, rods or other insufficient methods is needless; the current travels only over the paths provided for it, and electrolysis of gas and water mains is entirely obviated.

ADIATHERMANOUS GLASS.

In our issue of January 19th, p. 288, we gave an account of some investigations by Herr Richard Zsigmondy on the absorption of heat rays by a new ferrous glass devised by him, and capable of passing light while acting as a screen to heat rays. That glass has now become known under the name of "Schirmglas," or screen glass. Herr Zsigmondy has been continuing his researches into the absorption of heat by different other substances, and Dingler's *Polytechnisches Journal* gives an account of these.

The following table shows the percentages of the heat of an Argand burner *transmitted* by layers of the following substances 0·38in. thick :—

Concentrated sulphuric acid	15·7
„ hydrochloric acid	14·0
„ solution nitrate of manganese	14·0
„ nitric acid	14·0
„ solution aluminium chloride	12·9
„ phosphoric acid	12·7
„ alum solution	12·15
Iron perchloride (2·8 per cent. iron)	11·2
Copper chloride (bright blue)	8·2
Ferrous ammonia sulphate, 4·7 per cent. iron, colourless	2·6
Solution of iron in orthophosphoric acid, 5·6 per cent. of iron, colourless	2·1
Green vitriol, acidulated solution, 8·9 per cent. of iron, almost colourless	1·19

The acids are thus better transmitters of heat rays than water (about 12 per cent.). The ferrous salts of iron are good absorbers of heat rays; and their efficiency does not depend on the chemical salt used, so long as the iron is present in the ferrous state, but on the percentage of iron in the solution.

As to glass, neither alumina, nor lead, nor zinc, nor baryta, nor boracic acid, nor an excess nor a deficiency of alkali, has any marked influence on its absorptive power for heat rays, so long as the glass is colourless; but when the glass is coloured the absorption for heat rays is sometimes greater. The following table gives the percentages absorbed by different samples chosen :—

——	Thickness in millimetres.	Percentage of heat transmitted.
Silver glass, bright yellow	1·1	64·5
Table glass, bright	2·8	63·2
Mirror glass	7·52	63·5
Chromium glass, bright green	3·43	61·3
Copper glass, bright red	1·8	61·1
Table glass, greenish	3·0	59·1
Bright opal glass (flame appears reddish through it)	2·0	57·7
Bright blue copper oxide glass	2·7	53·0
Yellow iron-manganese glass	1·7	53·5
Brown iron-manganese glass	2·6	42·7
Dark red copper glass	2·1	51·5
Blue cobalt glass	2·3	41·0
Dark blue copper oxide glass	2·5	34·0

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, April 13th.

PHYSICAL SOCIETY.

5 p.m. Discussion on: "Calculating Machines," by Prof. O. Henrici. After which the following Papers will be read: (1) "The Minimum Temperature of Visibility," by P. V. Gray. (2) "The Mechanism of Electrical Conduction," by C. V. Burton.

JUNIOR ENGINEERING SOCIETY.

8 p.m. Ordinary Meeting at Westminster Palace Hotel. The following Paper will be read:—"Lubricants: their Use, Testing, and Analysis," by William F. E. Seymour.

ROYAL INSTITUTION.

9 p.m. Evening Discourse on: "Some Properties of the Electric Discharge through Gases," by Prof. J. J. Thomson, F.R.S.

MONDAY, April 16th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture. "Photometry," by Capt. W. de W. Abney, F.R.S.

TUESDAY, April 17th.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture. "Electric Illumination," by Prof. J. A. Fleming, F.R.S.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. The following Papers will be read: (1) "The Training of Rivers," by Leveson Vernon Harcourt, M.Inst.C.E. (2) "Estuaries," by Henri Léon Partiot.

WEDNESDAY, April 18th.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read: "Design applied to Carpets," by Alexander Millar.

ROYAL MICROSCOPICAL SOCIETY.

8 p.m. Meeting at 20, Hanover-square.

THURSDAY, April 19th.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. General meeting at 25, Great George-street. Presidential Address. The following Paper will be read:—"Description of the Grafton High-Speed Steam Engine," by Edward W. Anderson.

SOCIETY OF ARTS.

8 p.m. Foreign and Colonial Section. "Tasmania and the forthcoming Hobart International Exhibition, 1894-95," by G. Collins Levey.

FRIDAY, April 20th.

INSTITUTION OF MECHANICAL ENGINEERS.

7:30 p.m. General Meeting at 25, Great George-street. The following Paper will be read:—"Description of a Fluid Pressure Reversing Gear for Locomotive Engines," by David Joy.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting at 28, Victoria-street. A Paper will be read on "Secondary Batteries," by G. C. Allingham.

ROYAL INSTITUTION.

9 p.m. Evening Discourse: "Early British Races," by J. G. Garson.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

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NOMENCLATURE AND SYMBOLS.

In spring, an electrician's fancy lightly turns to thoughts of nomenclature. Whether this be due to a brain overstrained by attendance at meetings of scientific societies during the winter, or to premonitions of a midsummer madness which culminates in a Paper on symbols or names for units, with perhaps a new unit or two thrown in, we cannot say. The scientific world has been invited at different times to adopt kilobarads, of which, eighty-nine go to a pound weight per square inch; micro-franks, one of which is equivalent to eighty ampere turns; thoms, millihens, "and twenty more such names . . . as these, which never were, nor no man ever saw." For the most part, this name-giving does not arise from the advent of new and nameless ideas, but is connected with those physical quantities which for no very obvious reasons have been called units. As soon as somebody recognises that a certain quantity is a unit, he yearns for a name wherewith to dub it. Mechanical engineers have observed, and have calculated, the effects of friction for years; but have never felt the want of a unit of friction, nor when they determine the friction of water in pipes by loss of head in feet are they blamed for suppressing certain dimensions. Engineers who do not know that M/LT^2 are the dimensions of stress, and who have no idea of what is meant by torque or radian, are quite familiar with the calculation of torsion or twisting moment in inch-pounds or foot-tons, and would not be grateful for a "unit" named after some celebrated millwright.

On June 17, 1890, the American Institute of Electrical Engineers proposed to connect the names of FRANKLIN and of HENRY with some electrical units. Amongst other electrical quantities which had acquired unit rank, but which had not received suitable titles, was self-induction; and as HENRY'S

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claims to fame had been less widely recognised than those of FRANKLIN, the connection was pressed, and has now been adopted. On March 21st last, the same body urged that the honoured names of GILBERT, WEBER, OERSTED, and GAUSS should be associated with the "units" of magnetomotive force, magnetic flux, reluctance, and "flux-density." That GILBERT had no idea of magneto-motive force, and that OERSTED never imagined such a quantity as reluctance does not enter into the question at all. Our New York correspondent informed our readers in our last issue that "it is urged that there is a practical necessity for the adoption of names for magnetic units." And in its issue of March 31st, the *Electrical World* talks of "workers in practical electricity" having had "presented to them a system of practical magnetic units which seems as well if not better suited to their needs than any yet devised," as if something actually creative had taken place, and not merely a local christening. Do we want a unit of magnetomotive force? Does anybody outside the lecture-room use it? Is it not a clumsy analogical companion to the objectionable expression electromotive force? If something more practical than an ampere-turn is going to displace this well-known quantity, we shall be interested to see it. If 4π is going to be suppressed or included or dodged in some way, confusion is likely to arise. FARADAY gave us the idea of a line of force, and we have given it a quantitative value; the number of lines, define them how you will, is quite sufficient for all practical purposes without any new unit of magnetic flux, and *a fortiori* we can dispense with gausses. *Ars longa, vita brevis.* But to speak of gausses instead of "lines per square inch" will not greatly shorten art. Life, rather, will be more brief, for very worry of remembering what all these names mean. As far as reluctance is concerned, we are thankful to have the word, and this, with the symbol **R** to match the well-recognised **H** and **B** is quite sufficient, without any new name.

The question of symbols arises at once out of a discussion of names. The "Symbols for Physical Quantities and Abbreviations for Units," proposed by M. HOSPITALIER, and recommended by the Committee on Notation at the Chicago Congress have been issued by the *Electrical World* of New York, printed on a card for easy reference. These symbols were certainly not adopted by the Congress, and it is difficult to decide how much importance is to be attached to the recommendation of a committee. The table is useful for its columns of defining equations and for the dimensions of the quantities; but that is not its main object. It is doubtful whether a thoroughly representative international congress could, by discussion and amendments, produce a much better set of symbols, but for all that many writers will still decline to alter their custom and to adopt the characters selected by M. HOSPITALIER. The Frankfort Congress in 1891 gave some attention to this matter, and passed unanimously three resolutions of a general character. Physical quantities, such as current, were to be denoted by an italic letter a; units, such as the ampere, by a Roman capital A; and angles and physical constants, coefficients relating to properties of materials, such as μ for magnetic permeability, were to be denoted by Greek letters. This Congress went on, however, to "decide" that the practical electrical units should be represented by the capitals which constitute the initial letter of their respective names, A for ampere, F for farad, O for ohm, &c. Nearly three years have elapsed, but we are not aware that this decision has been regarded. M. HOSPITALIER's system was submitted to this Congress, and it was recommended that a committee should "kindly put the system to a practical test, and at the end of the present year (1891) publish the results of their examination in the technical journals." We are not aware that the Committee have kindly or unkindly done anything of the sort. M. HOSPITALIER asks us to use u for difference of potential and v for geometric volume, C for capacity, and K for moment of inertia. The thoroughly French I for the quantity which Frenchmen so curiously name *intensité du courant* is perhaps destined to supersede the C or the A used by some writers. The ragged German capitals for the chief magnetic units have given place in our columns and in the writings of most English electricians to block letters. The only argument that can be urged in favour of the untidy and indistinct German letters is that they were used by MAXWELL.

Having got his units and names for them, and symbols for the names, the electrician is not happy until he tacks prefixes on to them. The kilo-, milli-, centi-, are common, the deca- is rare, and the micro- is occasional. Messrs. HOUSTON and KENNELLY, however, are not satisfied with these, and in another column call attention to the claims of bicrohenrys, begafarads and quegohms. A writer hard-pressed for time or paper might, if he pleased, use such jargon in his note-book. He alone need understand it, and having invented it, may be expected to read it without much difficulty, but it is asking a good deal to invite the whole scientific world to bother itself with such prefixes. In the original report of the British Association Committee for the Selection and Nomenclature of Dynamical and Electrical Units, to which we owe the C.-G.-S. system, Mr. STONEY's suffixes, to denote the exponent of the power of 10, were recommended. Thus, the length of an earth quadrant is metre-seven, or 10^7 metres, and a horse-power is 7·46 erg-nines per second. The fact that this suffix system has not been generally adopted is sufficient reason for assuming that it was not wanted, sensible and easily remembered as it is.

OBITUARY.

PAUL JABLOCHKOFF.

An attempt to apportion a due share of credit for the invention of the steam-engine to Hero, the Marquis of Worcester, Savory, Newcomen, and Watt would be no more vain than to examine the proportion of honour which must be accorded to the inventors of the electric light. No one can deny a place to Paul Jablochkoff among the four or five men who by their scientific knowledge, their ingenuity, their perseverance, and by that art of convincing the public, which is so important an element of success—as success is generally measured—have given electric lighting to the world.

Paul Jablochkoff, who was born at Serdobsk (Government of Saratow) on September 14, 1847, died at St. Petersburg on Friday last.

M. Jablochkoff belonged to a distinguished and well-to-do family. His father was a municipal councillor and a member of the General Council of his province. His younger brother was, at the age of 28, a lieutenant-colonel in the Engineers, and took part in Skobeleff's expedition into Central Asia. M. Jablochkoff studied at the Military Engineering College at St. Petersburg, which he left in 1866. As he manifested scientific tastes he was sent to the Military Galvano-Technical School. His military service lasted five years, and in 1871, his particular aptitude for electricity having been noticed by his superiors, he was appointed director-general of the Moscow-Koursk telegraph lines for the Midi Railway Company. It was while he occupied this post and had the telegraph workshops at his disposal, that M. Jablochkoff began to take a deep interest in the subject of electric lighting. In the year 1872, the Nihilist propaganda first began to inspire terror, and when the Emperor travelled by rail it was decided to light up the track in front of the engine by means of an arc light. M.

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Jablochkoff was responsible for the lighting on the Moscow-Koursk section, and the frequent failures of the apparatus then employed induced him, no doubt, to consider all possible means of improvement. In 1875 he quitted the Imperial Telegraph Service, and from that date devoted his time exclusively to scientific pursuits. Passing through Paris on his way to the Philadelphia Exhibition of 1876, M. Jablochkoff was so pleased with what he saw of that city that he never got any further on the road to Philadelphia. At this time there was being held in London an Exhibition of Scientific Apparatus, and M. Bréguet sent M. Jablochkoff to London to represent that well-known firm. On his return to Paris, the Bréguet workshops were placed at M. Jablochkoff's disposal. Eight months of experimental work resulted in the famous "Jablochkoff candle." This discovery gave an immense impetus to electric lighting. A company was formed to work the patent, and in May, 1878, a magnificent row of Jablochkoff candles lit up the Avenue de l'Opéra at Paris. The Jablochkoff system of lighting soon spread, and before long "electric candles" were burning at Rome, and on the Thames Embankment in London. The "electric candle," however, is by no means M. Jablochkoff's only claim to fame, as the following list of patents taken out by him will show:—The electric candle, the distribution of currents by means of induction coils, an incandescent Kaolin lamp, the distribution and division of the electric current by means of condensers, a voltaic battery consuming coal, an alternate-current dynamo, a sodium battery, auto-accumulators, and a ribbon-wound electro-magnet.

M. Jablochkoff's patent, No. 1,996, of 1877, for "Producing and Dividing Electric Light," was deemed, if we may judge by the peaceable manner in which royalties were paid to its owners, the now defunct Electrical Engineering Corporation, the master patent in this country for alternate-current distribution by aid of transformers, although both the drawings and the second claim show that the inventor had in view series distribution, and merely used the "induction-coils" as a convenient means of preventing the interruption of the circuit by the failure of any single lamp. When a petition for prolongation came before the Judicial Committee of the Privy Council in April, 1891, a most curious discovery was made in regard to this patent. It was found that whilst the blue paper covers bore the date May 2, 1877, the face of the specification was dated May 22nd, the consequence being that two communications "On a New Form of Electric Light," made to the Society of Telegraph Engineers on May 9th, by the Acting-Secretary, Mr. W. E. Langdon, and M. L. Denayrouze, of Paris, became instances of prior publication and invalidated the patent. Mr. Moulton, nevertheless, sought to secure a confirmation of the patent under the law of 1877, but to no purpose; the amended petition for confirmation and prolongation being dismissed on May 13, 1891. The importance of the invention with which Jablochkoff's name is chiefly associated lay in its simplicity. When M. Dumas, President of the Académie des Sciences, described the Jablochkoff candle before the Academy, he said: "This discovery involves the suppression of all the mechanism usually employed in ordinary electric lamps." The Serrin and Duboscq lamps, excellent in their way, could not be run in series; but the new candles could be so connected with ease. The English patent is dated, No. 494, February 6, 1877.

To-day Jablochkoff candles have almost disappeared, and arc lamps, with more or less complicated mechanism, are common. Jablochkoff, in fact, succeeded in "subdividing the electric light," that is to say, successfully ran a number of lamps in series. That his candles flickered more than mechanical arc lamps was but a small disadvantage compared with the so-called subdivision. Practical electric lighting may be said to date from the lighting of the Avenue de l'Opéra in May, 1878. In that same month Brush applied for his English patent, No. 2,003; and in October, five months later, began that extraordinary period of inventive activity which, to a large extent, must be considered due to Jablochkoff's success.

MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(*Continued from page 646.*)

Steam.

Steam and Water.—The working substance in the steam engine is either steam or a mixture of steam and water; and its behaviour, under whatever conditions of actual practice it may occur, is the most complex of all working substances used at the present time. Steam is either the vapour of water or a condition of gas produced by superheating that vapour. In this series the term *water* will only be applied to the substance in the liquid state, the term *steam* being applied both to the vapour and to the ultra-vaporous gas, which latter we shall find it convenient to call *gaseous steam.* Our knowledge of the relations between these three substances—water, steam, and gaseous steam—and of their individual relations to thermodynamic quantities, is derived from numerous sources, but principally from the careful and exhaustive series of researches undertaken by Regnault, and published by him in 1847.† Up to the present time this knowledge is very incomplete, and the formulæ expressing these relations are quite empirical. In other words, although we are acquainted with the manner in which the properties of the three substances vary, we are unable to deduce those variations, because we do not know enough about the molecular properties of the substances.

If a mass of cold water is placed in the bottom of a closed vessel fitted with a sliding top, as shown in Fig. 8, so that the whole of the enclosed space is filled with water; and if

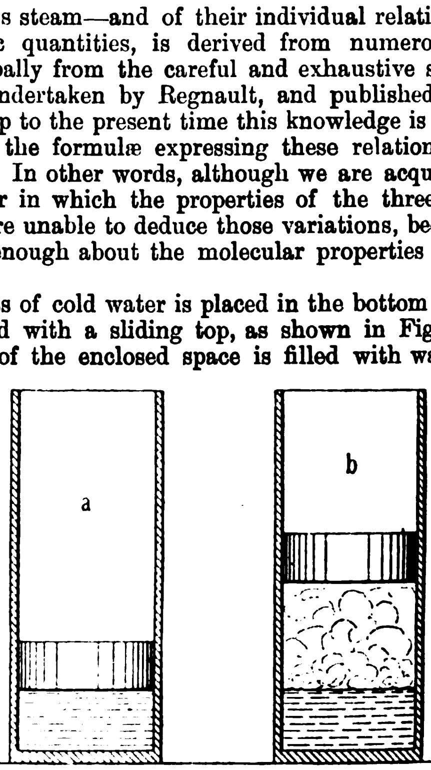

FIG. 8.

the water is now heated continuously, the following phenomena will be observed. We will suppose that it is possible to ascertain the temperature and pressure of the enclosed substance, as well as its volume, at any time. Let the external pressure on commencing be that of the atmosphere; and let the temperature of the water be that of melting ice (32°F.). At first, on the addition of heat, the volume will decrease at a slow rate and the temperature will rise, until 39·1°F. is reached. Then the volume and temperature will both increase as heat is added. Assuming the pressure on the piston to be unvarying, this will go on, and the enclosed space will be found to be always full of water, until a temperature of 212°F. is reached. Heat now added will cause the piston to rise at a much more rapid rate, and it will be seen that the increase of volume is due to the production of vapour between the piston and the surface of the the water. This transition is represented in Fig. 8 by *a* and *b*. It will be observed, however, that the addition of heat, no matter at what rate it may be added to the water, will not cause either an increase in the temperature or in the pressure of the steam, both these quantities remaining stationary till every particle of water has been passed into a state of vapour. The temperature at which this occurs is called the *boiling point of the liquid* or the *saturation point of the vapour*. Steam in this condition is called *saturated steam*. All the water having been evaporated,

* Condensed from a forthcoming work to be published by *The Electrician* Printing and Publishing Company. All rights are reserved.

† *Memoirs de l'Académie des Sciences*, Vol. XXI.; see also *Comptes Rendus*, 1854; *Edinburgh Phil. Jour.*, July, 1849; and *Phil. Mag.*, Dec., 1854.

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it will be found that the addition of heat will cause a rapid rise in both the temperature and the volume of the steam; the rate of change in the relations between pressure, volume and temperature being much more rapid than in a perfect gas. The steam is now said to be *superheated*, and the rise of temperature above the saturation temperature is called the number of degrees of superheat. After a considerable number of degrees of superheat it will be found that the steam behaves according to Charles' law, the volume and absolute temperature varying in simple proportion. In this state, the steam is known as gaseous steam. Steam in which water is held in suspension is called *wet steam*; and saturated steam which is just on the point of rising in temperature on account of all the water having been evaporated is sometimes called *dry saturated steam*.

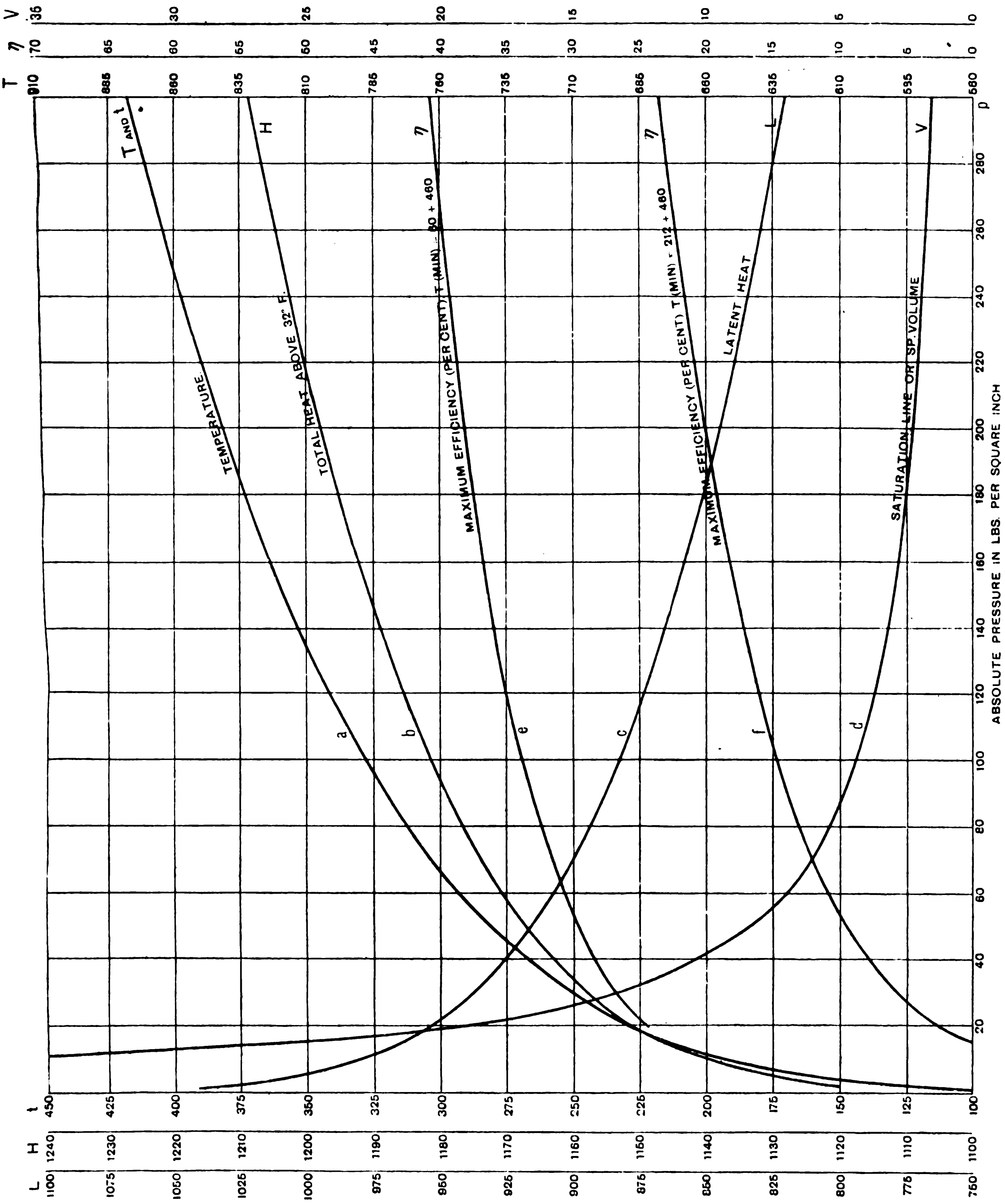

Fig. 9.

Thus far it has been assumed that the water and steam have been kept at constant pressure. Let it now be supposed that the foregoing experiments are repeated several times, during each time with a different pressure, either above or below that of the atmosphere. It will then be found that the general series of phenomena is always repeated, and in exactly the same order; but that the boiling point, or

saturation point, depends in every case upon the pressure; being a single-valved function of that pressure. In other words, for every pressure there is a definite temperature at which steam can exist in the state of saturation or at which there can be thermal equilibrium between steam and water with which it is in contact; this temperature varying with variations of pressure. If saturated steam apart from water, at constant pressure, is heated it will become superheated; if it is cooled it will partially condense; but the temperature and specific volume of the remaining vapour will remain unaltered. If saturated steam in contact with water has its pressure increased or decreased, it will rise or fall in temperature in such a manner that the temperature will always represent the saturation point corresponding to the pressure at the instant.

Properties of Saturated Steam.—As our knowledge of the properties of water and saturated steam is empirical, it will be most convenient to give at first the graphical representations of those properties, and to collect the empirical formulæ afterwards. A general study of these properties is perhaps best made by means of a set of curves such as will be found in Fig. 9. Here there are six independent vertical scales, each relating to the single horizontal scale of pressures. The six vertical scales are marked with index letters at the top and these letters are repeated at the extreme right end of the curves which relate to them. Thus, the curve (*a*) is marked T and *t* at the end, and gives on the scale T the absolute temperature, and on the scale *t* the ordinary temperature on the Fahrenheit scale, of the saturated steam. Similarly, the curve (*b*) gives on the scale H the total heat of 1lb. of the steam, reckoned above 32° F. The total heat is here considered to be the amount of heat required to raised 1lb. of water from water at 32° F. to saturated steam at the given pressure. It is equal to the sum of the latent heat of vaporisation and the sensible heat. The latent heat alone is given on the curve (*c*), as measured on the scale L. Both H and L represent heat in British thermal units per pound of steam. The relation between the pressure and specific volume of saturated steam is shown in curve (*d*), the specific volumes being measured on the scale of volumes, V, in cubic feet per pound of steam. This, the P.V.-curve of saturated steam, is often called the *saturation line.*

A close study of these four curves will reveal more than could be put into several pages of printing, so the author will avoid describing the most evident points of relationship between them, and will rely on the reader making a careful study of the curves. But a few important points must be briefly noticed. Firstly, it will be observed that the two curves (*a*) and (*b*) are sharply convex at the lower pressures, and tend to become almost flat and straight at the higher pressures, thus indicating that while the addition of a large amount of heat, or the production of a large increase of temperature, is necessary to give a definite rise of pressure when the pressure is very small, only a small rise of temperature, or a small increment of heat, will cause the same change of pressure when the pressure is initially high. For example, the difference between steam at 10lb. pressure and that at 20lb. is represented by the addition of 10·6 B.T.U. and a rise of 34·7°F. in temperature, while the difference between steam at 210lb. and that at 220lb. is represented by only 1·2 B.T.U. and 3·9°F. Secondly, of the total heat of the steam a lesser and lesser proportion is due to internal work and to the external work of increased volume, as the pressure rises. This is seen in the latent heat curve. Consequently, the curve of sensible heat—or the difference between the total and latent heats—must at all pressures rise at a greater rate than the curve of total heat.

Limiting Efficiency.—Since work can only be done in a heat engine by a fall in temperature of the working substance, saturated steam can only be made to do work by permitting it to fall in pressure. In a steam engine which works without expansion no working fall of pressure need occur; and in such an engine the work is done, not by the intrinsic energy of the cylinder steam, but by the latent heat of the evaporation of water at the surface of the water in the boiler. This will be evident when it is considered that the intrinsic energy of saturated steam is constant if the pressure is constant, which it is in a non-expansive engine. To perform work actually by the heat energy in a mass of saturated steam, that mass of steam must fall both in temperature and pressure; in other words, it must specifically expand. In ordinary engines the whole mass is made to expand, so that the total volume becomes greater; but it is conceivable that an engine might be constructed in which the specific volume of the steam might increase without any total increase of volume, a portion of the steam condensing to water. This would happen, for example, if the steam worked on a thermo-electric cycle. Now, the limiting or thermodynamic efficiency of the steam engine is determined by the temperatures between which the steam is worked, and therefore by the pressures between which the saturated steam expands, always assuming the steam to remain saturated. Moreover, since the lower temperature of the heat cycle may not be lower than that of the coldest of surrounding bodies—which is usually a supply of cold water—we may say that it is impossible to get a higher efficiency with saturated steam at any pressure than that which is fixed by the saturation point and (say) 60+460 absolute degrees. If we construct a curve which is the locus of these limiting efficiencies, we shall obtain the curve (*e*) in Fig. 9. It has not been thought necessary to plot this curve below 20lb. pressure.

Remembering that the efficiencies given by this curve on the scale, η, are the highest possible efficiencies where a natural temperature below 60°F. cannot be obtained, our first thought on looking at the curve must be that the steam engine is necessarily a very inefficient motor. And, indeed, this is the case, even to a more marked extent than is indicated on this curve. For, besides other sources of loss, it is practically impossible to work the steam down to so low a temperature of exhaust. One thing of importance, however, a cursory examination of the curve will reveal, namely, that it is possible to have a higher efficiency where the steam pressure is high than where it is low. This is the theoretical basis of the use of high pressures in steam working. The curve also shows that, whereas a small rise of pressure will produce a considerable increase in the efficiency where the pressures are low, even a very large rise of pressure will produce only a small increase of efficiency where the pressures are high. On this account, as we shall see more fully later, it does not pay to continue to increase the pressure of the steam beyond a certain point; for the prime cost and other expenses of the steam plant increase very rapidly with the pressure when the pressure is high.

Effect of the Atmosphere.—We have said that it is practically impossible to work a steam cycle down to a temperature of 60°F. There are several reasons for this, depending upon the special conditions in each case; but one of the most important reasons is the prejudicial effect of the atmospheric pressure. If the steam is exhausted from the engine into the air, or if some special means are not taken to prevent the atmospheric pressure being exerted against the moving parts of the engine, the lowest temperature down to which the cycle can be carried is that of steam at atmospheric pressure. For, if the air is allowed to exert its pressure on the exhausting steam, it will be useless to let the steam expand in the engine below the atmospheric pressure. For, if the expansion is carried beyond this point, then, although more energy may be taken from the working steam than would otherwise be the case, there will be a still greater amount of energy expended uselessly in overcoming the air pressure. The result would be a net loss of energy. Re-calculating the values of the limiting efficiencies for different pressures, on the assumption of a minimum temperature of 212+460 absolute degrees, we may plot the results and obtain the curve (*f*), which when read on the scale of efficiencies, η, is seen to be everywhere of lower value than the former curve. Two important facts are brought out by this curve: firstly, that a very considerable improvement of the thermodynamic efficiency of a steam-engine can be produced, at whatever pressure of steam it may be working, by screening the air pressure from the exhaust and working the steam down to the lower temperature which this practice

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may permit; secondly, that the pressure at which the curve of efficiency tends to become flat is a higher pressure in the curve (f) than in the curve (e), or, in other words, that the practical improvement of the efficiency by raising the pressure may be pushed to a further point in the engine with air back-pressure.

(*To be continued.*)

ON CERTAIN NEW PREFIXES PROPOSED FOR PHYSICAL UNIT MAGNITUDES.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

The increasing extent to which scientific unit magnitudes are being used in physical research has received a check by the inconvenient size of some of the fundamental C.-G.-S. units. particularly the dyne and the erg.

In order to lessen this inconvenience we would propose the following additional prefixes, which we have found convenient in our own work.

For example, instead of writing one thousand megergs, we would suggest the term one begerg; and, similarly, for the expression one million megergs, the term tregerg, and for a billion megergs, a quegerg, following the analogy presented by the words million, billion, trillion, and quadrillion.

Again, instead of writing the one-thousandth of a microfarad, we would suggest the use of the term bicrofarad, and also the tricofarad as the millionth of a microfarad where necessary.

The meaning of these suggested prefixes is, therefore, as follows :—

Bega = 1,000 millions, or a billion, or 10^9.
Trega = one million million, or a trillion, or 10^{12}.
Quega = 1,000 trillions, or a quadrillion, or 10^{15}.
Bicro = 1,000 millionth, or 10^{-9}.
Tricro = one trillionth, or 10^{-12}.

The following applications of these prefixes will suggest their advantages :—

From 1 metre = 1·0 metre = 100cms.
and 1mm. = 0·001 metre = 0·1cm.
„ 1 micrometre = 1·0 micron = 0·000001metre = 10^{-6} metre = 10^{-4}cm.
„ 1 bicrometre = 1 bicron = 0·000000001 metre = 10^{-9} metre = 10^{-7}cm.
„ 1 tricrometre = 1 tricron = 0·000000000001 metre = 10^{-12} metre = 10^{-10}cm.

The micron is of the order of the length of a light wave in the ether, and is a fundamental unit of magnitude in microscopy.

The bicron is a magnitude which will be useful in dealing with the mean free path of gaseous molecules according to the kinetic theory of gases.

The tricron is of the order of atomic dimensions according to the estimate of Kelvin.

From 1 megadyne = 10^6 dynes = Approximately the earth's gravitational force on 1 kilogram of matter.
„ 1 begadyne = 10^9 dynes = Roughly the earth's force on 1 ton of matter, *i.e.*, the weight of 1 ton.
„ 1 tregadyne = 10^{12} dynes = Roughly the weight of 1,000 tons.
„ 1 megerg = 10^6 ergs = 0·0737 foot-pound at Greenwich.
„ 1 begerg = 10^9 ergs = 73·7 foot-pounds at Greenwich.
„ 1 tregerg = 10^{12} ergs = 73·730 foot-pounds at Greenwich. = 37 foot-tons approximately.
„ 1 megohm = 10^6 ohms
„ 1 begohm = 10^9 ohms = 1,000 megohms.
„ 1 tregohm = 10^{12} ohms = 1,000,000 megohms.
„ 1 quegohm = 10^{15} ohms = 1,000 tregohms.

A begohm is about the insulation of 1 mile of well-insulated conductor.

A tregohm is about the resistance required to limit the deflection of a high-grade mirror galvanometer under 1 volt to one scale division of 1 millimetre at 1 metre range. Such a galvanometer might be called a *tregohm galvanometer.*

A quegohm is the limiting resistance with 1 volt and unit deflection, of an extremely sensitive mirror galvanometer, which might be termed a *quegohm galvanometer.*

From 1 microfarad = 10^{-6} farad.
„ 1 bicrofarad = 10^{-9} farad or 1/1,000 microfarad.

The C.-G.-S. electromagnetic unit of capacity being 10^9 farads is consequently a begafarad. The use of these prefixes, therefore, assigns a convenient name to the C.-G.-S. unit of capacity, which would otherwise require a special denomination.

From 1 henry = 10^9 cms.
and 1 microhenry = 10^3 cms.
„ 1 bicrohenry = 1 cm.

WATER-TUBE BOILERS.

As a good deal of interest is being taken now in water-tube boilers, we take from the columns of the *Engineer* the following particulars of trials made at the works of Messrs John Barry Ostlere and Co., Limited, Kirkcaldy, N.B., on two Babcock and Wilcox water-tube boilers, one fired by a "Juckes" stoker, the other by a "Bennis" pneumatic stoker.

——	"Juckes" stoker.		"Bennis" stoker.		
Date of test	20/12/'93	21/12/'93	22/12/'93	25/12/'93	26/12/93
Length of test ......hours	9	9	9	9	9
Test conducted by.........	Firm.	Firm.	Bennis.	Firm.	Bennis.
Number of tanks used...	40 { 40 and 40 gals. }		62	62	68
Total water evaporated, gals....................	5035	5073	7803	7803	8558
Class of fuel used	"Chews"	"Chews"	Dross	Dross {	"Chews" broken.
Price of fuel per ton delivered..................	8s. 6d.	8s. 6d.	5s. 6d.	5s. 6d.	8s. 6d.
Total fuel used ......cwt.	68	72	92	98	87
Fuel used per hour .. „	7·5	8	10·2	10·8	9·6
Water evaporated per hour ....gals.	559	563	867	867	950
Water evaporated per lb. of fuel ....lbs.	6·61	6·29	7·57	7·10	8·78
Cost of evaporation per 1,000 gals.	5s. 7d.	6s. 1d.	3s. 2d.	3s. 4d.	4s. 3d.
Extra work by "Bennis" stoker ....per cent.	...	...	53	53	68
Extra economy, fuel „	...	...	14	7	32

The water was measured by means of tanks. Each tank contained 130 gallons, and there was an overflow equal to 282 gallons per 68 tanks.

THREE-WIRE DISTRIBUTION WITH A SINGLE DYNAMO.

The Compagnie de Fives-Lille, says M. Ch. Haubtmann in *L'Electricien*, have recently fitted six 60-H.P. dynamos with a device enabling each one of them to be worked separately on a three-wire circuit; one machine of the kind, coupled direct to a Willans engine, is to be shown at the forthcoming Exhibition at Lyons.

The Fives-Lille device is illustrated purely diagramatically in Fig. 1. The dynamo brushes, B_1 B_2, are connected to the outside leads, L_1 L_2, of the three-wire system, and two diametrically opposite points, a and b, of the armature are connected together through a low-resistance coil D, which possesses, however, considerable self-induction to prevent the short-circuiting of the armature. To the middle point, O, of this coil, the end of the neutral wire, N, is joined. In cases where it is not practicable to rotate the coil D with the armature two diametrically-opposite segments of the commutator are joined up to two collector

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rings keyed to the dynamo shaft, and the ends $a\ b$ of the coil D take the form of collector bars, the neutral wire N being connected up as before to the middle point O.

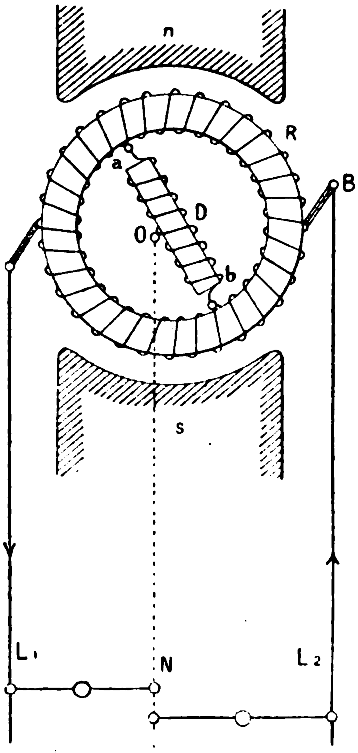

Fig. 1.

This device may also be used in the manner shown in Fig. 2, where the central station is supposed to be some distance from the area of supply, at the commencement of which one or

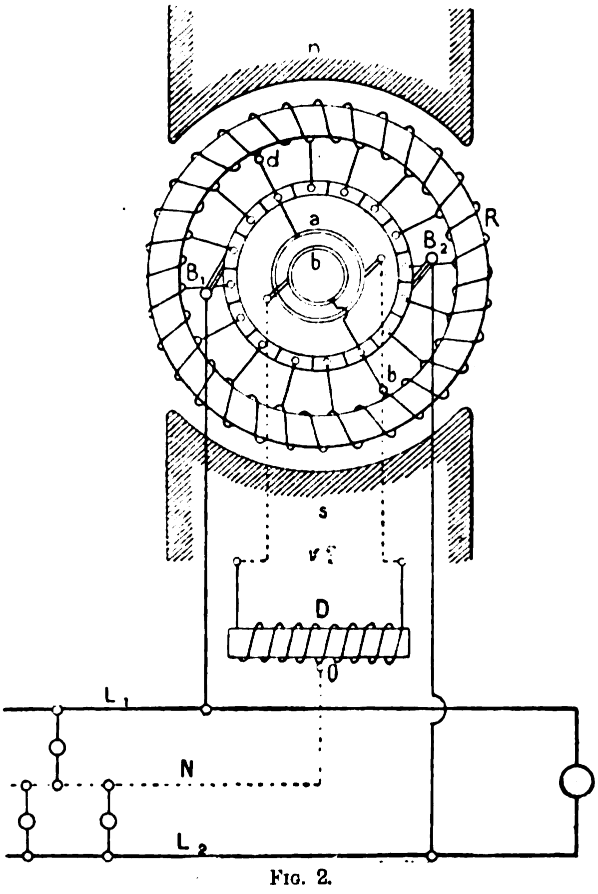

Fig. 2.

more of these "three-wire" equalisers may be joined up. It would seem as if the two sides of a three-wire system would have always to be very carefully balanced to prevent trouble with this device.

MAGNETIC QUALITIES OF IRON.*

BY J. A. EWING, F.R.S., AND MISS HELEN G. KLAASSEN.

(*Continued from page 640.*)

The next sample to be tested (Ring IV.) was of thin sheet iron, which, like the last, had been supplied to form the core of a dynamo armature. This iron, though supplied for a purpose in which magnetic softness is important, did not compare favourably with the thick sheet of Ring III. The ring was built up of 30 flat annuli, which were turned cut of larger punched discs. The thickness of the sheet varied in different discs from 0·044cm. to 0·050cm. The external diameter was 10·9cms. and the internal diameter 8·45cms., and the mean thickness of the sheets was 0·47mm. The discs were insulated from one another with paper. Nine cycles were

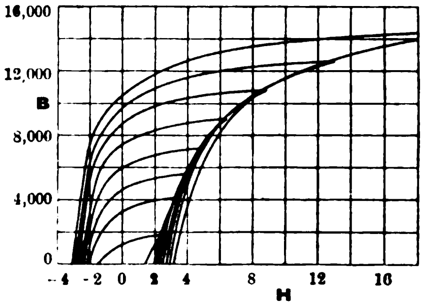

Fig. 11.—Ring IV. Thin Sheet Iron.

measured in the first instance, and then six small cycles, with a larger induction coil and a more sensitive adjustment of the current galvanometer. The results are given graphically in Figs. 11 and 12. The larger cycles, with the exception of the second, are drawn on Fig. 11. Fig. 12 exhibits the small cycles. The induction coil used in measuring the large cycles had 12 turns, but in the small cycles a coil with 195 turns was used to give a large magnification of the ballistic readings, the sensibility of the ballistic galvanometer itself being unchanged. The curves of the small cycles have been determined in this instance with particular minuteness, as a study of the behaviour of the iron under reversals of weak magnetising forces. In the lowest cycle the limits of the magnetising force are so narrow that the condition is approaching that of quasi-elastic magnetisation; there is, however, still a distinct trace of hysteresis.

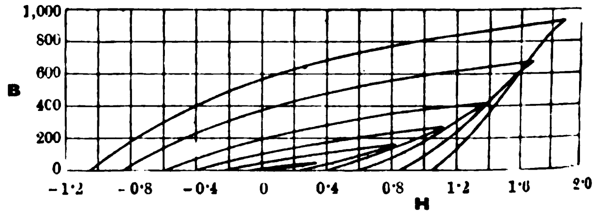

Fig. 12.—Ring IV. Thin Sheet Iron, Small Cycles.

From measurement of the curves of Figs. 11 and 12, the values of $\int H\, dI$ and of the coercive force have been determined, and the results are exhibited, with others, in Fig. 21. A reference to Fig. 12 will show that the overlapping of one cyclic curve by the next lower curve (corresponding to a slightly narrower magnetic range) is characteristic of low cycles as well as of high ones. The loss of energy in reversal (measured by the area enclosed within the curve) becomes very small, both absolutely and relatively to the magnetisation, in the lowest cyles; the molecular movements which constitute magnetisation are there approaching the almost perfect reversibility which, as Lord Rayleigh has shown, is attained when the range of force is still further reduced.

By way of further illustrating the behaviour of this sample under the weak magnetising forces of the small cycles, Fig. 13 has been drawn to show the total induced magnetism, and also the residual magnetism, in each small cycle, both in relation

* Abstract of Paper read before the Royal Society.

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to **H**. The figure forms an interesting example of the early stages of the magnetising process.

The next sample (Ring V.) was also of thin sheet iron. It was sent by Mr. Parker, of the Electric Construction Corporation, as a sample of the iron used in building up the cores of his transformers. This iron is supplied in sheets about 6ft. long and 3ft. wide, and its thickness is 0·367mm. To make the ring, a strip 2in. wide and 6ft. long was cut from the sheet,

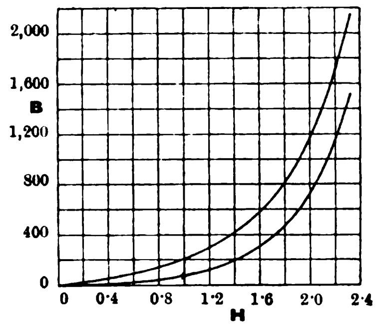


Fig. 13.—Ring IV. Thin Sheet Iron. Induced and Residual Magnetism under Weak Forces. Top Curve, Induced; Lower Curve, Residual Magnetism.

and this was coiled (along with a strip of paper for insulation) into a close spiral of the dimensions shown in the sketch (Fig. 14), the ends of the spiral overlapping one another for a centimetre or so. This is a convenient way of giving sheet metal the ring form suitable for ballistic tests; it is open, however, to the criticism that the bending of the metal is liable to harden it somewhat, especially near both surfaces, and it is possible that this consideration partly explains the comparatively sloping character of the curves (Figs. 15 and 15*a*)

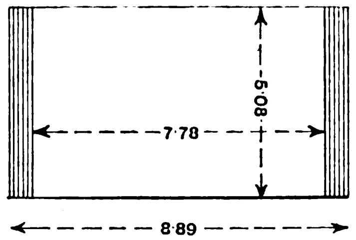
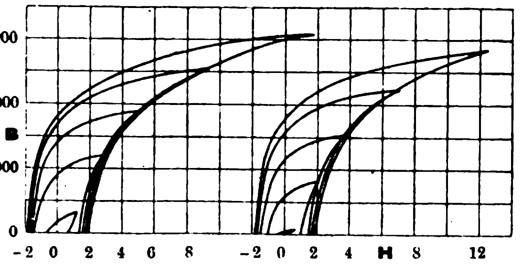


Fig. 14.—Section through Ring V.

obtained with this ring. A similar remark, of course, applies in the case of rings formed by winding soft iron wire.

These cycles are shown in Figs. 15 and 15*a*. Measuring from the curves we have the results, which will also be found in Fig. 21.

The remaining specimens dealt with in this section of our experiments were of iron wire. In Ring No. VI. the core was of fine cotton-covered wire 0·34mm. in diameter, which was kindly supplied to us for the purpose of these experiments by



Figs. 15 and 15a.—Ring V. Soft Sheet Iron.

a leading firm of manufacturers at the instance of Mr. W. H. Preece. It was described as Swedish charcoal iron, but the tests show that it was decidedly hard in the magnetic sense, having a rather high coercive force and other characteristics resembling those of mild steel. Six cycles were measured, with results which are given graphically in Fig. 16.

The next specimen (Ring VII.) was also of cotton-covered iron wire, of larger diameter than the last, namely 0·975mm. It turned out to be only moderately soft in the magnetic sense. In addition to the measurements of magnetic cycles, the results of which are given below, and in Fig. 17 and 17*a*, several other experiments were made with this ring with the view of determining directly the heating effect of magnetic reversals. These will be described in a later part of this Paper. The ring had a mean diameter of 9·6cms., and the net area of section of the iron wire forming its core was 1·00 sq. cm.

For the last sample on our list (Ring VIII.) we are indebted to Mr. James Swinburne, who sent a hank of the soft iron wire used in the cores of his "hedgehog" transformers. The diameter of the wire was 0·602mm., and its surface was bright.

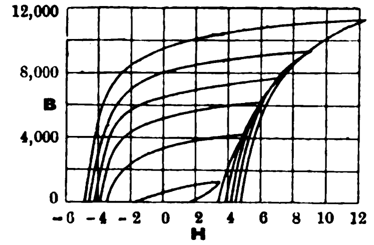
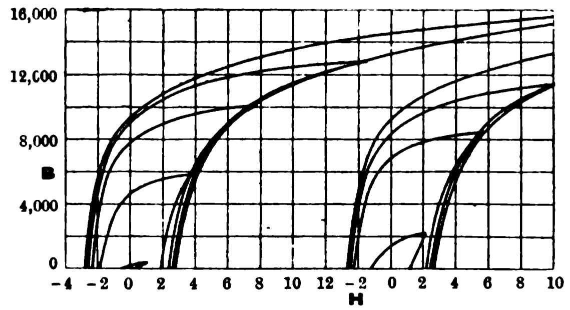


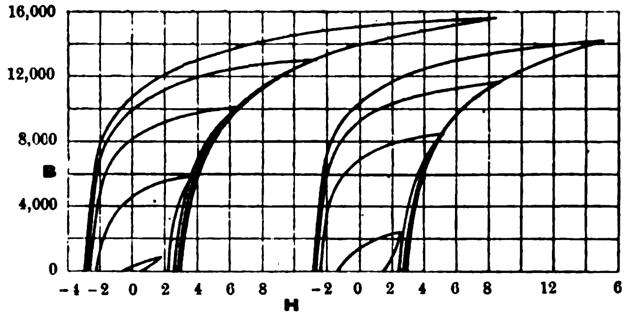
Fig. 16.—Ring VI. Fine Iron Wire.

On winding it into a ring with a mean diameter of 2·75cms., without, in the first instance, taking any steps to secure insulation between neighbouring turns of the bright iron wire, we found that the Foucault currents in the ring were so influential as to make the ballistic tests of it in this condition worthless. In all the previous examples the wire or sheet metal forming the core had been insulated by cotton or paper.



Figs. 17 and 17a.—Ring VII. Iron Wire.

The ring was then soaked in a hot bath of boiled linseed oil, which was allowed to penetrate freely to the core—a treatment which, we believe, is similar to that actually followed in the building of the transformers. It appears that this was effective in preventing the Foucault currents from passing from wire to wire. Tests made with the ring in this state, which we shall distinguish as the first state, are shown in Figs. 18 and 18*a*.



Figs. 18 and 18a.—Ring VIII., *before* Special Annealing.

The fact that the cyclic curves obtained from the metal in this state had somewhat rounded outlines, and gave values of $\int \mathbf{H}\, d\mathbf{l}$, which, though by no means exceptionally great, are greater than those given by the softest iron, led us to suspect that the metal had been slightly hardened, either in the manufacturer's hands, or in our coiling it into a ring for testing. Accordingly, we resolved to make another trial after annealing the wire in the coiled up state. The ring (No. VIII.) was

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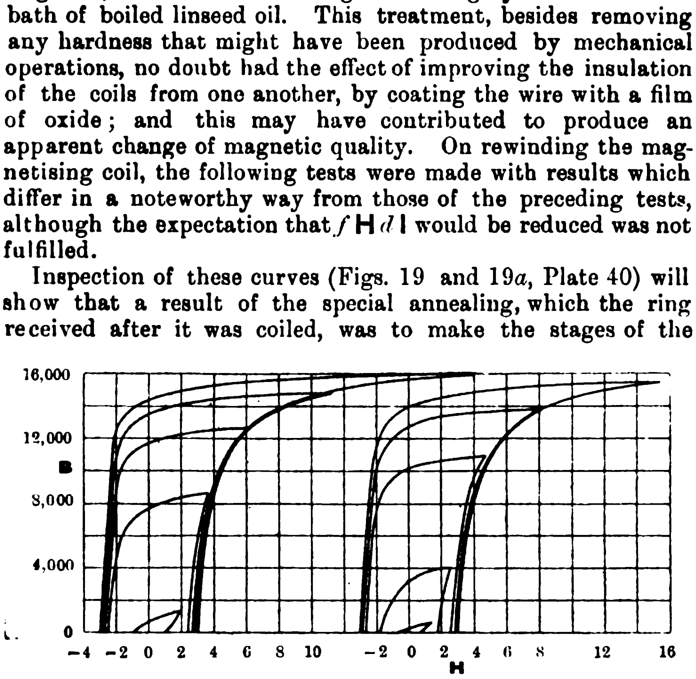
stripped of its magnetising coil, and was heated to redness in a forge-fire, after which it was again thoroughly soaked in a hot bath of boiled linseed oil. This treatment, besides removing any hardness that might have been produced by mechanical operations, no doubt had the effect of improving the insulation of the coils from one another, by coating the wire with a film of oxide; and this may have contributed to produce an apparent change of magnetic quality. On rewinding the magnetising coil, the following tests were made with results which differ in a noteworthy way from those of the preceding tests, although the expectation that $\int \mathrm{H}\, d\, \mathrm{I}$ would be reduced was not fulfilled.

Inspection of these curves (Figs. 19 and 19*a*, Plate 40) will show that a result of the special annealing, which the ring received after it was coiled, was to make the stages of the



FIGS. 19 and 19a.—Ring VIII., *after* Special Annealing.

cyclic process be much more sharply differentiated from one another than they were before. In other words, the curves are now exceedingly square-shouldered. The residual magnetism is high, and the rate of descent when reversal of magnetism is taking place is extremely rapid and uniform. $d\mathrm{B}/d\mathrm{H}$ in the higher cycles is about 13,000 at its maximum, and maintains a value little short of this, while B changes by as much as 20,000.

Fig. 20 has been drawn in further illustration of the magnetic qualities of this ring (Ring VIII. after special annealing). The curves in it show the whole induced magnetism and the residual magnetism (for each cycle) in relation to H. Taking the inclination of a tangent to the former curve drawn through the origin to measure the maximum permeability we find its value to be 2,420.

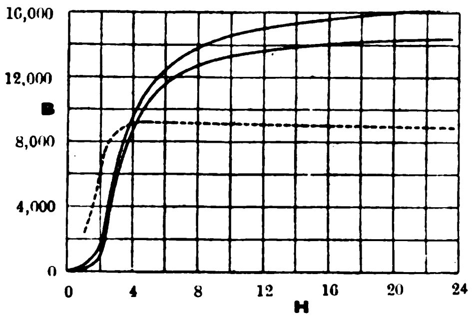


FIG. 20.—Ring VIII., *after* Special Annealing. Top Curve, Induced Magnetism; Second Curve, Residual Magnetism; Dotted Curve, Ratio of Residual to Induced Magnetism.

In the same diagram (Fig. 20) the curve drawn in broken line shows, in relation to H, the ratios of the residual to the induced value of B in each cycle. This curve rises with a rapid, nearly uniform, gradient (from a point to the right of the origin, since a finite amount of magnetising force may be applied without causing the iron to acquire any residual magnetism). It bends over fast when H is about 2·5, passes a maximum which is not sharply defined, and slowly falls as the magnetism is pushed into the region of saturation. Throughout the steep part of the magnetisation curve the difference between the residual and induced magnetisms scarcely increases at all, while B is increasing tenfold. The relation of the residual to the induced magnetism presents, in this and other respects, just those characteristics which the molecular theory (referred to below) would anticipate. In the present instance when the ratio is a maximum the residual induction is 93 per cent. of the induced.

The special annealing had hardly any influence on the value of $\int \mathrm{H}\, d\, \mathrm{I}$ and of the coercive force, notwithstanding its very considerable effect in changing the form of the cyclic curves, and in improving the permeability. The curve from Ring VIII. in Fig. 21 gives the relation of $\int \mathrm{H}\, d\, \mathrm{I}$ to B in this final state. The corresponding curve for the ring in its previous state would, if drawn, be nearly coincident with this one.

For the sake of comparison with these various specimens of iron we add here the values of $\int \mathrm{H}\, d\, \mathrm{I}$ (copied from *Phil. Trans.*, 1885, p. 556) obtained in tests made in Japan of a piece of soft iron wire. The method used in the Japanese tests differed from our present method; the specimen was a single straight piece, long enough to be practically endless, and its

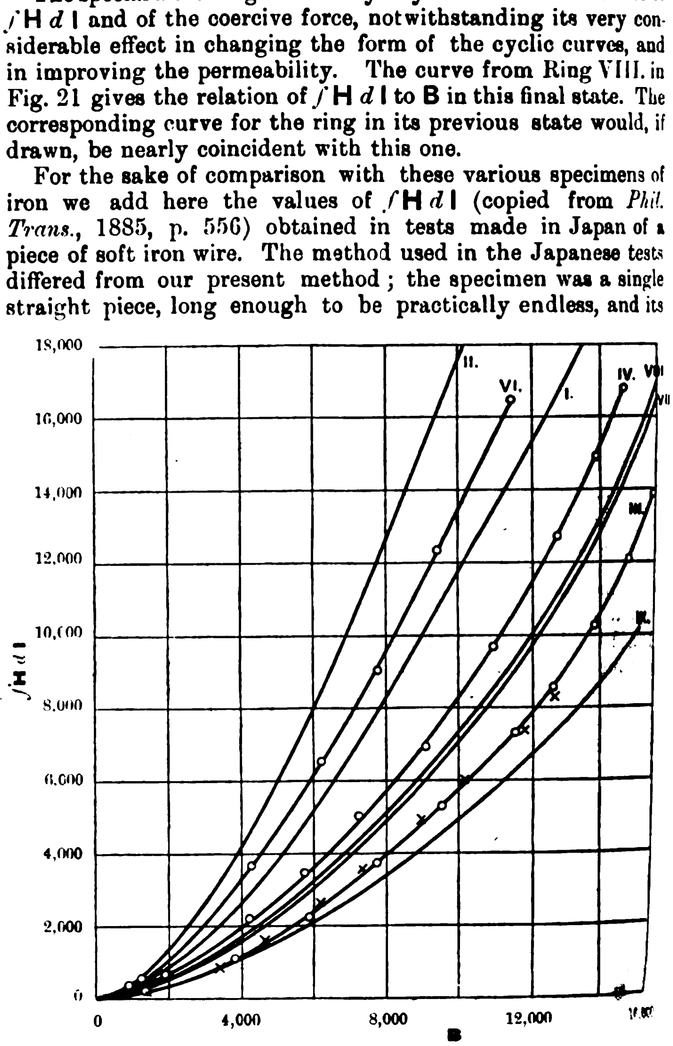


FIG. 21.—Curves of $\int \mathrm{H}\, d\, \mathrm{I}$ and B. Collected Results. The Crosses indicate Readings for Ring V.

magnetism was changed slowly, and was measured by a magnetometer. We have numbered these old tests IX. for convenience of reference.

IX.—*Old Tests made in Japan of a Soft Iron Wire.*

Limits of H.	Limits of B.	Limits of I.	$\int \mathrm{H}\, d\, \mathrm{I}$.
75·2	15560	1230	10040
26·5	13700	1090	8690
7·04	11960	951	6590
6·62	11480	913	6160
4·96	10590	842	5560
3·76	8790	699	3990
3·01	7180	571	2940
2·56	5950	473	2190
1·95	3830	304	1160
1·50	1970	157	410

None of the specimens tested at this time have given so low values of $\int \mathrm{H}\, d\, \mathrm{I}$ for the higher cycles, though the values in Rings III. and V. are practically identical with those in the Japanese iron for cycles in which B is less than 4000. The superior magnetic softness of this wire (No. IX.) was further shown by the fact that its coercive force after strong magnetisation was 1·75, whereas in all the rings now tested the coercive force exceeded 2. At least one other specimen of wire used in the Japanese experiments was as good.

The comparison suggests a doubt whether all that is possible has yet been done by manufacturers of iron to produce a quality specially suitable for such uses as the construction of transformer cores. The conditions of manufacture which secure

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low hysteresis appear to be imperfectly known, or, at least, to be less generally recognised than electricians might wish. It must, however, be admitted that with respect to hysteresis losses under the comparatively low intensities of magnetisation usual in transformers, the sheet iron of Rings III. and V. is very nearly as good as the wire tested in Japan.

This will be apparent from Fig. 21, where the values of $\int H\,dI$ are plotted in relation to B for all the rings, and also for the wire in question (No. IX.). The figure shows in a striking way the extent to which the dissipation of energy in a cyclic magnetising process may vary in different specimens even of soft iron.

To facilitate comparison we also give a Table of Numerical Values of $\int H\,dI$, measured from these curves, for the various specimens of iron.

The values for Ring. V. are nearly the same as for Ring III.

- IX. Very soft iron wire (Japanese tests).
- III. Sheet iron, 1·95mm. thick.
- V. Thin sheet iron, 0·367mm. thick.
- VII. Iron wire, 0·975mm. diameter.
- VIII. Iron wire (of "Hedgehog" transformers), 0·602mm. diameter.
- IV. Thin sheet iron, 0·47mm. thick.
- I. Fine iron wire, 0·2475mm. diameter.
- VI. Fine wire, 0·34mm. diameter. Supplied as Swedish charcoal iron.

Again, Fig. 22 shows the relation of B to H for the various rings. The values of B are the limiting values in the successive cycles, and are measured, as we have already pointed out, after the corresponding magnetic force has been many times reversed. They are consequently rather lower, especially in the early parts of the curve, than those values of B which a first application of H would produce. Comparing the curves of Fig. 22 we see that high maximum permeability does not necessarily imply small hysteresis losses. Ring VIII. with its "square-shouldered" curve has a higher maximum of permeability than any of the other rings, though its hysteresis losses are much greater than those of Rings III. and V. And Rings III. and V. differ decidedly in permeability though their hysteresis losses are as nearly as possible equal. A reference back to Fig. 15 will show that the curves exhibiting magnetic cycles may assume a sloping form, implying comparatively little permeability, and yet enclose but small areas. When iron is spoken of as magnetically soft the implication sometimes is that its permeability is high, sometimes that its hysteresis losses are small. The two characteristics, are, however, in great measure independent. It is interesting to notice also that the easy slope of some of the soft iron curves in Fig. 22 allows them to be crossed by curves for steel, even under moderate magnetising forces. For instance, a force of 13 *c.g.s.* induces more magnetism in the rather hard steel of Ring II. than in the very soft iron of Ring V. A comparison of permeabilities in respect to any such force as this would furnish no criterion of magnetic softness. It may, however, be added that the specimens which are soft in the sense of having small hysteresis losses excel in permeability in the initial stage of the magnetising process. Compare, for instance, the relative permeabilities of the rings when B is say 1000: it will be seen that the order in which they stand in regard to smallness of hysteresis loss, and in regard to permeability, is at this stage the same. If softness is to be judged by the B-H curve it is clear that the early portion of the curve is the best guide.

Values of $\int H\,dI$.

B.	IX.	III.	VII.	VIII.	IV.	I.	VI.
2,000	400	420	530	600	750	930	1,100
3,000	780	800	1,050	1,150	1,350	1,700	2,150
4 000	1,200	1,260	1,670	1,780	2,030	2,600	3,300
5,000	1,680	1,770	2,440	2,640	2,810	3,800	4,700
6,000	2,200	2,370	3,170	3,360	3,700	5,200	6,200
7,000	2,800	3,150	4,020	4,300	4,650	6,600	7,800
8,000	3,430	3,940	5,020	5,300	5,770	8,400	9,500
9,000	4,160	4,800	6,100	6,380	6,970	10,100	11,400
10,000	4,920	5,730	7,200	7,520	8,340	11,800	13,400
11,000	5,800	6,800	8,410	8,750	9,880	13,600	15,600
12,000	6,700	8,000	9,750	10,070	11,550	15,400	
13,000	7,620	9,200	11,200	11,460	13,260	17,300	
14,000	8,620	10,500	12,780	13,100	15,180		
15,000	9,730	12,150	14,600	14,900	17,300		

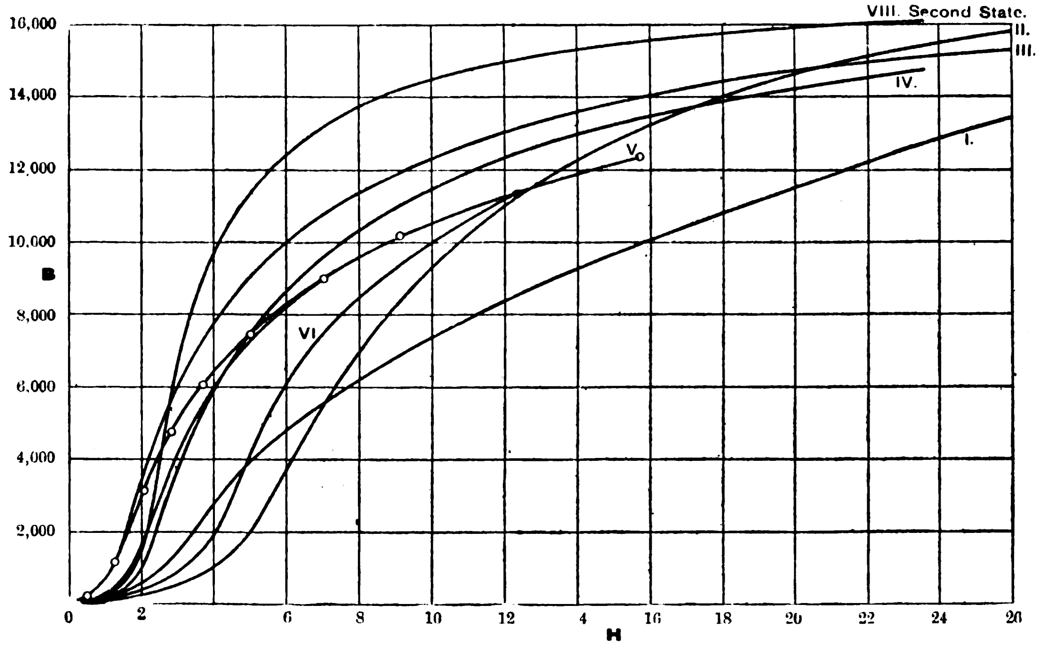

Fig. 22.—Curves of B and H

In a Paper read before the American Institute of Electrical Engineers* on the "Law of Hysteresis," Mr. C. P. Steinmetz has discussed certain experiments on the relation of $\int H\,dI$ to B, and contends that the empirical formula

$$\int H\,dI = \eta\,B^{1\cdot 6},$$

where η is a constant factor, is in good agreement with the results of experiment. From the figures Mr. Steinmetz gives, and from those which our own experiments supply, it appears that within a certain range of values of B this formula may be taken as giving a fairly close approximation to the real value of $\int H\,dI$. As an empirical formula of the kind is of use to designers of transformers, we have been at some pains to examine how nearly and within what range a formula of this type may be taken to represent the facts. It will suffice to refer to one example in some detail.

Taking Ring IV. (thin sheet iron) for which we have a

* *Transactions* of the Institute, January 19, 1892, vol. 9, p. 3.

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numerous and very consistent series of determination of $\int H\,dl$, extending from $B = 43$ to $B = 14{,}720$, we have tested the constancy of the index ϵ in the formula

$$\int H\,dl = \eta B^{\epsilon}$$

by plotting log B in relation to log $\int H\,dl$.

From $B = 2{,}000$ to $B = 8{,}000$, the curve obtained in this way is a good straight line giving the value 1·475 for the index ϵ, and 0·01 for η. When B is about 8,000 the inclination of the line changes, and from $B = 8{,}000$ to $B = 14{,}000$ we again obtain very nearly a straight line giving $\epsilon = 1{\cdot}70$ and $\eta = 0{\cdot}00134$.

Again, the measurements obtained from the small-cycle tests of Ring IV., show that from $B = 200$ to $B = 500$ the curve of log B and log $\int H\,dl$ is very closely a straight line, giving $\epsilon = 1{\cdot}9$.

Where B is above 500 the gradient of the line gradually changes. Taking the region from $B = 500$ to $B = 1000$ the value of ϵ is 1·68, while from $B = 1000$ to $B = 2000$ it is 1·55.

From these results it is clear that no formula of the type under consideration, with a constant index ϵ, will serve to represent the results within anything like the limits of experimental accuracy. The index begins by being 2 or nearly 2 (a result which follows also from Lord Rayleigh's experiments*): in the ring referred to, this decreases to about 1·47 in the region of high permeability, and then increases again to 1·7 when the "wendepunct" is passed. The changes in the index, indeed, correspond to the passage from one to another of the familiar successive stages in the process of magnetisation: comparatively high values of the index are found first in the initial stage of low permeability, and again in the stage of strong magnetisation when the permeability is reduced by the approach towards saturation, while in the intermediate stage where the curve of B and H is steep the index is decidedly low. The well-marked changes of gradient curve which characterise the magnetising are accompanied by scarcely less well-defined changes on the part of the index ϵ and the factor η, in the empirical formula devised by Mr. Steinmetz.

While, therefore, a formula of this type cannot be admitted to have any physical significance, it may still be serviceable in giving rough approximations for the purposes of the electrical engineer. Though the formula is by no means to be accepted as an equation to the actual curve of $\int H\,dl$ and B, the curve which it gives by a suitable choice of index ϵ and factor η lies fairly close to the actual curve, intersecting it at an intermediate point as well as at two extremes. And it is the case that an index of 1·6, or a number approximating to that, gives a curve lying generally in the neighbourhood of the true curve throughout the range of B which is of most practical importance. In the case of our Ring IV., for instance, the formula

$$\int H\,dl = 0{\cdot}0034\,B^{1{\cdot}6}$$

give values of $\int H\,dl$ which are nowhere (within the range of these experiments) so grossly divergent from the truth as to unfit them for use in calculations connected with transformer design. Thus we have:—

B.	Actual value of $\int H\,dl$.	Value calculated from the above formula.
150	7	10·3
300	31	31
500	80	71
1,000	256	215
2,000	750	650
4,000	2,030	1,970
6,000	3,700	3,780
8,000	5,820	5,930
10,000	8,340	8,540
12,000	11,550	11,430
14,000	15,200	14,630

The divergence is becoming considerable at the top of the range, but elsewhere the agreement is fair. It should, however, be observed that if we wish to make the curve given by the empirical formula coincide with the real curve throughout any short part of its range, other, and often very different values must be given to ϵ and η. Thus, if the part from $B = 2{,}000$ to $B = 8{,}000$ only is considered—a part which includes those values of B which are usual in transformer cores—the formula

$$\int H\,dl = 0{\cdot}01\,B^{1{\cdot}475}$$

will express the results very much more closely. For example:—

B.	Actual value of $\int H\,dl$.	Value calculated from the expression 0·01 $B^{1{\cdot}475}$.
2,000	750	740
3,000	1,350	1,345
4,000	2,030	2,060
5,000	2,820	2,860
6,000	3,700	3,740
7,000	4,650	4,690
8,000	5,800	5,720

Throughout this not inconsiderable range of magnetisation (the region, namely, of high permeability) the agreement is good, but other empirical constants are required to fit the earlier, and again the later parts of the curve.

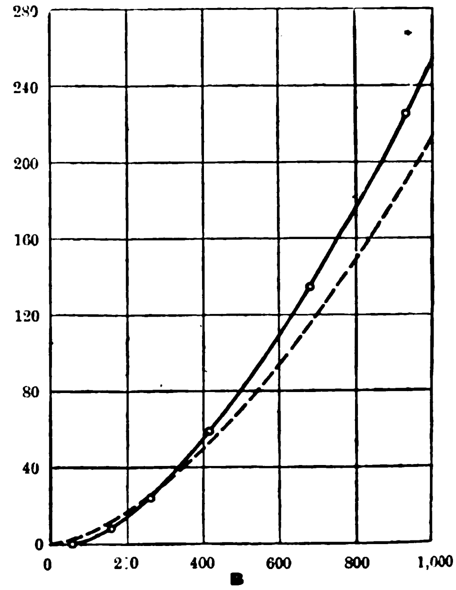

FIG. 23.—$\int H\,dl$ and B for the Low Cycles of Ring IV. The dotted line represents values of 0·0034 $B^{1{\cdot}6}$.

In further illustration of the point, we add a curve (Fig. 23), showing the actual values of $\int H\,dl$ in relation to B for the low cycles in the tests of Ring IV., and on the same diagram a dotted line is drawn, to show the value found for Mr. Steinmetz's formula, namely, $\eta B^{1{\cdot}6}$, the constant η being taken as 0·0034, since that value best accords with the tests of Ring IV. throughout the whole range of magnetisation. It will be evident from the diagram that this early portion of the curve is not even approximately expressed by the formula in question. The character and extent of the divergence is, perhaps, more obvious from inspection of the curve, than from comparison of the numbers which have been given above.

(To be continued.)

* *Phil. Mag.*, March 1887.

POWER TRANSMISSION BY MEANS OF HIGH-PRESSURE DIRECT CURRENTS.*

BY E. SCHULZ.

There are cases in which the use of series machines has distinct advantages over the employment of compound dynamos and shunt-wound motors, these residing chiefly in the fact that when used with high pressure the windings of the magnets have only to resist a small proportion of the total voltage instead of the whole; and

* Abstract from an article in *Elektrotechnische Zeitschrift*, March 8, 1894, p. 137.

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in the case of shunt coils the danger of breakdown is intensified by the highly inductive nature of the windings. Other advantages of series machines are a more constant efficiency with varying load, greater torque, and a fixed position of the brushes. The author describes a few applications of the series machine, chiefly in cases when it is a question of one motor at the receiving end; he finds that practice confirms the theory. After calling attention to the transmission, at Frankfort, in 1891, of 20 H.P. at 1,300 volts from the Palmen Garten to the Exhibition, which was done by series machines, he goes on to a transmission plant at Geisa, in Thüringen. In this case a cork factory, five kilometres from the station (Hünfeld), finding that coal was doubled in price by the cartage, owing to the mountainous country, determined to utilise a disused mill-stream in its neighbourhood to supply the power required—some 20 H.P. A turbine by Briegleb Hausen and Co., of Gotha, regulated by hand, drives by bevel gearing a horizontal shaft, which in its turn drives the dynamo, giving 650 volts and 32 amperes at 700 revolutions, and taking at full load 32 H.P. The dynamo is four polar, series wound, and for regulating the speed of the motor has a rheostat in parallel with its fields. On the switchboard is also a safety device, consisting of an automatic short-circuiter for the fields, and no fuses are required. The line goes in a large arc of a circle up the mountain to the factory about 1,000 yards away; it is of bare copper wire 5mm. in diameter, and is carried on poles and telephonic porcelain insulators, being protected by lightning conductors; a third wire, of iron, is used for signalling purposes. The motor is wound for 600 volts and 24 H.P. at 650 revolutions per minute, and drives by shafting the whole factory. The starting is excessively simple; it consists merely in closing all the switches, and then starting the turbine, when dynamo and motor both start up gradually; the speed of the latter is very uniform. The loss in volts is 50, and the efficiency is 75 per cent. from the shaft of the dynamo to that of the motor, as was guaranteed; and the installation has been working since November, 1892, without a hitch.

A second case is that of a factory in Chemnitz, where some 200,000 gallons of water a day are used for dyeing purposes, and this is raised by a pump worked by a motor to the factory 80ft. above the pumping station, and about a quarter of a mile away. This factory supplies the power from its main countershaft to a series dynamo running at 1,000 revolutions, and giving 30 amperes at 300 volts, and taking 14 H.P. The safety arrangements and regulating apparatus are similar to those at Geisa. The switch of the motor at the pumping station is practically always on, and when water is required the dynamo is started, and the motor immediately follows its motion. This installation has run 20 hours a day since its erection in December, 1892. A similar case is to be found in the dye works of Herr O. Sattler, in Meerane, Saxony, where, however, the power required is very small, only about 3 H.P., but the distance is over a mile.

A very interesting example is in the brass foundry at Rodewisch. A 55-H.P. turbine drives a 53-H.P. series dynamo, by shafting and belts, providing at 600 revolutions per minute 70 amperes at 500 volts; this current is carried by bare copper wires 10mm. in diameter, through a distance of one kilometre to the receiving station, where the series motor, running at the same speed as the dynamo and giving 41 H.P., drives by ropes a counter shaft. A mechanical coupling enables a steam engine of 80 H.P., which drives other machinery, to be also geared to this shafting, so that the engine and the motor run in parallel; and this arrangement is perfectly successful. It cannot be done with a shunt motor, which is too sensitive, and either takes all the load, or none, and then reacts on its dynamo. The compound motor works better, but the starting is difficult. Series motors have the advantage that when running in one direction they cannot reverse the current and drive their dynamo. The motor and the engine work in parallel 11 hours a day, and the motor works alone for 12 hours; and there has been no hitch since the start in September, 1893. At starting the motor was loaded up to 80 H.P. by cutting off the steam of the engine; the motor drove all the machinery and no sparking was visible, the advantage of a fixed position of the brushes being very evident.

LEGAL INTELLIGENCE.

Thompson v. Cowles Syndicate Company (Limited).

In the Court of Appeal on Tuesday, before the Master of the Rolls and Lord Justices A. L. Smith and Davey, the hearing was commenced of an appeal from the judgment in this case delivered by Baron Pollock on November 14th last. (See *The Electrician*, November 17, 1893, p. 73).

Mr. FLETCHER MOULTON, Q.C., said the plaintiff (Mr. Thompson) sued the defendant Company for the price of certain carbons sold by him to them. The case was heard before Baron Pollock, who found for the defendants, and he (Mr. Moulton) now appealed from that decision. There was originally in the pleadings a counter-claim, which was abandoned at the hearing, so that the only question before their lordships was whether the plaintiff was entitled to recover the price of the carbons, the defence being that the carbons were not good carbons. There would be two questions in the case, one as to what the contract was, that is, what liabilities it carried with it, and, secondly, as to whether the alleged breach was proved. The carbons were used in the process of electrically obtaining aluminium. The carbon rods were tied together in bundles, and used as conductors to convey the current into the bath and to convey it out again. It seemed to him most important that their Lordships should see the way the contract was made, in order to get at an understanding of what it was they really undertook to furnish. They (the plaintiff's side) said what they furnished were perfectly good. There was no question about their being anything but pure carbons, and there was no warranty of any kind. They were delivered, and the defendants worked with them, but they found that they gave them some trouble, so they did not continue to purchase them, and refused to pay for those which they had purchased.

The MASTER of the ROLLS: What did the judge hold?

Mr. MOULTON: That there was no warranty; but it seems to me that he also held that the purpose to which they were to be applied was a known purpose, and that they must be commercially fit for that, and then he held, I think by mistaking the evidence, that we sent something which was not that which we were supplying to other people for the purpose. We sent them a sample, quoted for carbons according to that sample, and sent carbons exactly like that sample. That is not contested. We sent carbons similar to those supplied to a firm doing the same thing for five years. I submit that the alleged failure was not a failure due to any defect of the carbon at all.

The MASTER of the ROLLS: What did the judge find?

Mr. MOULTON: He found that these were not suitable carbons for use in the aluminium process. Continuing, Mr. Moulton read the correspondence between the parties, showing that an offer was made and sample sent in 1891; attention was re-directed to this quotation in May of the following year, and an order was ultimately given.

The MASTER of the ROLLS, quoting a phrase in one of the letters, "of similar make to sample forwarded," said that did not constitute sale by sample.

Mr. MOULTON thought it was something very near it. Resuming his argument Mr. Moulton said he would pass on from his first point to the performance of the order. The plaintiff was the agent for a French manufacturer, M. Berne, to whom the order was passed on. That gentleman wrote saying that 3,000 kilos of carbon would be sent off in two qualities, so that the Cowles Company might make tests and choose which they preferred, and then the remaining 7,000 kilos to complete the order would be sent in accordance with their selection. That letter expressed the intention of M. Berne at the time of writing; but, as a matter of fact, only one quality of carbon was sent, and that was the same quality as the sample, and the same as that which had been supplied to the Swiss Aluminium Reduction Company in large quantities. He could not see why so much importance was attached to this letter. It was not as if one quality was to be cheaper than the other, or in any way different from the other, except that one might suit the particular mode of working of a customer better than another. As a matter of fact, however, that intention was not carried out, as would be seen from M. Berne's evidence. Now he came to the complaint against these carbons. From January, 1892, the defendants had been using certain carbons supplied by an American firm, who had, he believed, set up their own plant, and they had had an American expert over, who had arranged the plant and taught them their business, and told them exactly what current to send through these American carbons. He thought it was 141 amperes that was sent through each carbon. They had never had any experience of anything but these American carbons, which were very hard and metallic in ring. It was said that the American carbons remained black above the bath, whilst when the plaintiff's carbons were used they got red-hot, and wasting set in. They took the plaintiff's carbons, and used them with the same current as they had been using for the American carbons, making no experiments to find what was the proper composition of the bath or what was the proper current to send through them. They just did the same as they had done with the American carbons. What happened was this: Plaintiff's carbons got tremendously hot, so hot that they wasted away, because the air attacked them. They carried out the process in an open cistern, instead of covering in the cistern to exclude the air, and so prevent the wasting. The defendants said, "What your carbons did not do the American carbons did, and therefore yours are bad, and the Americans are good."

The MASTER of the ROLLS: Were yours cheaper than the American?

Mr. MOULTON believed they were a little dearer. Plaintiff replied, "It does not follow at all that ours were worse carbons than the American." There were only about four people in the world who did this difficult process, so that there was no "ordinary method" in the usual sense, and the best way of using particular carbons could only be determined by experiment. The plaintiff's contention was that they must have had the bath a great deal hotter when his carbons were used than when the American carbons were used; they must have done so from the very fact that in one case the carbons remained black, whereas in the other they got red-hot, for they had ascertained that their carbons were quite capable of taking a current of 142 amperes, and to have been used without getting even too hot to hold in the hand. Therefore, the failure was from no fault of the carbons. It might, indeed, be because the carbons were too good.

Lord JUSTICE DAVEY: You say they ought to have used a current adapted to the particular carbon; that they ought to have found out what was the right current for that particular kind of carbon?

Mr. MOULTON: That is my point, my lord.

Lord JUSTICE A. L. SMITH: You must admit there was the bargain to supply carbons for smelting.

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Mr. MOULTON: Carbon electrodes, I quite agree. But these are only big sticks of well-made carbon. You may use them in any way you like. They are sometimes used for the Cowles process.

The MASTER of the ROLLS: You must have known the particular purpose for which they were required.

Mr. MOULTON: We did, so much so that these were the things which we used to supply to the Swiss Company for the same purpose.

The MASTER of the ROLLS: It seems to me that you did not warrant at all that they should answer a particular purpose, but you did that they should be a merchantable article.

Mr. MOULTON: Certainly.

The MASTER of the ROLLS: The judge seems to have put you in the most favourable position as regards the contract, but to have found that you supplied articles which were not merchantable.

Mr. MOULTON: That they are merchantable carbon rods for use as electrodes in smelting there is no doubt. The only evidence of inferiority, and the only evidence at all of their not being merchantable, is the failure, without previous experiment of any kind.

The Court then rose for the day.

WEDNESDAY, APRIL 11TH.

When the Court resumed on Wednesday morning, after a consultation between the parties, Mr. Moulton said Mr. Bousfield and himself had considered the matter, and had arranged a settlement. The appeal would therefore be withdrawn.

Meux's Brewery Company v. City of London Electric Lighting Company; and Shelfer v. City of London Electric Lighting Company.

This was an action, the hearing of which was commenced before Mr. Justice Kekewich yesterday, for an injunction against the defendant Company to restrain them from so running their central electric lighting station at Bankside as to be a nuisance and a danger, and £10,000 damages were claimed.

Mr. Warmington, Q.C., Mr. Badcock, and Mr. Waight represented the plaintiffs, and for the defendants Mr. J. Fletcher Moulton, Q.C., Mr. Renshaw, Q.C., and Mr. Braithwaite appeared.

Mr. WARMINGTON, in opening, stated that the plaintiff's premises, the Waterman's Arms, Bankside, adjoined the electric lighting station of the defendant company, and since the works of the latter had commenced, the noise and vibration had become almost intolerable, whilst fissures had been developed in the walls of the house to such an extent that it was possible to push a stick or foot-rule right through the wall.

Mr. SEWELL, a surveyor, produced plans of the premises, and described his observations upon the occasion of several visits. On the 23rd of October, 1893, he first visited the plaintiff's house. On approaching it, walking along Bankside, he heard a considerable humming and thumping noise coming from the defendants' works, and felt an accompanying vibration. On the first floor of the Waterman's Arms the windows were rattling very much, and in the south-west angle (that nearest the defendant company's premises) there was a crack having the appearance of newness. This crack extended nearly the whole height of the room, was from a quarter to a half-an-inch in width, and went right through the wall. There was also a crack in the ceiling. In the room on the floor above there was a continuance of the crack in the wall, but it was wider, being over an inch in width. This also extended right through the thickness of the wall, eighteen inches, and he could push his foot-rule through. In this room the roof and the party-wall had parted company, and he could see daylight through the ceiling. The cracks on this floor also appeared to be new. He made a second inspection a few days later in company with Mr. Chatfeild Clarke, the defendant Company's surveyor. This was about half-past four in the afternoon, and although the vibration and noise were still distinguishable, they were not so pronounced as upon the previous occasion. He had gone to the house several times since, and found that the cracks had all spread and opened more. As the result of tests he had made, he was able to say that the vibration and noise were greater when the engines nearest the plaintiff's premises were running, and greatest when a number were running, but at different rates of speed—when they were not in step. He attributed the cracks, in the first place, to the fact that the defendants' pumping water out and making the foundations for their new premises caused Sir William Rose's house, which was on the other side of plaintiff's premises, to settle considerably towards the west side, pulling over the west wall of the plaintiff's premises, which were tied to it. The increase in the extent of the cracks was caused by the vibration consequent on the working of the defendants' engines. There were indications in the plaintiff's house of an original settlement towards the east, and the effect of the operations of the defendant Company had been to pull the west wall over in the reverse direction, and, therefore, to cause and increase the fissures.

When the Court rose for the day it was agreed that the cross-examination of the witness should be taken on Tuesday next, April 17th.

Parker v. London Metallurgical Company (Limited).

Mr. Justice Williams, in the High Court of Justice on Wednesday, gave judgment upon a summons issued by Mr. Thomas Parker for an order that his name might be struck off the list of contributories.

His LORDSHIP said that the applicant was not the allottee of the shares, but merely the transferee of Mr. Tremenheere, and the question was whether the latter had paid for the shares in cash. In order to constitute payment in cash, as distinguished from accord and satisfaction, it was necessary that there should be two debts payable *in presenti*, and that the Company and the person taking the shares should agree that an equal amount of the one debt should be taken in discharge of an equal amount of the other debt. When Mr. Tremenheere took his 100 shares there was a debt of £1,000 due from him to the Company. At the same time he was a creditor of the Company in respect of a loan of £1,000. That loan was to run for twelve months, unless he elected to take the shares set apart for him; in case he did so elect, the loan was to become immediately repayable, and he was then to be entitled to extinguish the £1,000 debt on the shares by setting against it the £1,000 due by the exercise of his option on the loan. He did exercise this option, and the Company thereupon credited him with the amount due on the shares and themselves with the payment of the loan. This transaction amounted to an immediate payment, and was not a mere contract as to something that was to be done *in futuro*. Mr. Parker, as transferee of Mr. Tremenheere, was therefore entitled to have his name removed from the register.

Chadwick v. the Woking Electric Supply Company (Limited).

A motion for judgment in a debenture-holder's action was made before Mr. Justice Stirling on Saturday last. The Company had issued 60 debentures of £50 each, and six of £500 each, and there had been default in payment of the interest. The principal thereupon became due and payable. Counsel explained that the receiver appointed in the action had entered into a provisional contract with certain persons for the sale of the whole business as a going concern, and, under these circumstances, his Lordship made an order for the usual account of the amounts due on the debentures, and an inquiry as to priority, with liberty to apply in Chambers as to the realisation of the property.

CORRESPONDENCE.

"IRON TESTING."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In answer to the letter in your issue of March 23rd from the Manchester Edison-Swan Company (Limited), as to our method of testing iron, we may say that we ascertain that the induction is equal in both cores by observing whether the voltage across the terminals of each coil is the same. It, indeed, is obvious that with iron cores of medium permeability that practically the whole magnetic resistance lies in the air gap, hence, with similar cores of iron the inductions are necessarily equal; however, this is practically verified as follows:—

The two coils are in series, and, therefore, have the same current, and, as the resistance of the coils is small, the voltage being equal, shows that the inductions are equal, or rather that the total number of lines is the same, and as the cores have the same cross-section, the inductions are equal.

It seems obvious that, since the total number of lines passing through a coil of small resistance is proportional to the E.M.F. on the coil, by varying the cross-section of the core the induction can be varied, and that this is correct is shown by the rate of increase of temperature varying with the cross-section of the core.—Yours, &c.,

Heaton Works, Newcastle. C. A. PARSONS AND CO.

THE HERMITE PROCESS AT WORTHING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to Dr. Kelly's report on the above, which you noticed in your last issue, permit us to point out that in our opinion the samples submitted to Drs. Klein and Dupre were not fair samples of the treated sewage, and that our view was supported by several members of the Worthing Town Council at their meeting last Tuesday. As a consequence of this feeling, the Council decided to consider the report as confidential, and not to adopt it or print it until it was confirmed by the investigations now being undertaken by the British Institute of Preventive Medicine. Unfortunately, Dr. Kelly had, on his own responsibility, allowed a large number of copies of the report to be distributed throughout the country. As you have given publicity to the report, we rely on your sense of fairness to give equal publicity to our protest.—Yours, &c., PATERSON AND COOPER.

European Works, Pownall-road,
Dalston, London, N.E., April 9, 1894.

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AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *March* 30, 1894.

Telephone Matters.—The expiration of the Bell telephone patent has been followed by the creation of numerous companies for the establishment of telephone exchanges in rivalry with those of the licensees of the Bell Company, but thus far little or no headway has been made. This is as might have been expected, for aside from the difficulty of now successfully competing with the established exchanges is the continued monopoly by the Bell Company licensees through the Berliner patent of all forms of transmitters, and of all the fundamental switchboard patents. There is no immediate prospect of the trial of the Government suit of some years standing against the Bell Company to annul its transmitter patent for fraud and collusion. The Bate Refrigerator case, also affecting valuable telephone patents, has been argued, and is now in the hands of the judges for decision. Owing to the important character of this case, however, it is thought that the Court of Appeals may certify it to the Supreme Court for a decision that will be thus final.

Education of Electrical Engineers.—An examination of the registers of various colleges and technical schools in the United States shows that there are now about 1,500 students in the different courses of electrical engineering, and the numbers in the several classes also show that the attendance is rapidly increasing. Great stress seems to be laid upon the design of electrical apparatus, although the graduates of the present year would probably be sufficient to provide a dozen designers for each position of the kind in the entire country—all of which it is needless to say, are now filled. In addition, owing to the great reductions in the technical staffs of all the electrical companies during the last year, which reductions will in most cases be permanent, there are now several scores of electrical engineers of experience and proven competency to draw on to fill vacancies in the remunerative positions as they occur, thus still further narrowing the chances of graduates at the present time. It is unnecessary to explain that this state of affairs is largely or entirely due to the popular delusion that "electricity is only in its infancy."

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.—The Corporation of Leeds having become owners of the tramways throughout the city, invite tenders for working the same under conditions which are partly set out in an advertisement appearing elsewhere, and of which conditions of letting, &c., may be obtained on application to Mr. John Harrison, town clerk, Town Hall, Leeds. Tenders have to be in not later than May 5th.

——— The Southampton Harbour Board require tenders for the work comprised in the lighting by electricity of the Town Quay, Southampton. Particulars can be obtained of the engineer, Mr. J. G. W. Aldridge, 9, Victoria-street, London, S.W.; and of 23, High-street, Southampton. Tenders have to be delivered to Mr. A. H. Skelton, clerk, the Harbour Board offices, the Town Quay, Southampton, not later than May 8th. Further particulars will be found in our advertisement columns.

——— The Council of the Borough of Brighton invite tenders for the supply and erection of Willans engines, continuous current dynamos, pipe work, spare armatures, &c. Further particulars are given in our advertisement columns, and all information can be obtained of Mr. F. J. Tillstone, Town Clerk, at the Town Hall, Brighton. Tenders have to be in by 10 a.m. on the 30th inst.

——— Messrs. C. H. Glover and Company, timber merchants, of Ormside-street, Old Kent-road, invite tenders for an electric jib wharf crane. Particulars will be found in our advertisement columns.

——— The Visitors of North Wales Counties Lunatic Asylum invite tenders for the construction and maintenance for a period of five years of a telephone between the asylum and Glanywern Hall, a distance of about three miles. Particulars of Mr. Barker, clerk to the Visitors, Denbigh.

TENDER INVITED.—*Extension of Time.*—The Edinburgh Corporation have extended the time for sending in tenders for the erection of the buildings, &c., on the central electric lighting station at Torphichen-street. Tenders must now be in not later than 10 a.m. on Tuesday next.

TENDERS ACCEPTED.—The Edinburgh Corporation have accepted tenders for the supply of cables in connection with their electric lighting scheme from W. T. Henley's Telegraph Works Company (unarmoured cables), the India Rubber Company (arc lighting cables), Messrs. Siemens Brothers and Co. (armoured cables).

PLANT FOR SALE.—Our advertisement columns contain particulars of an extensive plant for disposal, consisting of Marshall boilers, Armington-Sims engines, E.P.S. cells, &c., which is all in excellent condition, and of which particulars and cards to view can be obtained from Mr. H. Cuthbert Hall, A.I.E.E., 46, Queen Victoria-street, E.C., who will receive orders for the plant up to April 30th.

APPOINTMENTS.—Mr. Edgar Mapple has been appointed resident working electrical engineer to the Blackpool Corporation at a salary of £117 per annum.

——— Lieutenant A. H. Dumaresq has been appointed assistant instructor in electricity at the School of Military Engineering, Plymouth, *vice* Captain A. M. Stuart.

——— Mr. Harold W. Couzens has been appointed Engineer-in-Charge at the Corporation Electric Light Works, at a salary of £120 per annum.

——— Mr. A. J. Lawson, M.Inst.E.E., has been appointed Engineer and Manager of the County of London and Brush Provincial Electric Lighting Company (Limited).

LIQUIDATIONS.—The Official Receiver and Liquidator of Newington, Priddle and Co. (Limited) has called a meeting of the Committee of Inspection for Thursday next to consider a proposal to make a call on all the contributories of the Company of £1 per share.

——— A petition was presented for the winding up of the South Staffordshire Tramways Company (Limited) by shareholders, on Wednesday, and a legal objection that a company incorporated by Act of Parliament could not be wound up on a petition presented by a shareholder was overruled by Mr. Justice Williams, who considered that there might be some benefit to the shareholders in winding up, as there was apparently a surplus to be divided. As, however, charges of fraud had been made, it would be necessary for further evidence to be produced, and the hearing of the petition was accordingly adjourned.

ELECTRIC TRACTION.—The *Financial Times* of April 11th contains an article dealing with electric *versus* steam traction, from which very favourable anticipations are made of the results of electrical working by lines now in course of construction or in contemplation. The deductions made by the writer treat the City and South London line as a pioneer line, built under disadvantageous dividend-earning conditions, but serving to show the difficulties to be overcome and errors to be avoided in the construction of future electric lines.

DUPLEX UPRIGHT TUBULAR BOILERS.—Messrs. J. Weeks and Co., of King's-road, Chelsea, S.W., send us a circular containing a variety of testimonials from users of their patent duplex upright tubular boilers. The testimonials are of a decidedly appreciative character, and all bear date 1894, showing at a glance the established reputation of Messrs. Weeks and Co.'s boilers. Amongst the users are the Zoological Society of London, the Duke of Rutland, the Earls of Radnor, Lisburne, Sandwich, and Derby, and the owners of a large number of the principal private gardens throughout the country.

NEW FIRM.—Mr. Cathcart, late partner in the firm of Cathcart, Peto and Radford, has commenced business under the title of C. H. Cathcart and Co., at Dorset-buildings, Salisbury-square, Fleet-street, E.C.

MESSRS. DRAKE AND GORHAM.—This firm have received instructions from the Earl of Derby that the lighting of Derby House is to be entirely remodelled. The installation will consist of about 400 lights.

MESSRS. RASHLEIGH PHIPPS AND CO.—Amongst the contracts recently obtained by this firm are the lighting of Mr. George Grossmith's house, Dorset-square, London, and Earl Fingall's house in South Audley-street. The firm are also putting in a complete electric lighting plant at Mr. Rattray's mansion at Bear Hill, Twyford.

ELECTRIC COOKING AND HEATING.—The London Electric Supply Corporation (Limited) announce that an exhibition of electric cooking and heating apparatus manufactured by Messrs. Crompton and Co. is now on view at the Corporation's show room, Belgrave Mansions, Ebury-street, S.W., where demonstrations will be given every Thursday from 3:30 to 5 p.m. The series of demonstrations commenced yesterday (Thursday). The apparatus is always on view between 11:30 a.m. and 7 p.m.

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Rabbidge Telephones.—Many years ago the India Rubber Company were makers of and supplying Silvertown telephones, but at that time the commercial importance of this instrument did not look promising, and the Company allowed the telephone industry to pass into other hands. A new departure has now been made. We have received a price list of the Rabbidge patented telephone, made and supplied by the Company. This telephone is designed for speaking over short lengths, and is specially adapted for offices, warehouses, and in groups of buildings. It is very simple in construction and convenient in manipulation, occupies very little space, and its articulation is loud and distinct. The receiver and transmitter, as well as the call and switch, are contained in one piece, similar in form to the microtelephone, having the receiver at one end to be placed to the ear, and the transmitter at the other to be held near the mouth. This piece is connected by a flexible cord to a plug placed in a wall block (as shown by the illustration), which also bears a small peg on which the telephone is hung. A and B in the illustration show the two plugholes required when only two offices are connected. When out of use the wall block (about 2¼in. in diameter) can be screwed to the side of a desk, and the instrument can be used without the operator leaving his seat. No call bell is necessary, but instead a small vibrating reed is placed in the receiver, which, when the battery is applied, gives a clear whistling note. The usual wall switch is replaced by a tube of mercury in the handle of the telephone, which automatically changes the connections when the telephone is brought into a position for speaking. The transmitter consists of loose carbon granules, which prevent the tendency to "pack," as each time the telephone is inverted the granules fall from one side to the other, and lie loosely in the cell. No permanent magnet is used, and no induction coil, the current being derived from the battery in direct circuit through both receivers and transmitters. The battery recommended for use is four Leclanché cells, preferably the No. 2 sealed agglomerate block form; No. 1 size may be used where the work is constant, or where a large number of instruments are connected. The Rabbidge telephone, being manufactured by the Silvertown Company, it is unnecessary to say that good workmanship may be relied upon.

Messrs. John Bolding and Son (Limited).—Mr. John Bolding informs us that he has registered his business of brass founder and manufacturer as a private limited company, his reason being to give his employés a pecuniary interest in the business, which will be conducted as hitherto under his personal superintendence and management. No shares will be offered to the public, all the shares being held by Mr. John Bolding and the employés.

"The Journal"—Part 110 of the *Journal of the Institution of Electrical Engineers*, price 3s. 6d., is now ready, and can be obtained of Messrs. E. and F. N. Spon, 125, Strand, London, W.C.

Ayr.—The Borough Engineer has presented a report, in which it is proposed to provide a preliminary supply of 4,600 private lights, and 15 2,000 c.p. arcs, to replace 95 gas lamps in the streets. He estimates the total initial cost at £11,000, the annual up-keep at £1,641, and the revenue from 3,000 private lights at £1,650. It was subsequently agreed to invite Mr. Robert Hammond to examine and survey the borough, and to report generally on the electric lighting question.

Bedford.—The deputation recently appointed by the Corporation has waited upon the Board of Trade, and was accompanied by representatives of the Bedford Electric Light Company and representatives of the Bedford Ratepayers' Committee. After hearing Mr. Sydney Morse on behalf of the Company, Mr. Coward on behalf of the Corporation, and Mr. Roff for the Ratepayers' Association, Sir Courtenay Boyle said it was clear that there was not a concensus of opinion in Bedford as to what was best to be done, and this was one of the cases in which the decision of the Board of Trade should be at once communicated. The Board of Trade were glad to develop trade by facilitating the efforts of such companies as the Bedford Company, but the primary object must be the benefit of the ratepayers, who were in the first place represented by the Corporation. The Bedford Corporation had had an Electric Lighting Order since August 4, 1890, and had done nothing under it, but the time when some definite action must be taken by them appeared to have arrived. His (Sir Courtenay's) advice to Mr. Mundella would be that if the Corporation would pass the necessary resolution for resolving to carry out the supply of electricity within the area covered by their Order, their assent to the application of the Bedford Company would not be dispensed with. If the Corporation would not consent to proceed with their Order, then the Board of Trade would dispense with their assent to the Company's application. In the event of the Company obtaining the powers asked for, the area to be supplied would be matter for reconsideration. There was no reason to suppose that the Company could not amply satisfy the Board of Trade as to their ability to carry out the conditions of the Order, and this would have to be done within the prescribed time; meanwhile the Corporation's Order would not be revoked in order that they might have an opportunity of dealing with the subject. The matter, therefore, was one in which the Corporation had the power to carry out the Order already obtained, and if this were done the Company's application would not be granted, but unless the Corporation moved at once, the Company's Order would receive the assent of the Board of Trade.

Bootle.—The Town Council have resolved to light the public offices by electricity, and are advertising for tenders. It is anticipated that the expense will be about £500 per annum, and a saving of about £40 on the gas bill is also expected. £3,600 is to be borrowed to recover the cost, subject to the sanction of the Local Government Board.

Bradford.—Complaints have been received from time to time by the Gas and Electricity Committee of the Corporation as to the lighting of the out-townships in the district, and a sub-committee has been appointed to consider the best means of placing the townships of Heaton and Allerton, and other smaller districts, on equal terms with the rest of the borough as to lighting facilities.

Bristol.—The Council of the Bristol Chamber of Commerce has just issued its report, in which reference is made to electrical matters. Satisfaction is expressed at the outcome of the agitation made by the Associated Chamber of Commerce, by which 22 lighthouses on the British coasts have been connected with the shore by electrical communication, including Lundy Island, the usefulness of which has been clearly demonstrated during the recent winter storms. In reference to the extension of the telephone system, the report states that in 1891 the number of subscribers to the Bristol Exchange was 562, which has increased up to the early part of 1894 to 800, in addition to 250 private lines. Reference is also made to the importance of the extensive installation of the electric lighting works put down by the Corporation, and which is now supplying current throughout the district. The Industrial Exhibition held at Bristol is declared a financial success from every point of view.——An extraordinary meeting of the members of the Bristol Tramways and Carriage Company has been held, at which formal approval has been given to the promotion of a Bill, now before Parliament, authorising the Company to make additional tramways. In reference to the threatened opposition from frontagers in West-street, the Secretary stated that, seeing that all conditions of the Tramways Act were fully complied with in the Company's proposed Bill, it was unlikely that the opposition would have any success.——The Local Board of St. George at their meeting last week received a statement from the chairman as to the objections raised to the electric railway scheme. He said that from interviews with the objectors they seemed bent upon opposing the measure, although the statutory amount of road space was properly provided for in the Tramways Company's Bill. The original number of objectors was three, but on solicitation being sent round this number had been increased.

Buckingham.—The local gas company has decided to light all the lamps or none, and is "jibbing" at a contract which has been given to Messrs. Parr and Gillies to light some of the public lamps by electricity. The Town Council appear disposed to extend the electric lighting contract, and the local gas company may have reason to regret the position it has taken up on the subject.

Burton.—The Municipal Offices Committee have presented a report to the Town Council, in which it is proposed to introduce the electric light into the municipal buildings at an expenditure of not more than £997. 13s. This expenditure was approved.

Chelsea.—The Chelsea Vestry have had before them the important question of the property in pipes laid for electric lighting cables, and subsequently disused. In 1889 the London Electric Supply Corporation laid some iron pipes from Knightsbridge through to Draycott-place, and for a short time supplied electricity to houses in the vicinity, but, subsequently, the cables were withdrawn, and the pipes are now empty. The National Telephone Company asked for permission to use these pipes for their telephone wires, and this proposal Mr. T. W. E. Higgins, the Surveyor to the Vestry, recommended should be approved. A member of the Vestry expressed his opinion

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that through disuse by the original company the pipes became vested in the local authority, and it was ultimately decided that the Surveyor should inquire into the legal position and report.

CLONTARF.—At a meeting of the Town Commissioners, their approval was sought to the proposed electric tramway between Clontarf and the Hill of Howth, to be constructed by the Clontarf and Hill of Howth Tramway Company (Limited). After hearing the views of a deputation which waited upon them, the Commissioners adjourned the discussion on the subject to a special meeting to be held to-morrow (Saturday).

COLCHESTER.—The Public Library Committee of the Town Council will discuss at their next meeting the advisability of lighting the new Public Library by electricity.

DARLASTON.—The Local Board have agreed to the appointment of a special committee to consider the drawing up of a report to the Local Board on the subject of electric lighting.

DUBLIN.—Complaints have recently been made by subscribers to the National Telephone Company's system that undue preference is being given to new subscribers over those who had been subscribers to the Telephone Company of Ireland, whose business the National Company recently acquired. This has led to a correspondence, in which Mr. V. B. Dillon, Lord Mayor of Dublin, who is also a member of the Local Board of the National Company, points out that since the acquisition of the Irish Company's business the National Company have laid out large sums in improving the Dublin service, representing a total outlay of £20,000. The National Company had also decided to reduce the ordinary £12 exchange rental to £10 to subscribers entering into a five years' agreement, retaining the £12 rental for those who preferred the regular annual subscription. This arrangement having met with some opposition from many of the old subscribers, it has now been decided to make the rental £10, withdrawing the five years' condition. This brings to a satisfactory termination a state of affairs which has caused considerable agitation amongst the Company's subscribers in Ireland, who agree that since the transfer a great improvement in the service has resulted.

EALING.—The contractors for the electric lighting of this district have notified the Local Board, through their surveyor, that the Board will be in a position to deal with the question of private lighting, and, in fact, with the whole of the electric lighting of the district, by the beginning of August. Applications for a large number of lamps had already been received, showing that for private lighting the Board might expect an increasing demand for the electric current.

EDINBURGH.—Mr. Monkhouse, the Corporation's resident electrical engineer, has now assumed duty, his temporary official quarters being at the City Chambers. He has recently prepared a set of rules, which the Corporation are now issuing, to be observed by contractors in wiring houses to be supplied with the electric current.——The Corporation have taken counsel's opinion on the question of their agreement with Messrs. Dick, Kerr and Co. for the tramway rights. Mr. Cripps, Q.C., advises that the Corporation must not on any account allow the matter to pass this time without taking action. Generally the opinion is adverse to Messrs. Dick, Kerr and Co.'s arrangements.

FAREHAM.—At a meeting of the Local Board a letter was received to the effect that at the annual meeting of the shareholders of the Fareham Electric Light Company a resolution was passed authorising the Directors to offer their business to the town authorities. The letter was from Mr. Blake, who therefore offered the whole of the buildings, plant, machinery, mains, apparatus, &c., which the Company have installed, and for which they possess a Provisional Order for a term of 42 years from 1892. It was proposed by the Chairman of the Board that the proposal should be placed before a general meeting of the ratepayers, and this is to take place on the 25th inst.

FIRE AT NORTH WOOLWICH.—A disastrous fire occurred on Wednesday evening at the extensive works of the Fowler-Waring Cables Company at Henley-road, North Woolwich. The fire was first observed at 7:15, and commenced in the insulation room, which was entirely destroyed. The stock is damaged to the extent of between £5,000 and £6,000. The Fowler-Waring Company is very busy, but we are glad to say that little or no inconvenience will arise from the fire, and only a trifling delay will be occasioned by the disaster, which will temporarily throw out of employment a small number only of the Company's employés. The damage is fully covered by insurance.

GUILDFORD.—The Board of Trade have intimated that they propose to dispense with the consent of the Corporation to the Provisional Order applied for by the Holloway Electric Supply Company for lighting Guildford and district by electricity. If the Corporation wish to have any clause inserted whereby they can acquire the undertaking previous to the expiration of the 42 years' limit inserted in the Order, the Board of Trade are prepared to give the matter their consideration. The subject was dealt with at the last meeting of the Town Council, when it was decided by a small majority to ask the Board of Trade for power to purchase on statutory terms after 30 years, instead of the 42 years' limit provided in the Company's order.

GREAT MISSENDEN (BUCKS.).—Messrs. Habgood and Smith gave, last week, an interesting demonstration of electric heating and cooking, the plant being kindly lent by Messrs. Crompton and Co. for the purpose. The electric lighting of the village is progressing favourably, and many applications have been received from private consumers.

THE HARTLEPOOLS.—The Town Council have discussed the subject of electric trams, and have approved certain provisions and conditions set out by the promoters of the electric tramways in the city.

LIVERPOOL. — At a general meeting of the members of the Junior Reform Club, which was largely attended, it was unanimously resolved that arrangements should be made forthwith for the installation of the electric light throughout the Club's premises.

LONDON COUNTY COUNCIL.—A motion that the footways of the Victoria Embankment be widened in order to allow the electric light standards to be placed on the sides of the carriage-way has been approved. It has also been agreed that the Highways Committee consider and report to the Council on the feasibility of providing for the lighting of Westminster and Waterloo Bridges by electricity, apart from the question of the electric lighting of the Victoria Embankment.

MONTROSE.—The report of the deputation appointed to visit Edinburgh, Coatbridge, and Glasgow in connection with the electric lighting scheme is to be presented at the next meeting of the Police Commission.

MIDDLESBROUGH.—The Electric Lighting Committee of the Town Council have appointed a deputation to visit Halifax and Bradford, and to extend their visit to Huddersfield if necessary, to inspect the electric lighting plant laid down at these places, and to obtain information and report to the Council.

PERTH.—A proposal has been made by the local gas company to fit up the Town Hall for the electric light, and to supply a number of arc lamps for the street lighting. The gas company's tender for lighting the Town Hall for £106. 15s. has been accepted; 80 lights are to be provided.

POPLAR.—In reply to a question asking when Mr. Preece's report would be received regarding the electric lighting of the Poplar district, the Clerk to the Board of Works replied that Mr. Preece had been very ill, but that it was hoped that his report would be received in a few weeks.

PRESENTATION.—At Brighton, on Saturday last, Mr. G. J Philpott, late Chief Engineer of the Brighton and Hove Electric Light Company, was presented with a gold watch and chain as a *souvenir* of his connection with the Company, and as a mark of respect from those who had served under him. Mr. Philpott has joined Mr. Taylor at Croydon.

ST. OLAVE'S (SOUTHWARK).—The new offices of the Board of Works have now been completed. The building has cost £2,300 to construct, and has been lighted throughout by electricity by Mr Mackie.

SHIRLEY (HANTS).—The question of lighting their district by electricity is under the consideration of the Shirley and Freemantle Local Board, and at the meeting last week the General Purposes Committee were instructed to commence negotiations for the purchase of some disused factory premises in Mousehole-lane for a central lighting station.

SOUTHPORT.—The New Infirmary Committee have reversed a decision come to three weeks ago, and have decided that, at any rate for the present, the electric light shall be used in all the wards and rooms of the institution, and that the supply be obtained from the Southport Corporation's mains. As the production of electricity on the premises is now contemplated, the building committee was instructed to make the boiler house and chimney of ample dimensions.

SOUTH SHIELDS.—Since the appointment of Mr. J. A. Jeckell as borough electrical engineer, in November, 1893, the Electric Lighting Committee have considered the question of obtaining a suitable site for the central station, and have ultimately selected one known as the Low Foundry, which has been purchased for the sum of £4,400. The station will be on the river side, with a frontage of 125ft. This will enable the authorities to obtain coal at the lowest figure, and water for condensing will be almost costless, as, even at low tide, the water does not leave quay. The site has a total area of 2,500 square yards, and is very central.

STIRLING.—In connection with the intention of the Town Council to continue to oppose the application made by the Caledonian Electric Supply Company for a Provisional Order, a petition is to

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be sent to the Board of Trade to the effect that if the Council have another opportunity they will themselves make an application for a Provisional Order. According to the latest intelligence, the Board of Trade have decided not to proceed with the Caledonian Company's application.

SUNDERLAND.—A Local Board inquiry has been held, at which the proposal to borrow £26,000 for electric lighting purposes was investigated.—— A proposal having been made that electricity should take the place of gas for lighting the Union workhouse, it was decided at the last meeting of the Board of Guardians that they should wait until the Corporation supplied them with the electric light, and this amendment was carried.

WATFORD.—Mr. Rogers, who is well known in connection with electric lighting matters in this town, has written to the Local Board inquiring what steps they propose to take in order to secure the electric lighting of the town. An electric lighting company was formed 18 months ago, with the Earl of Essex as Chairman, but at that time the Local Board stepped in, and announced its decision to itself apply for a Provisional Order, and still nothing has been done.

WEYBRIDGE.—The new contract entered into between the local authorities and the Weybridge Electric Supply Company (Limited) provides for the 119 public lamps being lighted at a charge of £2. 17s. 6d. per lamp per annum.

WOKING.—It is stated that Messrs. New and Mayne have secured the control of the Woking Electric Supply Company's business and works, and that it is proposed to put down improved machinery. About ten miles of cables are already laid covering a large area, and the anticipated demand for current justifies Messrs. New and Mayne in making considerable extensions in the near future.

WORCESTER.—The City Council have adopted a resolution to rescind a decision come to last year to erect at the waterworks Tangye engines and pumps and Galloway boilers, at an estimated cost of £1,960, and decided to accept instead a tender of the Brush Company to supply and fix two sets of electrical pumping plant at an estimated outlay of £1,128, and also a tender from the same company to lay mains capable of conveying the necessary current to drive the motors and to light 1,000 lamps, *en route* from Castle-street to the waterworks, at a further cost of £961.

COMPANIES' MEETINGS AND REPORTS.

Eastern Extension, Australasia, and China Telegraph Company (Limited).

The following is the report of the Directors of this Company for the half-year ended December 31st last, which will be submitted to the forty-first ordinary general meeting, to be held at Winchester House, Old Broad-street, E.C., on Wednesday, the 18th inst., at 2 o'clock :—

The gross receipts, including Government subsidies, have amounted during the half-year to £251,698. 10s. 6d., against £247,766. 19s. 1d. for the corresponding period of 1892. The working and other expenses, including £21,122. 4s. 8d. for cost of repairs to cables and expenses of ships, absorb £76.574. 15s. 6d. against £91,768. 18s. for the corresponding period of 1892, leaving a balance of £175,123. 15s. From this is deducted £4,015 1s. 9d. for income tax, and £31,895 for interest on debentures, debenture stock, and contribution to sinking fund, leaving as the net profit for the half-year £139,213. 13s. 3d., which, with £81,116. 17s. 8d. brought forward from the previous half-year, shows an available balance of £220,330. 10s. 11d.

One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount on the 19th instant, making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1893. The balance of £107,830. 10s. 11d. has been carried to the general reserve fund, which, after being credited with interest received on investments during the half-year, now stands at £633,686. 2s.

The working of the Australian tariff arrangement for the third year of "Guarantee," ending 30th instant, is estimated to result in a loss of between £11,000 and £12,000, half of which will be borne by the Guaranteeing Governments, and the other half by the associated cable companies, in accordance with the terms of the agreement. This loss would, however, be far greater, but for the abnormally large traffic which was transmitted during a portion of the year in connection with the financial crisis in Australia.

In accordance with the provisions of the Trust Deed dated May 10, 1879, 371 of the Company's Five per Cent. Australian Government Subsidy Debentures amounting to £37,100 were drawn by lot on the 2nd instant for payment at par on July 2nd next. (The numbers are given in *The Electrician* of April 6th.)

With a view to carrying out the arrangements referred to at the last general meeting for increasing the security of the Company's China system, a contract has been entered into with the Telegraph Construction and Maintenance Company for the manufacture and laying of an alternative cable between Singapore and Hong Kong, connecting the island of Labuan and British North Borneo *en route*. The first section between Singapore and Labuan is now being laid, and the whole work is expected to be completed and the line opened for traffic before the end of the present month.

Your Directors have the satisfaction to report that the Netherlands-Indian Government have placed at the Company's disposal a special wire through Java for the transmission of the International traffic by the Company's employés, and a small station has been opened by the Company in the Government office at Sourabaya in connection with the same. This special wire gives the Company an efficient alternative communication to their Singapore-Banjoewangie cable.

Mr. Francis Augustus Bevan and Sir Albert J. Leppoc Cappel, K.C.I.E., are the Directors retiring by rotation, and offer themselves for re-election. The retiring auditor, Mr. Henry Dever, desires to offer his firm, Messrs. Deloitte, Dever, Griffiths and Co., for election as auditors to the Company. Messrs. Welton, Jones and Co., also retire, and offer themselves for re-election.

Indo-European Telegraph Company (Limited).

The following is the Directors' report to be presented to the general meeting to be held at Winchester House, Old Broad-street, E.C., on Thursday, the 25th inst., at noon. Holders of shares to bearer intending to be present at the meeting must deposit their shares at the offices of the Company before noon on Tuesday, April 24th.

The Company's revenue from all sources for 1893 amounted to £122.860. 10s. 4d., as compared with £117,479. 13s. 10d. for 1892, showing an increase of £5,380. 16s. 6d. The expenses were: on commercial and general account, £34,916. 5s. 11d. ; on maintenance account, £30,043. 11s. 7d.; total, £64,959. 17s. 6d., as against £62,148. 16s. 3d. for 1892, an increase of £2,811. 1s. 3d. Deducting the above expenses, taking credit for £7,557. 16s. 11d. brought over from 1892, and debiting income-tax, there remains the sum of £63,952. 3s. 8d. From this amount £15.000 has been placed to reserve, and that sum, together with £10.625 amount of interim dividend, have to be deducted, leaving a balance of £38.327. 3s. 8d. The Directors now propose the declaration of a dividend for the six months ending December 31st, of 17s. 6d. per share, making, with the dividend already paid, 6 per cent. and a bonus of 20s. per share, both free of income-tax, making in all 10 per cent. for the year, carrying forward £6,452. 3s. 8d. to the credit of 1894.

The Directors have to express their deep regret at the loss of the valuable services of their late colleague, Mr. Weaver, who died last September, and who had been connected with the Company since its incorporation. Mr. John von Berenberg Gossler and Mr. H. H. Meier retire from the Board by rotation, and, being eligible, offer themselves for re-election. The auditors, Messrs. C. F. Kemp, Ford and Co., public accountants, retire and offer themselves for re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

INTERNATIONAL ELECTRIC STORAGE (LIMITED).—This Company was registered on April 4th, with a capital of £200,000, in £5 shares, to purchase or otherwise acquire all or any of the shares, works, undertakings, business, property and liabilities in and of the Universal Electric Lighting Company (Limited) ; to acquire all or any of the letters patent of Messrs. Theryc and Oblasser for electric accumulators, granted to them in the United Kingdom and elsewhere ; to generate, produce, store, accumulate and distribute electricity and electromotive force ; to manufacture and supply electric locomotives, cars, motors, batteries, accumulators, distributing mains, &c. ; and generally to carry on the business of electricians, electrical and mechanical engineers, telegraphic and telephonic apparatus manufacturers, electrical appliance manufacturers, &c. The subscribers (with one share each) are : Major S. Flood Page, John L. Higgs, J. G. B. Elliott, James H. Mace, B. H. Van Tromp, Col. Ernest Villiers, and A. Schanschieff. The first Directors are : Major S. Flood Page, Messrs. Vaughan Cousins, John L. Higgs, James H. Mace, Charles Theryc, B. H. Van Tromp and Ernest Villiers.

STEEL AND GARLAND (LIMITED).—This Company was registered on April 5th, with a capital of £40,000, in £5 shares, to carry on the business of a manufacturer of and dealer in electric light fittings and general art metal work and brass aud iron founder, carried on at Sheffield and London.

WILLIAM ALLAN AND CO. (LIMITED).—This Company was registered on April 5th, with a capital of £50,000, in £100 shares, to purchase or otherwise acquire, and undertake all or any part of the business, goodwill, property, and assets of Messrs. William Allan and Co., of the Scotia Engine Works, in the borough of Sunderland, Durham, as from April 1, 1894. William Allan, M.P., is the Managing Director.

BOHM AND CO. (LIMITED).—The annual return of this Company, made up to February 19th, has been filed. The Company was registered on October 21, 1892, with a capital of £20,000 in £1 shares, to acquire the business of glassblowers and electricians, carried on by Ernest Böhm and Ernest B. B. George, at 42 and 43, Little Britain, London, E.C., and to carry on the business of glassblowers and workers, electrical and mechanical engineers, and manufacturers of electric, magnetic, telegraphic, and telephonic appliances and apparatus. 19.999 shares have been taken up, of which 19,992 were issued as fully paid to the vendors. Upon the remaining seven shares the full amount has been called, resulting in the payment of £1, leaving £6 in arrear.

MAZARRON ELECTRIC LIGHT COMPANY (LIMITED).—The statutory return of this Company, made up to March 14th, was recently filed. The nominal capital is £15,000, divided into 500 £8 per cent. cumulative Preference shares of £10 each, and 10,000 Ordinary shares of £1 each. All the Ordinary and 100 Preferred shares have been taken up, of which 9,995 Ordinary shares were issued as fully paid to the British and Foreign

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Trading Company (Limited), of 175, Dashwood House, New Broad-street, London, E.C. The full amount has been called on the remaining 7 Ordinary and the 100 Preference shares, resulting in the payment of £1,007. The Company referred to above now hold 5,493 Ordinary shares.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING COMPANY (LIMITED). The annual return of this Company, made up to February 26th, has recently been filed. 4,566 shares, out of a nominal capital of £50,000, in £10 shares, have been taken up, and a call of £8 per share made on 3,535, while a call of £6 per share has been made on the remaining 1,031 shares. This has resulted in the payment of £34,226, leaving £240 in arrears.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY COMPANY (LIMITED).—This Company's usual annual return was recently filed, when 6,769 shares of £5 each, out of a capital of £50,000, were allotted. A call of £4 per share on 6,701 shares has resulted in the payment of £28,735 (which includes a sum of £1,931, which has been received in advance of calls), while 68 shares have been issued as fully paid.

PONTYPOOL ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual return of this Company made up to March 18th, has been filed. Out of a nominal capital of £50,000, in £5 shares, 953 shares have been taken up. Upon 509 of these the full amount has been called, and upon the other 444 a call of £4 per share has been made, resulting in the payment of £4,341, which includes a sum of £20 paid on certain shares applied for but not allotted.

SCARBOROUGH ELECTRIC SUPPLY COMPANY (LIMITED).—The first annual return of this Company, made up to March 14th, has been filed. 2,450 shares of £10 each have been taken up, a call of £8 per share made, and the full amount of £19,600 received in respect thereof.

SMITH AND CHAMBERLAIN (LIMITED).—The annual return of this Company, made up to November 8, 1893, was recently filed. 1,528 shares, out of a nominal capital of £100,000, in £10 shares, of which 1,521 shares were issued, with £8 per share considered as paid. £8 per share has been called and paid on the remaining seven shares.

ST. JAMES AND PALL MALL ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company, made up to February 13th, has been filed. The nominal capital consists of 100 Founders' shares of £1 each, 19,980 Ordinary shares of £5 each, and 20,000 Preference shares also of £5, a total of £200,000. All these have been subscribed and allotted, and the full amount paid.

SUNBEAM LAMP COMPANY (LIMITED).—The annual return of this Company, made up to February 14th, has just been filed. Out of a nominal capital of £25,000, in £10 shares, 1,600 have been taken up, and of these 857 were issued as fully paid. Upon 455 of the remainder, £8 per share has been called, and the full amount has been called on 288 shares, resulting in the payment of £6,490, and leaving £30 in arrear.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—The annual return of this Company, made up to March 13th, has been filed. The whole nominal capital of £448,200, divided into 37,350 shares of £12 each, has been taken up, the full amount called, and all calls paid.

CITY NOTES.

ANGLO-AMERICAN TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have declared an interim dividend for the quarter ended 31st March last of 9s. per cent. on the Ordinary stock, and 18s. per cent. on the Preferred stock (less income tax), payable on May 1st.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—Notice is given that the eighth and final drawing of the Five per Cent. Debentures (1884 issue) of this Company—187 in number—will take place on the 20th inst. at the offices of the Company.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended April 8th were £852, as against £842 in the corresponding period of 1893, being an increase of £10. The total receipts for the half-year amount to £12,886, as against £12,856 for the corresponding period of 1893, an increase of £30.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY (LIMITED).—Letters of allotment for the first issue of 19,900 Ordinary shares in this Company are now being posted.

EASTERN TELEGRAPH COMPANY (LIMITED).—This Company announces the payment by warrants, on May 1st, of interest for the half-year ending April 31st on their Four per cent. Mortgage Debenture Stock. The transfer books will be closed from April 27th to May 1st, both days inclusive.

EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY (LIMITED).—This Company give notice of their intention to apply to the Board of Trade, under Section 6 of the Merchant Shipping Act, 1871, for an order to change the name of a vessel purchased by them for use as a telegraph steamer, from "Nentwater" to "Duplex." Any objection to the proposed new name must be sent in to the Marine Department, Board of Trade, by April 17th.

GREAT NORTHERN TELEGRAPH COMPANY.—The accounts are issued of this Company for the year 1893. The total receipts for the year, after deducting a loss on exchange of £42,275, and including a balance brought forward of £45,667, amounted to £352,975 against an expenditure of £77,793, leaving a balance available for dividend (after paying off 100 of the 1883 Five per Cent. Debentures, the payment of interest on the remainder, and the payment of interim dividends, which absorbs £95,250) of £179,932, out of which it is proposed to pay a dividend of 7s. 2d. per £10 share, taking £54,166, adding to the reserve and renewal fund £83,333, increasing the pension fund of the staff by £2,778, taking £1,500 for the remuneration of the Directors, and carrying forward £38,154 to next account. The reserve and renewal fund now amounts to £862,968, and the balance-sheet shows the investments on account of this fund, which are all of the gilt-edged description.

PETZOLD AND CO. (LIMITED).—It is notified that the whole of the debentures (£60,000) are now in course of being paid off at par. The English portion (£25,000) will be paid on presentation at the Crédit Lyonnais, 40, Lombard-street, E.C.

PHOSPHOR-BRONZE COMPANY (LIMITED).—The annual general meeting of this Company was held at the Bridge House Hotel, London Bridge, on March 30th (Mr. Henry Seebohm in the chair), when the Directors' reports and accounts were adopted. Mr. C. E. Taunton resigned his position as a Director, and Mr. Bernard Gibson was re-elected and Messrs. Francis W. C. Cumming and Richard E. M. Lagerwall were appointed Directors, the last named to be Managing Director.

SHEFFIELD ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—This Company invite applications for a new issue of 6,000 shares of £7 each, which will make up a total subscribed capital of £70,000. This new capital is required to supply mains in the residential districts of Ranmoor and Broomhill. The new shares, which will be subscribed for locally, are to rank for dividend along with existing shares as from December 31st last. The nominal capital of the Company is £98,000, in 14,000 £7 shares, and the Company has power to borrow on debentures £25,000.

SOUTHAMPTON ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—The annual meeting of this Company was held at the offices at Southampton on Wednesday in last week, under the presidency of Mr. G. T. Harper, J.P., who said that the prospects of the Company were very encouraging. The loss brought forward from 1892 of £755 had been reduced by last year's profits to £185; and with the continued demand for the electric current, there was every prospect that by the end of the present year they would have arrived at a dividend-earning stage. More capital was, however, required to enable the Directors to cope with the new applications for the light, and he hoped that local investors would take up sufficient shares to warrant them in incurring necessary expenditure. Notice would shortly be given of the intention of the Company to apply for a Provisional Order. The report (which appeared in our last issue) was adopted.

SUBMARINE CABLES TRUST.—Notice is given that on and after April 16th the sum of £1. 15s., on account of the coupon due April 15th, will be paid by Messrs. Glyn, Mills and Co., 67, Lombard-street, E.C. Coupons should be left with the bankers four clear days for examination.

THE "TAPE."—The Stock Exchange Committee have recently decided to call upon the Exchange Telegraph Company to withdraw its tape machines from their "outside broker" clients, and this the Exchange Company have agreed to do. It is difficult to see what public service this meddling order of the Stock Exchange Committee will effect, as an outside broker wishing to deal at tape prices will have little difficulty in effecting his object by the aid of the telephone. The Exchange Company, however, may be considerable losers by the action of the Committee, as many of its clients are members of the outside broker fraternity. The Stock Exchange Committee in taking this feeble action proves its incompetence to deal with a matter of serious public importance, viz., the relationship existing between the outside broker and members of the Stock Exchange. For some years the Committee have issued a small advertisement warning the public that members of the Stock Exchange are not allowed to advertise for business. This warning note has been withdrawn, and the Stock Exchange Committee thereby leave the public at the mercy of a set of sharks whose nefarious practices have recently come so prominently before the public.

WESTERN UNION TELEGRAPH COMPANY.—The following is the report of this Company for the quarter ended March 31st, 1894:—The condition of the Company at the close of the quarter ended December 31st, 1893, was as under:—

Surplus October 1, 1893, as per last quarterly report...		$7,208,180 13
Net revenues, quarter ended December 31, 1893		1,493,094 33
		$8,701,274 46
From which, deducting for dividend of 1¼ per cent. paid January 15th	$1,185,011 25	
Interest on bonded debt	224,212 25	
Sinking funds	20,000 00	
		$1,429,223 50
Left a surplus January 1, 1894, of		$7,272,050 96
Surplus January 1st, as above		$7,272,050 96
The net revenues of the quarter ended March 31st instant, based upon nearly completed returns for January, partial returns for February, and estimating the business for March, will be about		1,050,000 00
		$8,322,050 96
From which, appropriating for—		
Interest on bonds	$223,737 25	
Sinking funds........................	20,000 00	
		243,737 25
		$8,078,313 71
It requires for a dividend of 1¼ per cent. on the capital stock issued		$1,185,000 00
Deducting which leaves a surplus, after paying dividend, of		$6,893,313 71

In view of the preceding statements, the Committee recommend the payment of a dividend of 1¼ per cent. on the capital stock of this Company on April 16th.—The dividend may be collected through any bank on or after the 16th inst.

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WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended April 6th (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £3,113.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The Directors of this Company have decided to recommend the undermentioned dividends for the six months ended December 31st last:—On the First and Second Preference shares, 6s.; on the Ordinary shares, 9d.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price, April 4		Price Wednesday, April 11		Rate per Cent. Yielded (£ s. d.)	Dividend Due	Business Done During Week Ending April 11: Highest	Lowest
			TELEGRAPHS.								
£1,134,640	Stock	3/6	Anglo-American	42	44	41	43	5 16 3	Jan., Apr., July, Oct.	42½	41⅛
£2,932,680	Stock	27 0	Do. Preferred	79	80	79	80	6 5 0	,, ,,	79½	78½
£2,932,680	Stock	5/0	Do. Deferred	7½	7¾	7½	7¾	..	..	7¾	7⅝
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	100	103	100	103	3 17 8	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	11¾	12¼	11¾	12¼	5 4 0	Mar., June, Oct., Dec	12⅜	11 15/16
£18,700	£100	6%	Do. 5 per Cent. Bonds	99	102	100	103	4 17 1	January and July	..	–
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	107	111	4 10 1	June and December	108½	–
10,000,000	$100	$1¾	Commercial Cable Capital Stock	146	150	146	150	4 13 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12	13	12	13	6 3 1	February and August	12¼	12
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	,, ,,	..	–
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3	2½	3	5 6 8	April and October	..	..
6,000	5	10	Do. Preference 10 per Cent.	8½	9	8½	9	5 11 1	,, ,,	..	..
60,710	20	8 0	Direct United States Cable, 1877	9¾	10¼	9	9½	7 8 11	Jan., Apr., July, Oct.	10	9 1/16
400,000	10	2/6	Eastern	15	15½	15	15½	4 5 3	,, ,,	15 3/16	15
70,000	10	6%	Do. 6 per Cent. Preference	16	16½	16	16½	3 12 9	,, ,,	16 5/16	16 1/16
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	117	114½
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	107	110	107	110	4 10 11	February & August	108½	..
250,000	10	2/6	Eastern Extension	15½	15¾	15½	15¾	4 8 11	Jan., Apr., July, Oct.	15¾	15½
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113	116	113	116	3 9 0	February & August	116	113½
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103	106	103	106	4 14 4	January and July	..	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	103	106	103	106	4 14 4	,, ,,	105	–
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	104	107	104	107	3 14 9	February & August	..	..
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	107%	110%	107%	110%	3 12 9	May and November	..	..
180,227	10	1/3	Globe Telegraph and Trust	8¾	9	8¾	9	5 0 0	Jan., Apr., July, Oct.	8⅞	8¾
180,042	10	6%	Do. 6 per Cent. Preference	15½	15⅝	15½	15⅝	3 18 1	,, ,,	15 5/16	15½
150,000	10	5/0	Great Northern	21¾	22¼	21¾	22¼	3 16 4	Jan., April, and July	..	..
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 13 6	March & September	..	..
17,000	25	12/6	Indo-European	43	45	45	47	5 6 5	May and November	46	..
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	..	,, ,,	..	..
£100,000	100	6%	Do. 6 per Cent. Debentures	106	109	106	109	5 10 1	March & Septen b r	..	–
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red 1942	102	105	102	105	3 16 2	..	..	–
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	–	–
3,381	£100 Cert.	25 0	Submarine Cables Trust 6 per Cent.	113	118	113	118	5 1 8	,, ,,	–	–
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July	..	–
£249,900	100	5%	Do. 5 per Cent. Debentures	99	102	100	103	4 17 1	March & September	101½	..
30,000	10	2/0	West Coast of America	2½	3	2½	3	..	January and July	2¾	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	101	105	102	106	7 10 11	June and December	103	..
88,321	10	1/0	West India and Panama	1½	1½	1½	1½	..	..	..	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¼	10¾	10¼	10¾	5 11 7	May and November	10⅝	10¼
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9	10	9	10	6 0 0	,, ,,	9¼	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	107	110	107	110	4 10 11	June and December	..	–
64,242	15	4/6	Western and Brazilian	7½	8	7½	8	..	May and November	7⅝	–
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	6	6½	6	6½	..	..	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	2	2½	2	2½	..	..	..	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105	108	105	108	5 11 1	February & August	107	–
£222,700	100	6%	Do. 6 per Cent. Mort. Debs.. Series "B" 1910	105	108	105	108	5 11 1	,, ,,	107	–
$1,214,000	$1,000	7%	Western Union 7% 1st Mtg. (Building) Bonds	113	118	113	118	5 18 8	May and November	..	–
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	100	104	100	104	5 15 5	March & September	..	–
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	1½	2½	1½	2½	..	–	..	–
224,850	10/0	3⅓d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	–
220,000	£1	6d.	Oriental Telephone and Electric	..		..		..	Yearly	..	–
484,597	5	2/6	National	4⅝	4⅞	4⅝	4⅞	5 2 7	June and December	4 13/16	4 11/16
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	14½	15½	14½	15½	3 17 5	,, ,,	15⅛	–
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	14	15	14	15	4 0 0	,, ,,	14¾	..
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅜	5⅝	5⅜	5⅝	4 8 11	..	5 11/16	5 5/16
925,017	£100	4½%	Do. Deb. Stk. 4½%	115	117	115	117	3 16 11	January and July	116¾	116
58,000	5	1/0	United River Plate	1½	2	1½	2	–	,, ,,	1 13/16	1½
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	,, ,,	–	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11½	12½	11½	12½	–	..	12⅜	12½
20,000	10	6,0	Do. 6 per Cent. Cumulative Pref. (fully paid)	13¼	13¾	13¼	13¾	..	–	13½	13⅜
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	–	–
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	–	–	–
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		–	–	–	–
8,322	£5	..	House to House Electric	..		..		–	–	–	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		–	–	–	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	–	–
30,000	£5	1/9	Liverpool Electric Supply (£4 10s. paid)	5⅞	6⅛	5⅞	6⅛	..	–	–	–
15,000	£5	2/6	Do. (fully paid)	6 7/16	6 9/16	6 7/16	6 9/16	..	–	..	–
111,000	5	..	London Electric Supply	¼	¾	⅜	⅝	..	..	..	–
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	8	8½	7½	8	2 10 0	..	8 1/16	–
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	106	109	106	109	4 11 9	June and December	109	–
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	.	–	4¾	–
19,980	£5	4/6	St. James' and Pall Mall	6¼	6¾	6¼	6¾	.	–	..	..
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	–	8⅛	8
59,900	5	2/6	Westminster Electric Supply (fully paid)	5¾	6¼	5¾	6¼	3 4 0	–	6	5 13/16
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	8	1/6	Brush Electrical Engineering	3	3¼	3	3¼	5 10 10	–	..	..
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅜	2⅛	2⅜	5 1 1	..	2¼	..
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	103	111	108	111	4 1 1	March & September	..	..
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	3½	4	3½	4	..	January and July	..	–
12,139	5	..	Edison and Swan United	–		–		–	–	–	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	–	–	–
120,000	2	..	Electric Construction	½	¾	½	1	..	–	9/16	
12,845	2	..	Do. 7% Cumulative Pref.	1½	1¾	1½	2	..	..	1 11/16	1
91,195	2	10/0	Elmore's Patent Copper Depositing	½	¾	½	¾	–	..	..	–
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	..	..	..
50,000	10	15/0	India Rubber, Gutta Percha &c., Works	23	24	23	24	5 4 2	February & August	23⅝	23½
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	101	103	101	103	4 7 5	March & September	..	..
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	..	–	–	–
16,000	£10	..	Do. 8 per Cent. Preference	..		..		..	December and June	–	..
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	—	⅛	—	⅛	..	–	–	–
78,949	5	3/6	Swan United (£3. 10s. paid)	2	2½	2	2½	7 0 4	May and November	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	39	41	39	41	4 7 10	March and July	39⅝	39
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	..		..		..	January and July	..	–
37,514	£5	–	Woodhouse and Rawson Ordinary (£3. 15s. paid)	..		..		–	–	–	–
41,098	£5	–	Do. Preference (fully paid)	–		–		–	–	–	–
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	⅝%	City and South London Railway	27	32	27	32	4 5 11	May and November	..	–
37,500	£10	1%	Liverpool Overhead Railway	6⅞	7⅛	7½	7¾	–	–	–	–

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NOTES.

The Northern Society of Electrical Engineers is to be congratulated on its Papers on underground mains, and more particularly on the discussion which followed them. We will make no comparisons: sufficient unto each Society is the science or the engineering thereof. It is, however, noteworthy that it is from Manchester and not from Westminster that we get the interesting news that the cost of maintenance of the bare-strip conductors in Kensington is only 0·43 per cent. per annum, and that in the City of London an average demand of 4½ 8-c.p. lamps per yard of frontage has been provided for. A good deal of further information on the City lighting was given. It is possible that an account of this mysterious system will first be given in Japanese at the Electrical Society at Tokio, and will be published with characteristic illustrations in the 電氣學會雜誌

We have been obliged, through pressure on our space, to omit the long mathematical reasoning—we cannot call it proof—of the (theoretically) best resistance for the receiver on a leaky telegraph line. Dr. Sumpner has sent us a very much shorter proof, based on Bosscha's corollary of Kirchoff's law. The problem seems to be nothing more than a case of Jacobi's law, and, like Jacobi's law, it is not a sound guide for practice. Jacobi's law states that the mechanical work given out by a motor is a maximum when the motor is geared to run at such a speed that the current is reduced to half the strength that it would have if the motor were stopped; under these circumstances only half the watts furnished by the external source are utilised, the other half being wasted. Another well-known case is that the external work done by a battery is a maximum when the external resistance is equal to the internal resistance. In the present case the telegraph receiver is the motor, and the line may be taken as part of the internal resistance of the battery. The law says that half the watts must be wasted. In the simple case, the volts are wasted, being lost on the resistance. All the amperes arrive safely, and, being multiplied by the surviving volts, present themselves as available watts. If, however, the line leaks, whether at one end, at the middle, or all along continuously, some of the amperes are lost (no matter what becomes of them) and hence the watts at the motor are reduced. The same law holds, for it applies only to the resulting watts, and takes no account of the proportion of the constituent volts and amperes. As every student knows, Jacobi's law is not one of maximum efficiency. Battery power, however, is cheap enough in telegraphy, and a little departure in the Jacobi direction from the condition of maximum efficiency is permissible. The usual desideratum is that the current should be enough to make the receiving instrument speak well, and if, as Prof. Hughes suggests, instruments are made by the hundred, with no thought of the resistance or leakage of the line on which they are to be used, a complicated coefficient for telegraphic apathy must be introduced.

The new shunt box recently described by Prof. Ayrton and Mr. Mather, has the two important advantages that, within certain limits of resistance, it is applicable to any galvanometer; and that, when used with a ballistic galvanometer, the multiplying power of the shunt is unaffected by the extent to which the swings of the ballistic galvanometer are damped. The accuracy of ordinary shunt boxes is dependent on the temperature of the galvanometer coils, a quantity which is difficult to determine with any exactness. This defect is removed in the new form of shunt, as the accuracy of the latter only depends on the ratio of the resistances of the shunt coils. While, however, these advantages are beyond dispute, the further claim made that the resistance of the circuit is less altered when the new shunt is used than when the ordinary form of shunt is employed cannot be maintained. As a matter of fact, the change is sometimes greater and sometimes less. The fallacy in the argument given by the authors occurs in the last two lines of the appendix to their Paper, and arises from assuming that the resistance of the shunted galvanometer is always diminished when the shunt ratio is decreased. With the ordinary form of shunt, the change in the resistance of the circuit must always be less than that of the galvanometer; while with the new form, if, as is recommended, the resistance of the shunt is large compared with that of the galvanometer, the increase of resistance by using the shunt may be many times that of the galvanometer.

The experiments accompanying the Paper are only conclusive in showing that a galvanometer with a serious amount of damping, and therefore badly suited for ballistic purposes if the ordinary form of shunt is to be used, can be employed with the new form of shunt for the accurate comparison of condenser discharges. The results given for the comparison of currents are so nearly alike for the two forms of shunt, that the minute difference observed can quite easily be attributed to slight want of proportionality between the deflections of the

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galvanometer and the currents producing them. The selection of a shunt which happens to give a ratio of 99·63 for purposes of comparison was unfortunate, and greatly reduces the value of the experiments. The resuscitation of galvanometers with astatic needles and control magnets was hardly to be expected from Prof. Ayrton, who, we thought, had demonstrated the all-round superiority of suspended coil instruments.

The Paper read last week before the Institution of Electrical Engineers on the use of a hygroscopic varnish for the glass covers of voltmeter and other instruments was intended to be of a thoroughly practical character, and the idea will doubtless have its uses, especially in those climates in which you can light the gas by shuffling across the carpet and offering a knuckle to the gas-burner. When, however, the author of the Paper, instead of stroking the glass with his finger, rubbed it briskly, if not violently, with a handkerchief, the audience was convulsed with laughter. For three-quarters of an hour they had had an object lesson in the discomfort of naked glow lamps placed on a level with the eye, arranged, no doubt, to illuminate the dials, but incidentally facilitating the experiment by making the glass hot and dry. Just before the meeting, and not knowing which voltmeter had been varnished, we rather incredulously stroked the glasses of both instruments with a finger, as suggested in the Paper (which says nothing about rubbing with a dry handkerchief), and found no deflection in either case. In reply to an inquiry, we have received the following letter from an engineer of unusually wide experience:—

Manager's Office,
The —— Electric Supply Company (Limited),
London, W., April 17, 1894.

Dear Sir: I am obliged for your letter of yesterday's date, and am under the impression that Prof. Ayrton's varnish is to rectify a phenomenon rather than a common fault. Our instruments are now in a state of cleanliness which they have never before attained, for I have personally rubbed them until my arm ached, and have got my staff to do the same, but out of about 65 instruments I have only come across one which gives the amusement referred to, but this particular instrument does it so well that I must really tell you all about it.

It is a voltmeter with a scale up to 250 volts, continuous current, ordinary magnetic type, with a glass cover about 8in. diameter. I have this morning succeeded in obtaining a deflection 250 (volts ?) with the assistance of a tobacco pouch, this was simply stroked across the glass and quickly withdrawn. This rather shows there is a strong affinity between electrical pressure and tobacco. The instrument held the charge for a perceptible time, although it was in an ordinary engine-room in the usual African temperature, but the slightest moisture such as breathing on it dissipates the charge almost instantly, and then the instrument is none the worse, and all goes on merrily as before. But I find it very hard work breathing on the glass, for it requires a lot of puff, and requires some training for the art, such as one might obtain in a German band. I also find that rubbing the glass with a piece of paper gives far more pronounced results than an ordinary coat or cloth, &c. A piece of oily waste does nothing until the oil is polished away, but then, of course, the glass gets so much cleaner that this may possibly give rise to an impression that oil will not dissipate the charge. I cannot quite swallow the remarks about wiping the glass with the finger, or an accidental touch with the coat sleeve; I really have tried it, for my finger is sore, and I have almost worn a coat out with "accidental touching.' It really seems necessary to apply a certain amount of pressure and friction on the glass before an effect is produced, and it is quite clear that instruments are on the market and can be obtained, which will give rise to serious trouble if the men are too energetic in polishing up the instruments when they are reading them; but I have never known men to suffer much from this disease. As a practical source of annoyance I cannot believe it is so serious as Prof. Ayrton would have us suppose; even at the worst a strip of gold leaf inside a glass cover would obviate all trouble.

Of course, we must remember that other voltmeters will give trouble if treated in a particular manner—take, for instance, the Cardew voltmeter. One caused us to use bad language, for a greaser quite fresh to his work had been instructed to immediately cool any bearings, &c., which heated, and having, in his troubles, touched the Cardew voltmeter, and finding it hot he immediately swabbed it down with a bucket of cold water. Our customers said they had never had such a good light before, and very likely they never will again. I shall be pleased to show you the instrument I have mentioned any time you like to call here.

The working man is beginning to show signs of fighting against the employment of "mere electricians" in electric supply stations. This alleged flagrant violation of the principles of trades unionism has brought about a conflict between the Portsmouth Branch of the Amalgamated Society of Engineers and a set of men designated as "not mechanics but professional men," who are employed at the electric light station in order to "deal with no less than thirteen dials and work out mathematical calculations." The grievance of the unalloyed but amalgamated working engineers is that these "scientists" are receiving a *lower* rate of wage than the standard wage for mechanical engineers, and they are jealous that posts, which they consider could very well be filled by "the working man," should be held by men who do not enjoy the unalloyed happiness of being members of their amalgamated society, but who "the moment anything went wrong with the plant would be compelled to fly to mechanics for the execution of repairs." Further details of this incident will be found in our Trade Notes.

King's College Annual Dinner.—This will be held on Wednesday, May 30th, at the Holborn Restaurant. Sir Richard Webster will take the chair.

"James Forrest" Lecture.—There will be an extra meeting of the Institution of Civil Engineers on Thursday, May 3rd, at 8 p.m., when the second "James Forrest" lecture will be delivered by Dr. John Hopkinson, whose theme will be "The Relation of Mathematics to Engineering."

Electric Lighting Orders.—The Board of Trade has made Orders under the Electric Lighting Acts, relating to Barrow-in-Furness, Buxton, Chipping Wycombe, Chesterfield, St. Helens,' West Hartlepool, Grimsby, Harrow, Leyton, Monmouth, Peterborough, and St. Austell, and Bills to confirm them have been just laid before the House of Commons.

Cable Interruptions and Repairs:—

	Date of Interruption.	Date of Repair.
Garachico-Santa Cruz de Palma	Dec. 27, 1893	April 7, 1894.
Bonny-Cameroons	Mar. 21, 1894	April 16, „
Fao-Bushire	Mar. 20, „	April 9, „
Cayenne Paramaribo	Oct. 25, 1893	—
Bissao-Bolama	Nov. 24, „	—
Brest-St. Pierre (P.Q. Co.)	Mar. 29, 1894	—

' Singapore-Labuan Cable was opened for traffic on the 14th inst.

The Antwerp Exhibition.—One of the features of interest in the Antwerp Exhibition will be a number of exhibits illustrating the history and progress of the various forms of artificial illumination. All kinds of lights, from the early Pompeian and Roman lamps down to the most modern forms of electric lamp, will be represented. To electrical engineers a complete series of exhibits of this character would be both an interesting and instructive sight, and it is to be hoped that every effort will be made to make it as complete as possible.

Royal Society.—The following Papers were down for reading before the Royal Society:—Prof. Hartley, F.R.S., "On Variations observed in the Spectra of Carbon Electrodes, and on the Influence of one substance on the Spectrum of another." E. H. Barton, "Electrical Interference Phenomena, somewhat analogous to Newton's Rings, but exhibited by Waves along Wires." Lord Rayleigh, Sec. R.S., "On an Anomaly encountered in Determination of the Density of Nitrogen Gas." G. F. Emery, "Thermoelectric Properties of Salt Solutions."

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Electric Railways in London.—The Charing Cross and Hampstead deep level would, in the opinion of *The Statist*, be greatly improved if the line were to be extended across the river to Waterloo. "Then it would be possible to drop the parallel conception of the Waterloo to Baker-street line. Another hint. The extension of the City and South London railway is going to the Angel at Islington. There will be a terminus at that centre, and another of the Charing Cross and Hampstead line at Euston. Now, about half-a-mile of underground extension between these two terminals under the Pentonville-road, would give a splendid sweep of railway at very small cost, because there are no terminals to build. We could then run from Euston to Stockwell."

Waste Steam and the London Sewers.—In the London County Council's General Powers Bill now before Parliament a penalty not exceeding £20, with £5 a day for continuance, is imposed for discharging into the sewers "any waste steam, condensing water, heated water or other liquid (such water or other liquid being of a higher temperature than 110 degrees Fahrenheit), which either alone or in combination with other matter or liquid in a sewer may cause a nuisance or involve danger or risk of injury to the health of persons entering the sewers or be injurious to the structure or materials of the sewers or works of the Council." Any penalty under this section is only to be recoverable by the Council, and no proceeding under this section to recover any such penalty is to be commenced except in pursuance of a recommendation from the Committee of the Council charged with the management of the sewers after a report from the medical officer, chemist, or engineer of the Council.

Obituary.—Col. William Haywood, the engineer to the City Commission of Sewers, died on Friday last. He had occupied this post for 48 years. The construction of the Holborn Viaduct was carried out at a cost of nearly four millions under his direction, and among the many other important street improvements may be mentioned the construction of Queen Victoria-street. Col. Haywood took a very early interest in the introduction of the electric light to illuminate the streets of the City. He visited Paris with a Committee of the City Commission of Sewers in 1878, and again in 1881 in connection with the question. Under his supervision the sum of £12,000 was expended in experiment and trial by the Commission. His reports on the subject were numerous and exhaustive; but he had a strong aversion to the City authorities themselves undertaking to generate and supply the electric energy. He gave close attention to many of the details of the present system of street lighting in the City.

Capt. Abney on Photometry.—In his concluding lecture, Capt. Abney described the use of revolving sectors for reducing a beam of light. Fox-Talbot was the first to employ this device, and Mr. Kempe was the first to introduce a mechanism for altering the size of the opening while the sectors were in motion. He had used this system for 10 years and had never know it fail. He alluded to the work of an American experimenter who thought that an error was introduced when small openings were used. It was admitted by this experimenter that with monochromatic light there was no error; it followed that what was true for each ray was true for the sum of them. He would not waste the time of the audience over such fallacies. Various uses and modifications of the Rumford or shadow photometer were shown, as, for example, the measurement of the reflecting power of opaque screens, in terms of the reflecting power of white paper as a standard. The method of calibration of an absorption wedge, both for white light and for the spectrum by the use of a split beam was explained. The author concluded by showing the greater extinction of red than of green light when the luminosity was reduced. A screen illuminated by red light equal to the candle-power of an amyl-acetate lamp ceased to be visible at50ft., but an illumination by green light of the same candle-power ceased to be visible at 700ft.

Electric Cooking.—Homer sometimes nods, and the usually well-informed *Pall Mall Gazette* recently published an article extolling the electric cooking at the Chicago Exhibition, and making no reference whatever to the state of this art in England. Amends were, however, made on Monday last by a full description of Messrs. Crompton and Co.'s system. An oven, heated to 350°F., taking 25 amperes, is heated in a quarter of an hour with rather more than half a Board of Trade unit, and as there is no draught through the interior, as in a gas oven, it will retain its heat for an hour, and if more is required, a very small current will suffice. A frying pan takes 2½ amperes, and to boil water on a small scale for tea costs one-sixth of a penny. In the course of an interview, Mr. Crompton is reported to have said:—

The Americans are generally supposed to have invented this notion, and we to have stolen it; but, as a matter of fact, we are miles ahead of anything they have got in America, and I fairly startled an American who came to see our things fresh from the Chicago Exhibition. He refused at first to believe his eyes. The most important discoveries we have had to make relate to the enamels in which the wires are bedded, and to certain dry processes of manufacture. It was thought to be impossible for a long time to get an enamel that would resist the very high temperatures required without softening. We have found one at last, and now we use three kinds of enamel. First of all a coating of the hardest enamel is laid on the iron plate, and the little conducting wire is spread upon it. Then a second coat of enamel, not quite so hard, is laid over that; and finally, a coat of decent white enamel is spread over all. The difficulty used to be to put on the second layer without melting the first, and allowing the conductor to sink through and touch the iron plate. Another important change we have made is the substitution of nickel-steel wire for copper or some other metal, which was used at first. But the thing which has really settled the business, and made the industry a practicable one, is a method we have devised for crimping and laying on the fine wire by machinery on to a dummy plate, and so transferring it bodily to the enamel. Formerly it used to be laid on by hand, a difficult matter at the best, and most trying when you are dealing with hot layers of liquid enamel.

The New Atlantic Cables.—The cable-ship "Faraday," belonging to Messrs. Siemens Brothers and Co., has just left the Thames with the first portion of the Commercial Cable Company's new cable aboard. There are at present working ten Atlantic cables, and two more will be laid this year. Of these twelve cables, seven will have been made and laid by Messrs. Siemens. In 1875 Messrs. Siemens laid the Direct United States cable, in 1879 the French cable, in 1881 the northern Western Union cable, in 1882 the southern Western Union cable, and in 1884 two cables for the Commercial Cable Company. The following are the weights of material used in the manufacture of the third Commercial cable, which is in all 2,201 nautical miles in length:—Copper wire, 495 tons; gutta-percha, 315 tons; jute yarn, 575 tons; steel wire, 3,000 tons; compound and tar, 1,075 tons; total, 5,460 tons. The laying will be done in two expeditions; the first, which has just started, will comprise the shore ends and intermediate sections—in all about 700 nautical miles. The first section will be laid from Waterville, in Ireland, out into deep water, and the end will then be buoyed. The second section will be laid from Canso, in Nova Scotia, over the Great Bank of Newfoundland into deep water, and this end will then be similarly buoyed. The "Faraday" will then return to Woolwich to take in the cable for the second expedition, which will start in the middle of June, and will comprise the 1,500 nautical miles of deep-sea cable.——The new cable for the Anglo-American Company, to be laid from Valencia to Heart's Content is being manufactured by the Telegraph Construction and Maintenance Company, and it will be submerged during the summer; two of the latter Company's ships being employed in the operation. This cable, some 1,850 knots in length, will be mechanically and electrically probably the most perfect cable yet manufactured. The conductor will contain more copper to the mile than that of any submarine line yet made, which will give a very high speed of transmission—over 40 words per minute. The 1873 Atlantic cable has never required any repair to the deep sea portion since is was laid 21 years ago, and there cannot be any doubt that cables recently constructed, with all the knowledge acquired by the experience of the past, should have a much longer life and greater immunity from interruptions than in the case of those laid in the earlier years of submarine telegraphy. Of the fifteen cables (including the three earliest, not now working) which have been laid or are about to be laid between Europe and North America, eight will have been made and laid by the Telegraph Construction Company, viz, those of 1858, 1865, 1866, 1869, 1873, 1874, 1880, and 1894.

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THE TESTING OF ENGINES AND BOILERS.*

BY PROF. ALEX. B. W. KENNEDY, F.R.S.

LECTURE II.—ENGINE TESTING.

The lecturer said that he would in this lecture confine himself entirely to engine testing, and in order that he might keep himself within reasonable limits, he would practically confine what he had to say to the testing of steam engines of a stationary type; he should not speak of locomotive or marine engines, nor of gas engines.

In engine testing they were looking for two quantities essentially, first the consumption of water per horse-power hour, and secondly the ratio of net to gross power, or what was commonly called the mechanical efficiency of the engine.

He would take the question of water measurement first. Water might be measured for engine trials in two ways, either into the boiler or out of the engine. As to methods of measuring into the boiler, he had practically nothing to add to what he had already said in his previous lecture. He would only give them one caution, which did not affect the question of boiler testing but did affect engine testing. Sometimes, where they had a very big boiler and a very small engine, they were tempted to measure the steam used by the engine by getting the water high in the glass to start with, evaporating it until it stood low in the glass, and then measuring it by pumping in enough water to fill up the glass to its original level. This should never be done. The errors caused by change in the mean temperature of the water in the boiler and by the vagaries of the gauge might be 20 or 25 per cent. of the quantity evaporated.

By measuring the water that was used *out of* the engine was meant, of course, measuring the steam after it was condensed. That could be done easily and readily by any of the methods of water measurement which he had mentioned to them, if only they had a surface condenser to work with. If they had not a surface condenser, it was obviously out of the question, although of course possible by certain calculations. But it was obviously an undesirable thing to calculate any quantities which were capable of being directly measured. So for practical purposes they either measured the water as it went into the boiler, or, in the case of a surface condensing engine, they measured it when it came out of the engine. He need hardly say that there were many advantages in the latter plan if only they could carry it out practically, because the water that went into the boiler did not all get to the engine *as steam*. Not only might there be priming in the boiler, but also a good deal of steam actually formed might sometimes be condensed in the steam pipes and get to the engine finally only as water. Therefore, to find out the amount of actual steam which got to the engine as steam it was well to use a separator just before the engine in the hope that the separator would catch all the water in the steam before it got to the engine, and so allow it to be measured separately. He need hardly say that they had not yet, unfortunately, got a convenient form of portable surface condenser, so that nearly all engine tests which they might have to carry out would have to be made by measuring the water into the boiler. In that case they had to be doubly particular about correction for height of water level, and the thing to aim at was to make that correction as small as possible by keeping the level as nearly as possible constant during the whole running of the test.

As to the duration of an engine trial, this need not be so long as the boiler trial if only they could get the conditions steady. They could not get the conditions of combustion in a furnace steady under a very considerable length of time, as he had pointed out before. But if they were measuring the water out of the engine; if, for instance, they were letting it run into a large tank on a weighing machine, so that they could tell exactly how long each 100lb. took to pass through the engine into the tank, it was occasionally possible with steady working to get a good trial even in half an hour, quite easily in an hour. Suppose, for instance, that they found that the time intervals per 100lb. of water were consecutively 1min. 52sec, 1.53, 1.50, 1.52, and so on. If this went on for half an hour they might safely consider they had got into steady condition, and in such a case half an hour might be sufficient to give them a trustworthy figure—one which would continue the same if the trial continued for ten hours. They could not, however, do that if they were measuring the water into the boiler. In that case the trials must be much longer; it was generally a matter of several hours even as a minimum in the case of an engine trial.

Incidentally, between the water and the power measurement, they required to know the steam pressure, rather because it was an important piece of information, along with the steam temperature, than because it was actually much used in engine-trial calculations. The steam pressure would be read by means of a steam gauge; and of all the lying pieces of apparatus for which engineers were responsible perhaps steam gauges were the least trustworthy. The best thing to do, no doubt, if they wished to gauge the pressure fairly accurately, was to put a steam engine indicator with a tested spring on to the boiler beside the pressure gauge and calibrate the pressure gauge by the indicator.

Now as to power measurement. Here three quantities were required: (*a*) the engine dimensions; (*b*) the mean piston pressures; and (*c*) the speed. It was no use getting the mean pressure right to seven places of decimals if they made a mistake of one revolution per minute, which would often correspond to an error of 1 per cent.—each of the three quantities required to be found with the same degree of accuracy.

As to the engine dimensions he might just remind them that if they were testing an engine about which they did not know anything, and if something depended on the result, it was advisable to have off the covers and guage the real dimensions for themselves. They would also not forget to make an allowance for the rods in the cylinders.

Assuming that they had got the engine dimensions right the two other matters were those to which they would pay most attention. Let them take the pressure first; that was to say, the thing which they measured by the use of a steam-engine indicator, because, as they knew, no engineer or inventor had been kind enough to bring out for them a power measurer which would really integrate the work done by the engine. From the indicator diagram they really measured only the mean height, or pressure, and not the area or work. It would be a very great benefit to all who had to do with the running of any kind of engines if they could find out at any instant the rate at which work was being done. Such pieces of apparatus existed in books, and he believed they had been made. He was afraid it would puzzle them very much to buy one. They must therefore content themselves with using an indicator as a method of measuring pressures. Of course, in measuring pressure they depended on two things—first, the mechanical accuracy of the indicator, the size of its cylinder, the ratio of its leverage, and so forth, which could be reasonably well tested; and secondly, the accuracy of the indicator spring.

Since the Crosby type of springs had been introduced, much more reliance could be placed on indicators than was formerly possible. Probably few of them could in their ordinary work really test indicator springs, but it was always possible to get them tested against a mercury column, and it was very advisable to have this done from time to time. Time would not allow him to discuss different types of indicators. He supposed most of them who had to do with high-speed engines at any rate used Crosby indicators. There were other indicators for high-speeds in the market, but they were newer and not so well-known. There were, of course, also the older types of indicator, now very much improved in construction, which were perfectly useful and reasonably accurate for all speeds up to say 80 or perhaps 100 revolutions per minute. Indicator gear, the apparatus for driving the indicators, formed a subject about which a good deal had been written.

It was a very useful exercise, which he believed he had more than once set to his old students at University College, to find out the possible error in an indicator card caused by a peculiarly bad arrangement of indicator gear. His recollection of the matter was that they had to arrange their indicator gear uncommonly stupidly in order to produce any sensible error in the diagrams! He thought, therefore, the

* Two lectures delivered at the Finsbury Technical College, Dec., 1893.

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question of indicator gear might on the whole be left to the common sense of the engineer in charge of the test. Some of his own assistants, he thought, would say that it was a much greater difficulty that the indicator gear was sometimes so made that if anything went wrong to it they had to stop the engine to put it right. This also is mere matter of common sense. There were two or three things they required specially to note. The use of strings that were longer than was absolutely necessary was to be avoided ; the use of steam pipes to their indicators which were longer than was absolutely necessary was to be much more avoided ; and when those pipes were comparatively small in area they had to be avoided altogether. He was not prepared to say that with a slow-running engine they might not get very fair results—probably correct results—from an indicator placed on the ordinary double mounting connected to each end of the cylinder by one pipe with a three-way cock below the indicator ; but it was not an advisable arrangement to use, and was very liable to cause considerable error unless the pipes were of very ample dimensions indeed ; he meant unless they were ¾in. bore, or something like that. But the arrangement should certainly not be used if the engine were a high-speed one. In that case they should make the pipes perfectly straight, put the indicator right on the end of them, and keep everything as short as they possibly could. He might, perhaps, give them one or two practical hints about the indicator cards, as to what they should put on them and what they should do with them. The best rule on the whole was to put as little on the actual indicator card as possible. He was supposing now that they were carrying out a trial in which they might have to take from 20 to 30 sets of indicator cards, each set, perhaps, having four or more diagrams. The main thing to have on each card was a number and a date. One indicator card was very like another, and after they had been lying in an office for months the only way of identifying them was by the date, which should be marked by a date stamp. What they really required for their indicator cards was a log-sheet, which should have something like this information on it : in the first column "Time," in the second the number of the diagram, in the third the revolutions per minute, and in the fourth possibly the steam pressure at the engine. It really was of no use writing a lot of statistical information on the back of their indicator cards when they were carrying out a test. It was very nice if they had one set to show everybody, but for serious testing it was only a nuisance.

He had with him a little set of rules which he made out in connection with some very important trials which he was carrying out a little while ago, and he added them here in case they might be of use to his hearers.

Instructions for taking Indicator Diagrams.

See that indicators have the proper length of stroke and are not on their stops.

Blow through before taking every card.

Mark number of card in top right-hand corner.

Let H.P. top cards begin with No. 1, H.P. bottom with 101, I.P. top with 201, I.P. bottom with 301, L.P. top with 401, and L.P. bottom with 501.

Let top and bottom cards of each cylinder be taken as nearly as possible together, and the whole set as quickly as possible.

After having taken a set of cards and entered time in log, &c., put on the new papers at once for the next set.

Draw atmospheric line by hand with full stroke of indicators.

In cases where the work is divided into watches, proceed as follows :—

First watch to get indicators ready before starting, and note numbers of indicators and marks and scales of springs on log sheet.

Second watch to verify these numbers and after taking last cards on the watch interchange top and bottom indicators of each cylinder.

Third watch to verify the changed numbers.

Fourth watch, after taking last set of cards, to take off indicators, verify the springs, and put them in boxes.

Examine every set of cards before putting away, to detect anomalies or errors. Compare top and bottom cards of each cylinder for length, pressure and general appearance. If any difference is noticed, or anything suspicious about cards, report at once to engineer in charge of the test.

Keep the indicator boxes shut, and the papers in them.

Most of these points would be well-known to any of them who had been taking indicator cards largely, but certain points might possibly be novel.

It was a very good plan in the middle of a trial, especially if the cards had been at all queer, to change the indicators from top to bottom, and *vice versa*; they might sometimes find out then that the fault had been due to the indicator, or make certain that it had been due to a valve set. One other thing. While the cards were being taken, keep an eye on them. He meant, do not take them as a matter of course and finally put them away and go on to another set, but examine them carefully and see if there is anything suspicious about them. By doing that they could "spot" an error and be able to say whether it was an error in the indicator or in the engine. When taking the cards let the pencil go over each a dozen times or more. They should not upon any account entertain the horrible idea which some people did, that it was nice to have but one line ; it might make a pretty card, a cleaner line, and so on, but that was not what they were seeking—that was obviously a matter of no importance.

Supposing they had got their cards, the next thing was to get a result from them ; that was to say, to measure the mean pressure. Suppose their indicator springs were checked, or that they knew that they were right, that they had got their diagram, and that they now wished to get the one result for which they took that diagram. He was surprised to find a little while ago that diagrams were still being calculated by the laborious process of dividing them into ten parts, then measuring and writing down separately the pressure at each tenth—even putting it sometimes separately above and below the atmospheric line—then adding together and dividing by ten. He hardly imagined that any student of the Finsbury College would use—or perhaps even know of—this method! He need not say there was no occasion for it at all, unless they wished to give the largest possible chances of error. Probably the best way of measuring indicator cards was by means of a planimeter. He thought, on the whole, a planimeter, carefully used, and taken round every card twice, would be more likely to give correct results than any measurements of ordinates. But planimeters were not always at hand. When without a planimeter the best plan was one of which Mr. Maw, the editor of *Engineering*, had told him long ago ; he did not know whether it was original with him, or from whom it came. It was simply this : divide off the card into the usual ten parts, draw the lines if their eyes were not sufficiently accurate to guide them square across the atmospheric line, then take a long strip of paper, at least ten times as long as the height of the card—sectional paper of the length of foolscap would do—mark the height of the first division upon it, then move the strip until they got to the next division, mark that, and move on to the next, and so on. Then the marked length on that piece of paper was the sum of the lengths of the ten divisions, and the only error they could have made would be the error of parallax in marking the paper when they put it right on to the indicator diagram, which was a very small error. They did not have any arithmetical error in adding up their ordinates, because they had not measured them separately, they simply measured with the ordinary scale of inches divided into tenths, or whatever it might be, and simply marked off the decimal place. On the whole, he thought that was the quickest and most accurate method of getting the mean pressure from an indicator card if they had not a planimeter. If they had a planimeter they should use it. Those who did use them most could generally put them up to a few little dodges for reading them without absolutely destroying their eyesight before they grew old! When they had got their mean pressure they wanted to calculate from it the indicated horse-power. (They would suppose for a moment that they had got their speed.) There were one or two matters connected with the calculation of power from cards which were worth remembering. If they had a great number of cards in one trial all taken at about the same power it was obviously unnecessary

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for them to calculate the power of them all. They would calculate the mean pressures for them all and then find the mean mean pressure and get the power from it. That would save them a good deal of arithmetic. In any case, of course, they would use an "engine constant." That was to say, they would not go through the formality of multiplying by the area and dividing by 33,000, or whatever it might be; they would use an engine constant which was really the power the engine would give out with 10lb. mean pressure and 100 revolutions per minute, or something of that kind. That engine constant included all the arithmetic except the speed and the mean pressure, and as those were variable they could not, of course, include them in any constant. They would find it extremely convenient, if the engine were a compound one, to reduce the mean pressure to the low-pressure cylinder and to work finally with only the pressure reduced to the low-pressure cylinder. Until they had used that method of working they would hardly know how convenient it was, and what an insight it gave into the extent to which engines were fully loaded. They knew, for instance, that an engine working with 150lb. boiler pressure might have a mean pressure reduced to its low-pressure of 45lb., 50lb., or 55lb., depending on the ratio of expansion, and so forth. If in such an engine they found the mean pressure reduced to the low pressure cylinder was only 25lb., they at once had an important piece of information, that that engine was working with such a high ratio of expansion that it was only doing about half the power it was capable of doing. He did not say that it ought to do double the power, but they knew it was only doing half, and that was a piece of information which it was often rather important to have. The only way of getting it clearly in their minds was to have all their pressures reduced to the equivalent pressure on the low-pressure cylinder.

He would now go on to the consideration of the measurement of the speed of the engine, that was the number of revolutions per minute. This was done in three ways. It might be done by a counter or by a tachometer, or simply by the use of a watch. The counter might be of two kinds. For most engines, at any rate for those which did not run too fast, it was better to have a regular Harding counter, an integrating counter, one that told the total number of revolutions made from the beginning. That was the ordinary form of counter with a dial more or less like a gasmeter dial, one which carried automatically. Assuming the counter to be working right, it would give absolutely the number of revolutions made during the trial in a way that nothing else did. It did not give the number of revolutions made at the particular instant when they were making diagrams; but if they had a long trial and many diagrams that did not matter. There was another good counter, called the Eddy counter, a very ingenious thing, which had a piece of clockwork inside it. It ran for half a minute, and was driven by the engine itself when pressed against the end of the shaft. They had only to set the counter to zero, put it against the shaft and let it run. The number of revolutions could be read off from a dial. He had tested this counter, and it certainly was convenient. It, however, had the drawback that they could not check it. They could only check it by comparing it with a stop-watch, and comparing two half-minutes on the stop-watch and another on the counter was not easy. There was a very nice counter recently brought out, called May's counter, a counter with a dial something like a watch face, which they merely pushed up against the engine shaft in the usual way, allowing it to run for a certain time by the watch. The only particular point about this was that it ran either way and recorded either way rightly, having a very pretty reversing apparatus inside. Or they could take another of the common forms of counter. As, for instance, the very good Harding counter of the same type, which could be pushed up against the end of the shaft. There were two things they needed particularly to notice. One was that the end did not shift on the shaft. It was very liable to do so if the holes were not good; that was to say, if the pin on the end of the counter did not bite the punch mark on the centre of the shaft. They could feel if it slipped, but of course could not make the correction. They could sometimes get over that by using india-rubber on the end of the counter pin, or anything to make it stick. The second point was a much more important one. Any counter, except Eddy's, was dependent on the time for its correctness. For that there was nothing like the ordinary stop-watch, one that could be started by the pressure of the finger in the usual way, because there was no difficulty in holding the counter and the watch close together, or in making the two actions simultaneously. They could easily withdraw the counter at the instant the large hand of the stop-watch got round to its minute or half-minute. He strongly advised them to make it a minute; errors were not always easy to avoid with half a minute, especially if they were not quite accustomed to doing that kind of thing, and especially if they had not a watch with a centre-seconds hand that went right round the dial. It was not at all easy to get an accurate reading for a minute, still less for half a minute, on the seconds hand of an ordinary watch.

Then they could get the readings by the tachometer, which registered automatically the speed per minute. It had a pointer whose indications were proportional to the speed, and from which they could read off from the dial the exact speed. This was mainly of importance as telling them whether or not their engine was running steadily. They must never trust to its indications until they had actually checked them by a positive counter of some kind. After they had checked a given tachometer with a positive counter, and found it right, they could, of course, trust it, or at least for a certain time. Or, lastly, they could get the revolutions in the ordinary way by counting either by ear, or by letting some part touch the hand. But in this case they should never forget that it was necessary always to begin counting with "nought," and not with "one," otherwise they would have one revolution too many.

He would emphasise that it was no good taking special pains, getting their indicator springs checked and using the very best instruments they could get, and taking all sorts of elaborate precautions if they counted the speed for half a minute in a careless sort of manner, for an error in the speed had just the same effect as an error on the indicator card.

The next thing, and a very important one, was, the resistance on which the engine was to be worked, especially if they wished to find its mechanical efficiency. Of course, if the engine were working a factory, or anything of that kind, they were simply getting the gross indicated horse-power, and that was all they could measure; but if the engine were being tested for mechanical efficiency, they wished to find something for it to work on, and they must find some kind of resistance, generally in the way of a friction brake. Engineers had been working for many years at a transmission break, an instrument which should transmit power and measure it while it transmitted it. There was not very long ago a very neat transmission brake in that building of Prof. Perry's, but he did not think that it had been made on a large scale. There was in point of fact no transmission brake made on any very large scale. Therefore they had to use an absorption brake, which actually took up the work that was being done. The most convenient brake for them to use under all circumstances was, no doubt, a rope brake, such as he believed was first used by one of Messrs. Ransome's foremen for a rough trial conducted somewhere in Egypt, and described by Sir Fredk. Bramwell many years ago. There was a flywheel to the engine, or a pulley put on specially for the purpose. Around that pulley was carried a rope, or two, or three, or four ropes, a weight was attached at one end, and a spring balance fixed at the other. The actual weight on the brake was, of course, the difference between the value of the weight and the readings on the spring balance. Both these could be accurately measured, and the radius to the centre of the rope. When those measurements were made, the speed and the brake power could be measured quite accurately, independently of co-efficients of friction, or of balancing or adjusting levers, or anything of the sort. A brake such as that he exhibited could be made very easily indeed. That brake was used at the Society of Arts' trials a good many years ago, and the whole thing was worth only a few shillings. It was a very cheap instrument for an instrument of such extreme accuracy. This particular brake at the Society of

Arts' trials carried about 15-brake horse-power; it consisted of two ropes of ⅝in. in diameter. It ran on a flywheel of 5ft. 6in. diameter at 160 revolutions, and carried a net weight of 177lb. The wheel was not cooled artificially or lubricated in any way, and that was the very outside weight they could have got out of it without overheating, so they might take that as rather a limiting case. In another case, where he was able to cool the flywheel with water, he had a flywheel 5ft. 9in. in diameter running at 137 revolutions, and he got a net weight of about 300lb. on it, and took up a brake horse-power of 19 instead of 15, with exactly the same brake, the difference being that in that case the flywheel was cooled. The largest brake that he had used, and he should fancy the largest rope brake that had been used, at least in this country, was on a flywheel 16ft. in diameter, running at 75·8 revolutions per minute. If they worked that out, he thought they would find about 44 miles an hour to be the speed of the fly-wheel rim. The net weight on the brake was about 300lb., and it took up 91 B.H.P., with four ropes in parallel each 1in. diameter. With those proportions they might be quite comfortable about the brake. The only thing was they had to keep it cool. In that case the fly-wheel was especially good, its rim was made trough-shape, and all that was necessary was to arrange a cock, always letting a little water run into it. The water was evaporated, and all that was necessary was to keep enough water in to prevent the wheel from ever becoming dry inside. He had had many trials with that brake, and never found the slightest trouble with it.

When they had got their indicated horse-power and their brake horse-power they had the efficiency of the engine at one power only. That might be sufficient for their purposes; it depended upon their object in making the trial. It certainly was not sufficient if their object was to know as much as possible about the engine. If they wanted to know fully how the engine was running they must make tests of it at different powers. They must measure, for instance, the brake horse-power, the indicated horse-power, and the total water consumption per hour at quarter load, half load, three-quarter load and full load. If this were done with care and completeness it would enable them to make such a diagram of mechanical efficiency and of water consumption at different loads as would practically tell them all the leading characteristics of the engine. For the best method of drawing such diagrams and the methods of dealing with them he could only now refer them to Mr. Willans' two Papers read before the Institution of Civil Engineers and the discussions on these Papers. If circumstances did not allow them to make the progressive trials really complete, it was worth while to get at least the consumption at half load as well as at full load. A diagram drawn from two sets of power measurements only was, of course, not a complete one; but it would certainly give them very much more than double the information that they would get from one set of power measurements only. At each load at least three complete sets of indicator diagrams should be taken. He had not specially mentioned above the taking of diagrams at no load—that is, with the engine running empty, because, although the results if accurate, were very valuable, the taking of these diagrams correctly was a difficult thing to do, and the power taken up by the engine running light was probably obtained more accurately from the curve than by direct measurement. The reasons of this would be familiar to any who had tried to take light cards. They were, first, that such cards were very apt to have loops in them, and the presence of such loops exaggerated very much all the errors caused by the springs. In addition to this, it was very difficult to keep the speed accurately steady at light loads, and any increase or decrease of the speed just at the instant while the cards were being taken would out of all proportion increase or decrease their area. It should be remembered, however, that for the taking of light cards it was not important that the engine should be run up to full speed. It should only be run at such a speed as would ensure that the cards would be quite steady. From these the value of the pressure reduced to the low-pressure cylinder could be obtained, and from it the indicated horse-power at any speed.

He was sensible that in the time at his disposal, although he had already exceeded the usual limit, it was quite impossible to cover the whole ground of such a large subject as that on which he had been speaking. He hoped only that he had been able to put before them a few of the more important points connected with it with which his personal experience had chanced to make him familiar.

THE ROLLASON WIND MOTOR.

We give this week an illustration of a small windmill plant for electric lighting by wind power, which is now to be seen in a field near Willesden Junction. The motor is designed to develop a maximum of 5 H.P. with an estimated wind velocity of 18 miles an hour; at very much higher winds than this, it being found advisable to switch the motor off the dynamo rather than to utilise the power it might develop. At the particular locality in which the mill is now placed, an average

The Rollason Wind Motor.

wind of from eight to 10 miles per hour can, it is said, be relied on for 10 hours a day. The wind motor is mounted on a light wrought-iron structure, and consists of four vanes measuring, over all, 19ft. by 20ft. These vanes are set at right angles to one another around a central vertical shaft, and each vane has the shape of a circular cylindrical segment. The driving force of the wind is directed upon the concave sides of the vanes; and, to eliminate back pressure on the convex sides, as they beat up towards the wind, these are protected by a screen. This screen is seen in the illustration, to the right of the central spindle. The position of this screen is automatically shifted when the direction of the wind shifts, so as to expose a maximum of vane surface on the driving side in winds from every quarter. The normal speed of the vertical shaft is seven revolutions per minute; and, at this rate, the dynamo which it drives makes 500 revolutions. The electrical power developed can either be stored directly in secondary batteries, or run

on to the lamp circuit with these batteries in parallel as pressure regulators. The electrical plant at Willesden Junction comprises 27 E.P.S. cells of the T type, each cell containing 15 plates; together with a number of complicated devices for preventing the light from fluctuating with the vagaries of the wind, as well as for throwing the wind motor out of gear when the wind is either too high or too low. We understand that the price of the motor is £200, exclusive of the electrical plant and fittings, or about £40 per maximum horse-power developed. From the meteorological records, the promoters of this wind motor estimate a mean of about 3 H.P., which would bring the cost per horse-power developed up to about £67; but we should be disposed to consider an all-round average of 2 or 2½ H.P. as being more nearly what might generally be expected, to say nothing of the losses which must take place between the motor and the lamp mains. It will not, therefore, be very wide of the mark to estimate the cost of motor plant alone at not less than from £80 to £120 per average useful horse-power. The electrical plant would, owing to its greater complexity, be more costly than usual, and might very well be estimated at not less than £120 per average useful horse-power, bringing the total prime cost up to more than £200 per horse-power. Now, a good gas engine of small power can be obtained for about £24 to £30 per horse-power, and the cost of electrical plant driven by such is not much greater; while a far less cost of up-keep and repairs might be expected, than in the windmill plant with its complicated system of storage of power. One further point: we do not see how it would be possible to build a very much larger motor than the sample one at Willesden Junction, so that anyone who needs more than about 3 H.P. would be under the necessity of erecting two—perhaps a whole row—of these engines.

AN ASTATIC STATION VOLTMETER.*

BY PROF. W. E. AYRTON, F.R.S., AND T. MATHER.

The rapid development of electric lighting generating stations during the past three years has resulted in a greatly increased perfection in the regulation of the pressure, and consequently has created a need for measuring instruments of much greater precision than was previously required. At the same time, the powerful dynamos now employed, and the large currents that flow through the mains on the switchboards at these generating stations, has greatly increased the disturbing influences to which electro-magnetic measuring instruments are subjected. Consequently, it is not to be wondered at that voltmeters and ammeters which answered fairly when the output of the stations was small have had to be discarded as being unsuitable for the present requirements.

The authors have, therefore, been engaged for some time past in developing an electro-magnetic voltmeter to fulfil the following conditions:—

1. Be unaffected by an outside magnetic field, whether uniform or not, and as strong as the disturbing magnetic field on any ordinary central station switchboard.

2. Be unaffected by an outside electrostatic disturbance such as is produced on rubbing the glass front of the instrument.

3. Have no temperature error.

4. Have a high resistance, so as to measure equally accurately the *true* pressure at the end of long thin pilot wires, or in the station itself.

5. Have a scale of large radius, and one very open at the working pressure, so that a small change in the pressure can be detected.

6. Be dead beat.

Condition No. 1 is most easily fulfilled by employing a powerful stationary permanent magnet and a moving coil, for such an arrangement has the great advantage that it cannot indicate a pressure unless a current be actually flowing through the coil; whereas soft iron and other types of voltmeters, when placed in a fairly strong magnetic field, may have the pointer deflected across the scale when no current whatever is passing through the instrument. But it is not sufficient to merely employ one permanent magnet and one moving coil, as is proved by the fact, which is probably not generally known, that the very beautiful Weston voltmeter,* in spite of the permanent magnet being strong, and the air gaps in which the coil moves being extremely small, indicates slightly differently when put in different positions in a magnetic field, even as weak as that of the earth's, the change in the reading being about one-fifth per cent. when the instrument is placed horizontally and turned through an angle of 180deg. in a horizontal plane. This voltmeter, therefore, cannot, of course, give constant indications in a varying magnetic field 50 or 100 times as strong as that of the earth's. Now, Messrs. Clark and Malpas have found, by experimenting with our portable magnetic field tester, that a field of 20 C.G.S. units, or one rather more than 100 times as large as that due to the earth, is the sort of magnetic disturbance that occasionally occurs on the switchboards of existing central stations, while fields of six C.G.S. units—that is, 30 times the earth's field—are quite common.

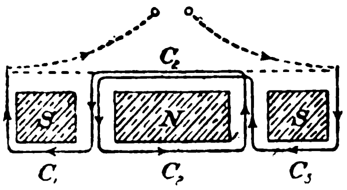

FIG. 1.

If the coil be wound astatically, and be acted on by two powerful permanent magnets inside the voltmeter, with their poles oppositely directed, good screening can be obtained from a uniform disturbing magnetic field; but errors will be produced if the disturbing field be *non*-uniform, such as is caused by a mass of iron, or by a conductor carrying a current, placed near the voltmeter. We have, therefore, carried this principle of astaticism further by employing *three* permanent magnets and a coil wound in three parts, as shown diagrammatically in Fig. 1, the area of the middle coil being double that of either of the end ones; and in this way we have obtained an arrangement which is comparatively unaffected by either a uniform or a non-uniform magnetic disturbance.

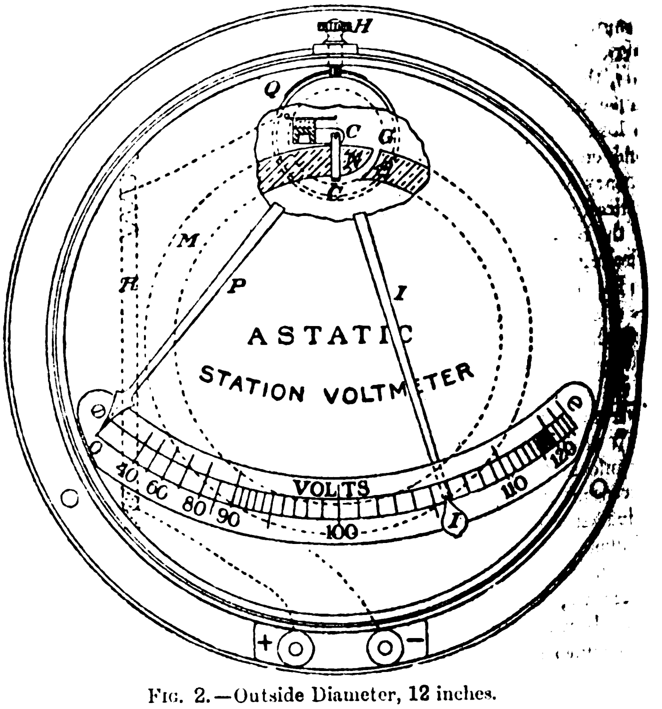

FIG. 2.—Outside Diameter, 12 inches.

The moving coil principle also enables conditions 3 and 4 to be fulfilled, for the resistance of this 100-volt instrument is about 7,000 ohms; and as only 3 per cent. of this is composed of copper wire —viz., that wound on the moving triple coil—while 97 per cent. is of manganin wire, indicated by the stationary coil R in Figs. 2

* Paper read before the Institution of Electrical Engineers, April 12th.

* Tests made from month to month of the sensibility of two of the latest form of the Weston voltmeter show also that the sensibility slowly *increases*. This arises, probably, from the permanent magnets having been too much weakened before these instruments were originally calibrated, so that the magnets have *increased* their strength with time. These two instruments now read 1·3 per cent. and 1·7 per cent. too high respectively, after allowing for the fact that the unit potential difference employed in the original calibration was the legal volt, and not the "Board of Trade" or "International" volt.

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and 3, the temperature error is practically negligible. This high resistance also causes the power required to actuate the voltmeter to be very small, not more than about $1\frac{1}{2}$ watts being absorbed at 100 volts with this voltmeter.

The control is produced by a weight, because this is the method of exercising a controlling force that is least likely to vary, and because the objection to the employment of a gravity control—that the voltmeter cannot be used in any position—is of no importance in the case of a switchboard instrument.

Fig. 2 shows the voltmeter in elevation, while Fig. 3 gives a plan; both figures being drawn partly in section, so that the working parts may be more clearly seen. The triple coil, C_1, C_2, C_3 (Fig. 1), passes over the poles of the three magnets, M_1, M_2, M_3 (Fig. 3), the direction of the winding being such as to cause the deflecting forces for each portion of the coil to be in the same direction. The current is led up to and away from the coil by very thin flexible silver strips attached to the points of the stationary pieces w, w' (Fig. 3).

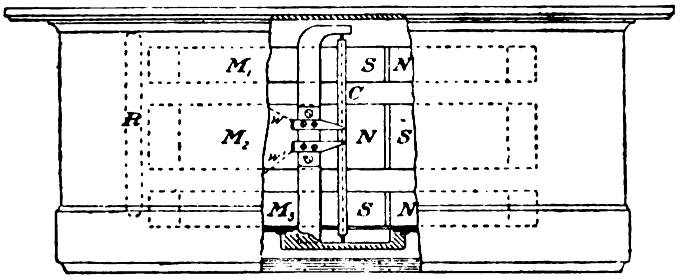

Fig. 3.

Conditions 5 and 6 are satisfied by specially shaping the air gaps, and we find that without sacrificing the quickness of motion of the pointer P too much, we can flatten the calibration curve at the working part of the scale so that 1-100th part of a volt variation in the pressure can be detected.

A bit of the scale, *full size*, is seen in Fig. 4, and, although large and bold, an additional means for indicating whether the pressure is correct or not is provided by means of the index I (Fig. 2). This index can be moved and set at any desired position by turning the milled head, H, which actuates a crown wheel segment, Q, carried by the ring to which the arm I is attached. This index arm is coloured *red*, while the pointer P and the arrow-head at the lower end of the index arm are coloured *black*. If the pressure be exactly right, the red index arm is entirely covered by the black pointer; whereas, if the pressure be high or low, red is seen to the left or right of the pointer respectively. An attendant can, therefore, see from a distance of many yards whether the pressure has exactly the desired value,

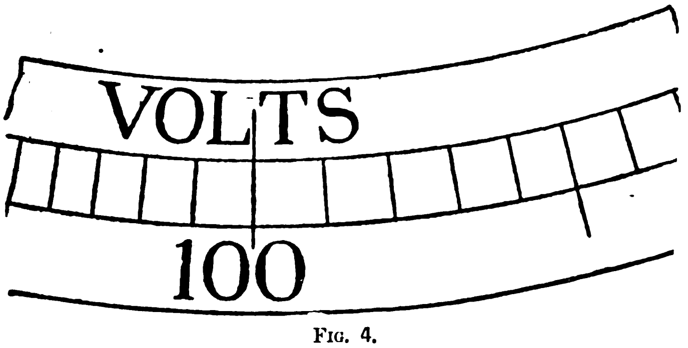

Fig. 4.

or is above or below it. The same milled head, H, works the arrangement for clamping the moving parts during transport; but this clamping device is so arranged that the moving parts cannot be clamped as long as the pointer is on any part of the graduated scale; hence there is no risk of the coil and pointer being accidentally clamped while the voltmeter is screwed up to the switchboard. To clamp the moving parts before removing the voltmeter, take out the two side screws that hold the voltmeter to the switchboard, and turn the instrument around the top screw until the pointer is deflected to the left of the graduated scale; then turn the milled head so as to bring the index up to the pointer, when the moving parts will be firmly clamped.

Lastly, the inside of the glass cover is coated with a layer of our transparent conducting varnish, described in the previous paper read to-night, and the instrument is thus screened from outside electrostatic action. Hence there is no fear of a change in the reading being produced by cleaning the glass—a very serious source of error, which is not uncommon with electro-magnetic voltmeters in actual use in electric light central stations.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, April 20th.

Institution of Mechanical Engineers.

7:30 p.m. General Meeting at 25, Great George-street. The following Paper will be read:—"Description of a Fluid Pressure Reversing Gear for Locomotive Engines," by David Joy.

Institution of Electrical Engineers.

8 p.m. Students' Meeting at 28, Victoria-street. A Paper will be read on "Secondary Batteries," by G. C. Allingham.

Royal Institution.

9 p.m. Evening Discourse: "Early British Races," by J. G. Garson.

TUESDAY, April 24th.

Royal Institution.

3 p.m. Afternoon Lecture: "Electric Illumination," by Prof. J. A. Fleming, F.R.S.

Institution of Civil Engineers.

8 p.m. Ordinary Meeting. The following Papers will be further discussed:—(1) "The Training of Rivers," by Leveson Vernon Harcourt, M.Inst.C.E. (2) "Estuaries," by Henri Léon Partiot.

WEDNESDAY, April 25th.

Society of Arts.

8 p.m. Ordinary Meeting. The following Paper will be read:—"Some Recent Developments of Photographic Chemistry," by Chapman Jones, F.C.S.

THURSDAY, April 26th.

Society of Arts.

4:30 p.m. Indian Section. The following Paper will be read:—"Municipal and Village Water Supply and Sanitation in the North-West Provinces and Oudh," by Sir Auckland Colvin.

Institution of Electrical Engineers.

8 p.m. Ordinary Meeting. The following Paper will be read:—"Cost of Electrical Energy," by R. E. Crompton, M.Inst.C.E.

FRIDAY, April 27th.

Physical Society.

5 p.m. The following Papers will be re :—(1) "The Mechanism of Electrical Conduction," by Dr. C. V. Burton. (2) "A Graphic Method of Constructing the Curves of Current in Electro-Magnets and Transformers," by Major Hippisley, R.E. (3) "The Design and Winding of Alternate Current Electro-Magnets," by Prof. S. P. Thompson, F.R.S.

Royal Institution.

9 p.m. Evening Discourse: "Action of Light on Bacteria and Fungi," by Professor H. Marshall Ward, F.R.S.

*** Particulars of meetings to be held or Papers to be read before Scientific Societies during the ensuing week should reach us not later than Thursday, 6 p.m.

Another Amperian Rule.—So many rules have been published, giving the relative directions of the current and the lines of force or whirls surrounding it, that a writer in the *Electrical World*, of New York, has to apologise for introducing a new one. The apology in this case is the same as the one usually given, that the author believes it to be simpler and more easily remembered than the others. The present rule applies to the direction of the lines of force encircling the wire. To remember the direction of the magnetic whirls around a current, one has only to remember that if the current flows like the ink from a pen (that is, down the nib), then the direction of the magnetic whirls around this current will be the direction of the circular motion of the whole pen in drawing these whirls clockwise. It may be observed that the direction of such a spiral is the same as though one started to write the small letter *m* (magnetism). If, however, the whirls be drawn counter-clockwise, as though writing the letter *c*, the current represented by the flow of ink down the pen will be the one induced by the generation of these lines, as in transformers. The disadvantage of this kind of rule is that within half-an-hour of reading it the average man will not remember whether it ought to be "not *c* but *m*" or "not *m* but *c*;" and he will think he has to write *c*, when he has not, because *c* produces magnetism; and he will imagine that in the other case it ought to be *m*, because the magnetism induces *c*.

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INDICATOR DIAGRAMS.

In commenting on Prof. KENNEDY's lecture on Boiler Testing three weeks ago, we remarked that many ridiculous reports have been made on tests of engines and boilers by engineers ignorant of the principles as well as of the details of such work. An incomplete or inaccurate test of a boiler generally carries its own condemnation on its face, but a careless or incompetent test of an engine is more difficult to detect by mere inspection of the recorded tests, and the reproduction of indicator diagrams, more often useless than not, serves only to give a flavour of actuality to a number of more or less imaginary figures. In a thorough and complete report, specimen diagrams may be given, since they form part of the description of the engine, but where implicit confidence can be placed in the engineer, his results of indicated horse-power are to be accepted as they are given. Publication of the diagrams themselves gives no more information on this point, and is suggestive of the man who, having a house to sell, carried about a sample brick in his pocket. While nothing can tell more truly the characteristics of an engine, the action of its valves, its use or abuse of steam, and the power developed in the cylinders; no written record, whether penned by the hand of man or by a recording mechanism, is so hard to interpret. CÆSAR BORGIA could read between the lines when MACHIAVELLI wrote, and it is sometimes possible to affirm that the heel of a diagram shows that the indicator was on its stop at the end of the stroke; but who can say whether the cord stretched, or if the revolutions had been properly counted? Treacherous as indicator diagrams may be, it is probable that more engineers have deceived themselves, by

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want of proper care in taking them, than have been deliberately misled by such subtle documents. Prof. KENNEDY gives the palm for downright lying to the ordinary steam-pressure gauge; but there is no artful fibbing or subtle prevarication here, the falsehood is of the most simple character and can be detected by any boiler insurance inspector on his annual visit. Prof. KENNEDY'S lot does not seem to be thrown among the old school of engineers, nor of those who have received and still follow the traditions of that school. We fancy that the practice of dividing an indicator diagram into ten parts and adding separately is still the rule rather than the exception, though no doubt the Finsbury student may never have heard of it. Planimeters, of course, afford the best means of measuring diagrams, but we hope that both Finsbury and other students have a second string in case no planimeter is to be had. We remember using up all the margins of a newspaper in measuring a number of diagrams in the train, using a two-foot rule for a scale; a planimeter certainly could not have been used under the circumstances.

Prof. KENNEDY'S advocacy of a simple rope brake with a spring balance and a weight instead of clumsy levers, tightening screws or complicated automatic appliances, is very welcome. New forms of Prony brake are continually being invented, and the idea of a brake costing only a few shillings seems to be a positive disadvantage in the opinion of some people. We shall not be surprised to hear of a Prony brake with electro-magnetic adjustments and a mirror and scale for reading. Fortunately in electrical engineering there is no difficulty in finding an absorption dynamometer, of moderate output, for any dynamo can be so used, with a resistance and a pair of instruments. In any electrical factory, the efficiency can be easily measured by the Hopkinson or, better, by the three-machine method. In the majority of cases in electrical work, the efficiency of a combined plant is to be measured, and the separate efficiency of the dynamo need not be determined. It is necessary, then, only to attend to the indicators and to the electrical measurements of the output. It is not easy to make a mistake about the output, unless inductive resistances are used with alternating currents, and this allows all the more attention to be paid to taking the diagrams.

Not only is practice necessary in this art, but practice on different kinds of engines. The mode of taking diagrams varies from the leisurely and dignified work in the engine-house of a large waterworks, down to the exciting occupation of indicating an express locomotive while strapped on to the buffer-beam. Like other arts, engine indicating has its refinements, and refinements overdone become fads. The engineer of one of the large shipping companies had a fad that the chief engineer of each steamer should indicate his engines every day. One of these officers was rather dense, and in fact quite unaccustomed to the work. The Company's engineer drilled him through all the details and at last got a good set of cards. "Bring me back some like these," he said as the vessel started for Melbourne. Every day the second engineer took two pairs of diagrams, and brought them to his chief, and every day the latter formally handed over two pairs of diagrams, duly initialled and dated, to the captain. One day the chief engineer was seriously ill. The diagrams were brought to him as usual. "Tear them up," he whispered. "Look in that drawer." The second engineer drew forth a packet of blank indicator cards, and a pair of neat zinc templates. "Scribe a set of diagrams round those," murmured the chief; "put in the atmosphere lines where you see them marked, and take them to the skipper."

NOTE ON THE BEST RESISTANCE FOR THE RECEIVER ON A LEAKY TELEGRAPH LINE.

BY DR. W. E. SUMPNER.

In a Paper just read before the Institution of Electrical Engineers by Prof. Ayrton and Mr. Whitehead it has been shown that, however complicated may be the manner in which leakage to earth occurs along a telegraph line, the receiving instrument which gives the best results will be such that its resistance is equal to the resistance of the line measured between the two terminals to which the instrument is to be connected. Thus, taking Fig. 1 (from their Paper) to represent the telegraph line, the best resistance for the receiving instrument q is that resistance which a Wheatstone's bridge would measure if connected with the end of the line Q and earth, the measurement, of course, being made by the false zero method if there are any electromotive forces, such as are represented by the battery b, either in the line or fault.

That this result should be true, whatever the law of distribution of the leakage along the line, seems at first sight very remarkable, and it is sufficiently important to warrant the inquiry whether its truth cannot be established in some simpler manner than by means of the rather difficult mathematical proof advanced by the authors of the Paper. It may therefore be of interest to give the following simple proof which occurred to the present writer while the Paper was being read before the Institution.

It will first be necessary to recall to mind a simple fact true of any network of conductors, however complicated. This property, which has been known for many years, is as follows. If *any* two wires contained in a network of conductors be called A and B, the current which is produced in B by inserting a unit electromotive force into A is exactly the same as the current which is produced in A by inserting a unit electromotive force into B. Thus in the network of wires forming an ordinary Wheatstone's bridge, if the insertion of v volts in the battery branch produce a current of a amperes in the galvanometer, then the insertion of v volts in the galvanometer branch will produce a current a amperes through the battery branch.

Referring now to Fig. 1 of the Paper, the effect on the receiver q will depend on (1) the current produced in q by the battery b, and (2) the sensibility of the receiver q. If the resistance of the receiver be r, its sensitiveness will be proportional to the square root of r; and the effect on the receiver is measured by

$$C\sqrt{r},$$

where C is the current produced in q by the battery b. The value of C depends on r, and we have to find that value of r for which $C\sqrt{r}$ is a maximum.

Now, from what has been said, the current C produced in the receiver q by the battery in b is exactly the same as the current which would be produced in b by a battery of the same voltage placed in the receiver circuit q. But if a battery of this voltage were actually placed in the receiver circuit q, the current which would be produced in q itself would be

$$\frac{V}{r+R},$$

where V is the voltage of the battery, and R is the resistance between Q and earth of the telegraph line. This current would flow along the line, branching off into the various leakage circuits, until the residue C passed through the battery circuit at b. The ratio of C to the total current in the arm q would depend on the resistances of the different branches of the network, but would not depend on r, the resistance of the branch q. So that, as far as variations of r are concerned, we may say that the value of the current C is simply proportional to $\frac{V}{r+R}$.

Thus the product $C\sqrt{r}$, to which the effect on the receiving instrument is proportional, is equal to

$$k\frac{\sqrt{r}}{r+R},$$

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where k is a constant which does not depend on r. The value of r which makes this expression a maximum is

$$r = R,$$

or the resistance of the receiving instrument should be equal to the resistance of the line measured between the terminals to which this instrument is attached.

As this result has been obtained without any assumption with regard to the manner in which the leakage is distributed along the line, it must be true for all modes of distribution, however complicated.

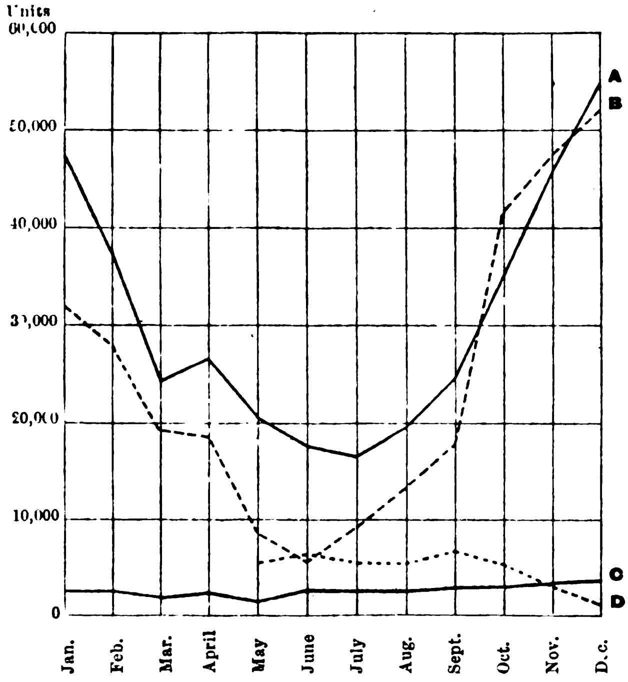
Moreover, it is clear that if a receiver, of resistance r, is used in any network of conductors, and if $f(r)$ represents the sensitiveness of the receiver, the best value of r will be such that

$$\frac{f(r)}{r + R}$$

is a maximum. Thus, if $f(r) = r^n$ where n is less than 1, it can be shown that the best value of r is $\frac{nR}{1 - n}$.

THE ST. PANCRAS ELECTRIC LIGHTING.

The statement of accounts of the St. Pancras Vestry Electric Light Undertaking for the year 1893 shows that this enterprise has progressed to much the same extent as the other metropolitan electricity supply businesses. The total capital expenditure up to December 31st last amounts, in



A General Supply at 6d. per Board of Trade unit, 1893.
B Ditto ditto ditto 1892.
C Ditto (Day Supply) at 3d. per Board of Trade unit, 1893.
D Ditto ditto ditto 1892.

round figures, to £96,000, some £7,000 having been spent during the year. The total revenue amounts to £15,021, as against £11,003 in 1892; the total outgoings amount to £8,809, as against £8,427. In other words, the revenue has increased 36 per cent., whilst expenses have only grown by 4·5 per cent. This big increase of income is, however, due largely to the so-called revenue from public lighting, which has more than doubled itself in 1893, whilst the sale of current by meter only brought in 17 per cent. more than in 1892.

Turning to the debtor side of the accounts, it will be found that 36 per cent. more revenue has been earned with an increase of less than £42 in the coal bill, and with an actual decrease of over £300 in the wages account. The management expenses, around which there must always be considerable ambiguity in municipal undertakings, appear to have been estimated on a different basis in 1893 than was the case in 1892; for instance, "stationery and printing" cost only £49 last year, against £276 in 1892; similarly, "general establishment charges" amount to only £148 in 1893, against £282 in 1892. Coming to distribution, the troubles with the mains, of which there have been so many rumours, have run up the cost of repairs and maintenance from £20. 16s. 2d. to £378.

The net result is that the St. Pancras undertaking made a profit of £6,212 in 1893, as against £2,575 in 1892, and not only paid all the current interest on loans but wiped off arrears, and paid off a little of the electric lighting debt.

Some of the curves which accompany these accounts are reproduced herewith; they show pretty plainly how relatively small the day demand for current remains, even at 3d. a unit.

THE BEST RESISTANCE FOR THE RECEIVING INSTRUMENT ON A LEAKY TELEGRAPH LINE.*

BY PROF. W. E. AYRTON, F.R.S., AND C. S. WHITEHEAD, M.A.

1. If there be a single earth fault at any one point of an otherwise good telegraph line, PQ (Fig. 1), it is easy to prove that the best resistance to give to the receiving instrument at either end of the line is equal to the apparent resistance of the line tested from *that* end when put to earth at the other end through a resistance equal to that of the signalling battery at that end. For example,

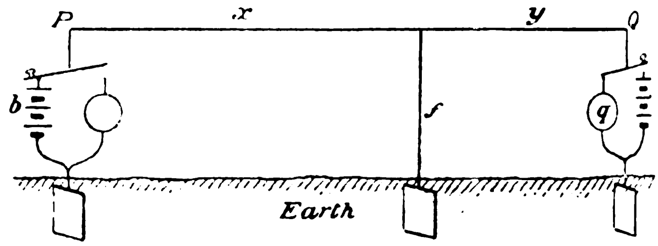


Fig. 1.

if we desire to know what should be the value of q, the resistance of the receiving instrument at the Q end, the line must be tested from the Q end (Fig. 2) when put to earth at the P end through a resistance, b, equal to that of the signalling battery usually employed at that end.

And the magnetic effect produced by an electro-magnet of given size, shape, and construction is proportional to the product of the current into the square root of the resistance of the wire with which the coil is wound. Therefore it follows that the magnetic effect of the receiving instrument at Q is proportional to $A\sqrt{q}$, and this has a maximum when q is equal to the apparent resistance of the line tested from the Q end and put to earth at the P end through a resistance b.

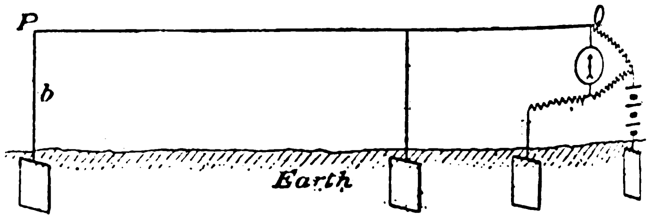


Fig. 2.

2. During the course of some lectures at the Guilds Central Technical College last year on faults on telegraph lines, the question arose whether the above result was universally true for a distributed leak all along the line, or only for a single earth fault; and, if this solution were not generally true, then what was the best resistance to give to the receiving instrument at the end of a telegraph line the leakage along which followed any law. The complete solution of this question shows that when the line is uniformly leaky the receiving instrument ought to have a resistance equal to the apparent resistance of the line when tested at the receiving end and put direct to earth at the sending end.

The resistance of the signalling battery does not in this case appear in the best value to give to q, but that arises from the fact that, whereas when we were dealing with a single earth fault we assumed that the signalling battery had a fixed E.M.F. and a fixed resistance, here we have assumed that the potential of the sending end of the line, was kept constant. Now this is the same thing as supposing that the signalling battery of fixed E.M.F. has an extremely low internal resistance. The two results are therefore the same.

*Abstract of a Paper read before the Institution of Electrical Engineers.

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If the distributed leak follow *any* law, the general differential equation cannot be integrated, and we must deal with the problem of determining the best resistance to give to the receiving instrument at the end of the leaky telegraph line without actually integrating equation, and without expressing in an explicit form the value of the current that passes through the receiving instrument. The Paper shows by an elaborate mathematical calculation that, whatever be the nature of a leak on a telegraph line—whether the leak be a single one, or be distributed along the line according to any law of distribution—the same rule holds true for the best resistance to give the receiving instrument, viz., the receiving instrument at either end should have a resistance equal to the apparent resistance of the line when tested from that end and put direct to earth at the other end.

Speakers whose remarks are prefaced by an asterisk have returned their abstracts revised :—

DISCUSSION.

*Mr. W. P. GRANVILLE said Prof. Ayrton and Mr. Whitehead had laid down a law that the best resistance for the receiving instrument should equal that of the line as measured at that end, the distant end being put to earth. Might he suggest the following addition ?—that the measurement be made with a duration of contact approximately equal to the duration of contact used in signalling. This was especially important in the case of submarine cables.

*Prof. HUGHES said it was quite a treat to hear a telegraph Paper : it was so long since they had had one. He did not quite like the title of the Paper. The "best resistance" would evidently be none at all. What they wanted was conductivity, and they wanted the least resistance possible in the electro-magnet, provided they could get the magnet to do what they wanted it to do. He thought all tests of an electro-magnet should be made under conditions such as those in which they were used, particularly with rapid instruments on lines. He made a special study of the subject many years ago for his printing telegraph. The law then in general use, and he had seen it published since, was that the resistance of the receiving magnet should be equal to that of the line. His first magnet was so constructed. He always doubted the law, and made a special course of experiments to test it. He found, of course, that the self-induction of the magnet induced an apparent resistance also, so that the resistance of the magnet would be enormous. If they took an electro-magnet that was designed for a line of 500 miles, he found the best thing under all conditions of losses and varying conditions was to have the electro-magnet $\frac{1}{4}$ of that resistance. If the resistance of the line was very low through losses, he reduced the magnet resistance down to $\frac{1}{16}$. He was quite convinced that the resistance of all the receiving instruments throughout Europe was too high. The principle which he had adopted throughout in his instruments was to reduce the resistance as much as possible, and he had experimented on lines of thousands of miles in length. These experiments were not laboratory experiments, but involved watching days and days and months and months to see the effects on each line, and he had never met with a case where a large resistance, equalling that of the line, would work as well as one which was a quarter of that of the line. Therefore, he thought it was a great mistake to have *too* high a resistance in the magnet. The tendency of Prof. Ayrton's method would be to lower the resistance of the magnet. But when they designed electro-magnets for telegraph instruments they could not state any given law for one electro-magnet, because telegraph instruments were all constructed up to a certain model, and the models were sent indifferently all over the country, one working over 500 miles, one over 300, and one, perhaps, on a short circuit. Makers never knew where their instruments were going, and the telegraph people did not pay any attention to the resistance. So the makers had to try and find out the average length of line and the average conditions, and design their electro-magnets to meet the average conditions. He did not know what resistance Prof. Ayrton would choose for a 5,000 ohm line. His Paper was not very clear with regard to that.

*Prof. AYRTON, in replying, said he was sorry that, after what the telegraphists had said so often as to their interests being neglected, and that they never had telegraphic Papers, and so on, they did not come forward and discuss a telegraphic Paper when one was read. If they would only come and say that the Paper was wrong it would be something. Of course, in presenting the Paper they did not wish it to be supposed that in the long practice of telegraphy people had not got some notions of what was the best sort of resistance to give the receiving instrument. He remembered that the late Mr. Schwendler, twenty-two years ago, published a rule that the resistance of a telegraph relay should be equal to $\frac{5}{8}$ of the true resistance of the line wire. That did not mean the resistance tested as he had described, but the true resistance of the wire neglecting all leakage. He (Prof. Ayrton) was not aware, however, that this problem had ever before been examined mathematically in a perfectly general form, so that the solution should be applicable to any law of distribution of leakage along the line. As Prof. Hughes had said, the title was, perhaps, a little misleading. It might appear that a telegraph instrument was better if it had a certain resistance than if its coils were wound with wire of infinite conductivity, what was, of course, meant was that resistance was a bad thing while many convolutions were desirable ; but inasmuch as with no material could they obtain convolutions without resistance, there was a certain resistance which was the best for the instrument under particular conditions, and, as they had shown, generally the best resistance for a receiving instrument was the apparent resistance of the line as tested at the receiving end and put to earth at the sending end. The question had been asked, what was the good of obtaining a rule which depended on the insulation of the line? The insulation of the line changed from day to day, and they could not be perpetually altering the resistance of their receiving instrument. The answer was, when the line was in good order and the insulation high, there was no difficulty in signalling ; it was only when the insulation was low, through rain along the line, that the trouble occurred. Therefore he thought it would be best to adapt the resistance of the receiving instrument to suit the line in its worst normal condition. Prof. Hughes had asked what resistance he would give to an instrument if the resistance of the line was 5,000 ohms. He thought he would find a good deal higher than 300 ohms would be good. In India they did not make a number of instruments with an average resistance and send them out so that a line 50 miles long had the same resistance as lines working across the country from Calcutta to Bombay, but they wound the relays to suit the particular line it was to work on. In that country they were suffering, some twenty years ago, from having much too low a resistance, whereas Prof. Hughes had apparently been troubled by his relays having been wound with too high a resistance.

TRANSPARENT CONDUCTING SCREENS FOR ELECTRIC AND OTHER APPARATUS.*

BY PROF W. E. AYRTON, F.R S , AND T. MATHER.

It is well known that electrostatic instruments require to be screened from outside electric disturbance, in order that their indications may be correct ; but it is not so generally recognised that instruments intended to measure small forces, such as certain types of *electro-magnetic* voltmeters, delicate vacuum gauges, &c., are liable to give wrong readings from an electric attraction being exerted on the pointer, such as is produced by the glass cover when it is touched or cleaned.

There is on the table here a well-known type of gravity *electro-magnetic* voltmeter, which may be found on the switchboards of many English and continental electric light stations. At the present moment its terminals are not connected with the electric light mains of the building, so that it should indicate zero pressure. Let me, however, but stroke the right-hand side of the glass cover with my finger, and the pointer, as you see, at once turns to 80 volts or more. Conversely, let the terminals of the voltmeter be connected with the electric light mains: the pointer should point to about 100 volts, for that, as you know, is the pressure supplied by the Westminster Company. The voltmeter appears to be indicating correctly ; but, on stroking the left-hand side of the glass cover, the pressure, as read by the instrument, appears to suddenly fall to some 40 volts. And a similar effect is produced if a piece of wash-leather or dry waste be used in place of the finger.

If, then, it is possible to cause this instrument to indicate at will 60 or 80 volts too high or too low, how impossible must it be or feel sure that the glass cover—which is, of course, maintained in a dry condition in a hot engine-room—has not been electrified by some accidental touch of the coat sleeve sufficiently to cause an error of 3 or 4 per cent. in the reading of the voltmeter !

We find that it is not merely with this particular type of voltmeter that an error can be produced by stroking or rubbing the glass cover, for other electro-magnetic instruments that we have tried can also have their pointers deflected in the same way, but not to the same extent.

Nor, of course, is this source of error in any way connected with a voltmeter being an instrument constructed to measure an electrical magnitude, for it would equally exist if the glass were clean and dry and the controlling force remained of the same magnitude, no matter what was the quantity the instrument was constructed to measure. For example, on the table there is a vacuum gauge the wheel-sector-pinion of which has been replaced with an Ayrton-Perry magnifying spring. This gauge is, no doubt, very sensitive, for you observe that the pointer moves even when I produce an extremely slight diminution of pressure by rotating the short length of india-rubber tube as slowly as I can ; the change of pressure on pinching the tube, or even on dropping it, is indicated by the pointer. On the other hand, the pointer is of glass, and, therefore, is not suitable for being acted on by an electrostatic force ; still, a stroke on the glass cover, as you see, causes the pointer to deflect through several degrees.

It has been known for a long time that it is possible to screen an instrument from such outside electrostatic disturbances by surrounding it with a metallic cage composed of wire or of strips of tinfoil. Such a method of screening, however, has the great disadvantage that it renders it difficult to observe the exact position of the pointer from a distance, for the wires or strips of tinfoil cover up the pointer more or less. We therefore thought of placing the pointer underneath the metallic dial of our electrostatic voltmeters, and of only allowing the tip to project through a slot in the dial plate. But this method we abandoned on trying it eighteen months ago, for to make the screening good, the visible part of the pointer must be reduced to a spot, and the exact

* Paper read before the Institution of Electrical Engineers, April 12th,

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position of this spot we found less easy to read at a distance of several feet than that of a long black line, which is the appearance of a pointer when it is visible along its whole length. This method of screening has, however, we understand, been recently adopted by a firm of instrument makers.

We next considered whether it was not possible to make a perfectly transparent conducting screen, so that, while the electrostatic screening of the pointer should be practically perfect, the pointer and dial should be as easily seen as if the screen were not present. Our first idea was to make the glass cover double, and to insert between the two sheets of glass a layer of clear conducting liquid. Fearing, however, trouble from leakage of the liquid, or from the liquid becoming gradually turbid and giving the dial a dirty appearance, we turned our attention to depositing films of solid matter on the inside of the glass cover, or shade, of sufficient thinness to be practically transparent, but with the solid particles near enough together to be conducting. We tried smoke, silver deposited in layers of various thicknesses, mercury vaporised and deposited, sal-ammoniac vaporised and deposited, &c., but we were quite unable to obtain in this way both transparency and electric conduction.

After a conversation with Prof. Boys, when discussing the problem that we were then engaged in solving, we commenced experimenting on varnishes, with the view of arriving at a varnish which should be as hard and as transparent as *clear* shellac, but which, instead of being an insulator like shellac, should be a sufficiently good conductor to allow of the instantaneous production of an induced electric charge to balance the electrostatic action of any outside body. Glass plates were coated with gum, with coaguline, with the gelatinous electrolyte used in accumulators (composed of sodium silicate and dilute sulphuric acid), with isinglass dissolved in acetic acid, with gelatine dissolved in acetic acid, with isinglass dissolved in a mixture of acetic and sulphuric acids, and with gelatine dissolved in the same mixture. After much experimenting, we arrived at the following two methods of coating a glass cover, or shade, which gives perfectly satisfactory results:—

No. 1.—Dissolve ¼oz. of transparent gelatine in 1oz. of glacial acetic acid by heating them together in a water bath at 100°C. To this solution add half the volume of dilute sulphuric acid which has been prepared by mixing 1 part of strong acid with 8 of distilled water by volume, and apply the mixture while still warm to the glass shade, which should be previously polished and be warm. When this film has become very nearly hard, apply over it a coating of Griffith's anti-sulphuric enamel.

Method No. 2.—Thin the gelatine solution, prepared in the manner previously described, by the addition of acetic acid (say 2 volumes of acid to 1 of the solution), and, after polishing the glass, float this thinned solution over the glass cold. Drive off the excess of acetic acid by warming, allow the glass to cool, and repeat the floating process, say, twice. Thin the anti-sulphuric enamel by the addition of ether, and float it over the gelatine layer applied as just described. Expel the ether by heating, and apply a second layer of this thinned anti-sulphuric enamel.

With experience, such as Messrs. Elliott and Messrs. Paul have at length acquired after much practice, a layer can be applied, either according to method No. 1 or No. 2, so that, when finished, it is quite hard to the touch, and so transparent that it is only by looking at the glass plate obliquely that the presence of the varnish can be detected. It is also so conducting that when a potential difference of several thousand volts, alternating with a frequency of 200, is set up between the needle and inductors of one of our electrostatic voltmeters, the pointer, which is metalically part of the needle, is not visibly attracted by a metallic rod held just outside the glass close to the pointer, this metallic rod being electrically connected with the stationary inductors.

Without experience, however, it is somewhat difficult to apply the coating so that it is not either cloudy, or a comparatively poor electrostatic screen, or both.

This second electromagnetic voltmeter—which, like the former, has been kindly lent us by Mr. Barley, of the Knightsbridge electric light central station—looks exactly like the other one, and, indeed, behaved exactly like the other one when we received it. It has, however, had a layer of our transparent varnish applied on the inner side of the glass subsequently, and you will find that you may rub the glass as much as you like, or even hold a rubbed stick of ebonite near it, without producing any effect on the pointer.

Again, these two clear glass shades, belonging to gold-leaf electroscopes, are one of them coated with our varnish, and the other not. Which is the uncoated one is at once apparent from the alteration produced in the deflection of the gold leaves when I approach a stick of rubbed ebonite near the lower part of the glass shade of the uncoated one, for no such change in the deflection is produced, as you see, when the ebonite rod is brought near the glass shade, which is protected by a layer of this varnish applied on the inside.

The following is an abstract of the discussion on the Papers on a Station Voltmeter and a Transparent Conducting Screen. Speakers who have returned their proofs revised have their remarks prefaced by an asterisk :—

DISCUSSION.

Mr. MORDEY thought the open scale arrangement of the voltmeter described was the most important feature that had been brought out in direct-reading instruments for a long time. Instrument makers had as a rule divided their scales to get proportionalities in the scale ; proportionalities were very nice things when one got them, but it was often more important to have a very large and open scale. He hoped the authors would pursue their labours further and give them alternating-current voltmeters with the same features. He must congratulate the authors on the transparent conducting screen. He thought perhaps he was the first to draw Prof. Ayrton's attention to the necessity for something of the sort.

The CHAIRMAN (Mr. Crompton) said the phenomena of the electrification of the glass of instruments was very well known to every electric light station apprentice, and the way of preventing it becoming a serious nuisance was also well known. The way was, after wiping the glass, simply to touch it with the finger. So far as he knew no inconvenience had ever arisen from the phenomena ; it was, in fact, rather interesting, and rather a slow thing to get the instruments to act, as they had been made to do that evening by being carefully warmed up by means of the lamps in front of them. He did not think Prof. Ayrton would have got the phenomena at all but for the fact that they had been having weather more like that usual in the south of Spain than an old-fashioned English spring. He thoroughly agreed with the points raised as to the requirements of a good station voltmeter ; but he fancied that Prof. Ayrton had but carried out what many of them had carried out before, and that some of his improvements were not new. The pointer which he had described was identical with the form which his (the speaker's) firm had used for some time past. The clamping device appeared also to have been used by them and others. The way in which Prof. Ayrton got over the difficulty by using a moving coil, which was a very beautiful development of Mr. Weston's method, had only one serious defect, that it was so costly. Mr. Weston's instruments were so costly that it was a luxury to have one in each station, and he was afraid that when they multiplied Weston's coils by three, and applied as much care to producing the three permanent magnets as Mr. Weston applied in producing one, it would be found that the instrument was so costly as to be scarcely within the reach of many of them. The voltmeter of modern times had to be made and sold for £3 or £4. By employing instruments with soft iron deflecting pieces, as astatic as possible, so as to provide them with an exceedingly strong field, they did not get results sufficiently good for their purpose, which was to have in the station one good electrostatic voltmeter, either a Sir William Thomson's multicellular form, or something resembling that, and have that as the voltmeter for reference, and have a large number of voltmeters on the switchboards sufficiently close to the reference voltmeter, so that the errors at different times of the evening might be known and noted. The errors might be 1 per cent. or 1½ per cent. ; but those who were working at the switchboards were accustomed to them, and could make allowances for them. They found no difficulty in obtaining voltmeters for small sums which were accurate within that limit of error. He would point out to Prof. Ayrton that he would not make a very sensitive instrument with three coils arranged in the way he described, for the weight of those coils was something considerable, and with the balancing weight added would be so much for the pivot to carry that the instrument would be much more sluggish than one with a deflecting piece, that deflecting piece acting as the weight, or else having an additional weight of small magnitude. As regard the open scale, he thought equally open scales had been obtained by several people.

*Prof. AYRTON, in replying, said Mr. Crompton rather implied that he had manufactured a defect in the measuring instrument, and then shown how to get over it, and that it was rather a feat to show the defect. Now, Mr. Mordey was not, as a matter of fact, the first to draw his attention to this electrostatic action, because in a certain central electric lighting station in London of no small importance, four years ago, he was shown a row of those instruments, and was told they could not be used because of the difficulty that the pointers were attracted when they cleaned the glass. Mr. Crompton said it was quite easy to get over the difficulty—one had only to touch the glass with your finger. Curiously enough, a central station engineer had written to him to point out the bigger effect produced when the glass was touched with the finger. This engineer went on to say, which was wrong reasoning, for very often central station engineers did reason wrongly—I think you will have to put a varnish outside as well as inside, because not only do you get an effect when you rub the glass, but you get a much bigger effect when you touch it outside with your finger.—It was not an easy matter to de-electrify glass by simply touching it with the hand. As regards warmth, that was, of course, the difficulty. With the warmth which they could not avoid having in a central station the instruments were as dry as, if not drier than, the instruments he had on the table with the glow lamps in front of them, and the effect was as noticeable. As to the clamping device, it was fair to themselves to say they had used this particular device in connection with their electrostatic voltmeters which were not the subject of the Paper before them, for some three or four years. Mr. Crompton said the use of a moving coil with a permanent magnet produced a sluggish instrument. In that he might say without hesitation Mr. Crompton was absolutely wrong, because it was well known that you could increase the force to any amount you liked if you only had a sufficiently powerful permanent magnet. The proof was that the watts employed in this instrument exhibited were only 1½ at 100 volts, and they got a pretty quick motion of the needle. was the fact of Mr. Weston taking the idea of using a

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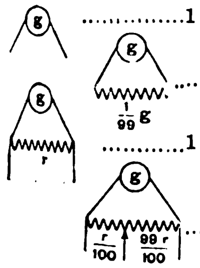
moving coil and a powerful permanent magnet which enabled him to make portable voltmeters of very high resistance. No portable voltmeter was ever made of over 10,000 ohms before Mr. Weston made his. How did he obtain it? Simply by utilising the principle that Maxwell was the first to point out, and that Lord Kelvin had employed in his syphon recorder. They did not use any controlling weight in their instrument; they used a weight to control it, but not an auxiliary weight. The weight was the weight of the coils themselves, and they said that with 3 per cent. of the whole resistance wound on the moving triple coil they could get force enough to give a quite sufficiently quick motion. In reference to the price of instruments, it must not be forgotten that the Weston instruments were made in America. American workmen were paid twice as much as workmen here, and they were able to keep up those high prices because of the very heavy import duty levied on goods coming from other countries. They must not, therefore, jump to the conclusion that because the Weston instrument was an expensive one, other instruments using a moving coil must be equally expensive.

A UNIVERSAL SHUNT-BOX FOR GALVANOMETERS.

At the last meeting of the Institution the following additions were made to the discussion on the above Paper (see *The Electrician*, April 6). Speakers who have returned their proofs revised have their remarks prefaced by an asterisk:—

*Prof. AYRTON, having read the addition to his Paper, said since the Paper was read there had, of course, been criticisms of the method they proposed for shunting. One of the criticisms was mistaken, because it was based really on a wrong conception of the way in which shunts were used. The objection that had been made was this: In Fig. 4† (*The Electrician*, April 6, p. 629) the method they proposed, the current that passed through the galvanometer, the largest current, was less than the current of copper, and was supplied when the galvanometer was bought; it was by a good maker, it was screwed down close to the galvanometer, and had been so for years; it had been kept in a basement, where the temperature did not vary very much, and still the comparison of the two currents with the same galvanometer was not as accurate, using this shunt supplied with the galvanometer, as the comparison of the same two currents, using their universal shunt, made without any reference whatever to this particular galvanometer, the coils having been wound by a person who had never seen it and knew nothing of the resistance of the galvanometer. All uses of the deflecting galvanometer were either to measure two currents or to measure two rushes of electricity. He would now take two condensers. Taking the ordinary method first, one condenser having 1/3 of a microfarad capacity, the other unknown, but somewhat larger, then with the same electromotive force and discharging successively through the same galvanometer they obtained two deflections. If they simply took the swings using the ordinary shunt the apparent ratio of the second to the first was 99·38. As a matter of fact, the second capacity was somewhat greater than 100 times the first. It was stated in the criticism he was referring to that shunts had "a definite damping constant"—ordinary shunts, of course. He was not quite sure what that meant. But if it meant that the same correction was to be applied in all cases, then it was wrong. Moving the controlling magnet from the position it was in to another position a little further up, and performing exactly the same experiment, with the same galvanometer and the same ordinary 1/99 shunt, the ratio of the swings was 91·87. Not only were both these wrong, but they were not wrong by anything like the same percentage. One was 3 or 4 per cent. wrong, and the other about 12 per cent. Now, using their own shunt, which was not made for this particular galvanometer, they got a ratio of 103·5 for the capacities of the two condensers when the controlling magnet was down, and 104 when it was up (*see* Table); as a matter of fact, the true ratio was 103·45. Therefore, those two results obtained with the new method of shunting were practically the same; and not only were they both the same, but they were both right; that was to say, no correction would have to be applied, hence they got much

Comparison of Currents.				*Comparison of Capacities.*						
				Controlling magnet down.			Controlling magnet up.			
Current in main.	Deflection.	Apparent ratio of 2nd current to 1st.	True ratio of 2nd current to 1st.	Capacity of condenser.	Swing.	Apparent ratio of 2nd capacity to 1st.	Capacity of condenser.	Swing.	Apparent ratio of 2nd capacity to 1st.	True ratio of 2nd capacity to 1st.
 ....1 micro-ampere	590·6	99·63	100·0	1/3 of microfarad	637·0	99·38	1/3 of microfarad	629·1	91·87	103·45
..........x	588·4			x	633·0		x	578·1		
...........1 micro-ampere	536·7	99·99	100·0	1/3 of microfarad	575·5	103·5	1/3 of microfarad	559·0	104·0	103·45
........x	536·6			x	595·5		x	581·3		

in the mains. When the main, M_2, was moved to the dotted position no doubt the current then passing through the galvanometer was one-tenth of what previously passed, but not one-tenth of the current on the main. Therefore it was contended that the method was not capable of very great application. That would be valid if Thomson reflecting galvanometers were instruments of invariable insensibility and were provided with direct-reading scales graduated in micro-amperes. But as they all knew perfectly well, owing to the change of astaticism of the needles from day to day, the change of position of the controlling magnet and of the masses of iron in the neighbourhood, the constant of the Thomson galvanometer had to be taken whenever they had to use the instrument. Now it was just as easy to take the constant of the galvanometer when permanently shunted with a resistance r as when there was no such shunt. There was nothing like an example. He had two currents that he wanted to compare (*see* Table); one was a current of a micro-ampere, the other was a current of x, the value of which he did not know. He would take his own method first. The micro-ampere was the micro-ampere in the mains. When one micro-ampere passed along the main the deflection was 536·7. Then sending the current x, a current much larger than the first, through the main, he changed the position of the main wire, and found the deflection to be 536·6. From this he knew the ratio of the two currents in the mains to be 99·99. As a matter of fact, the true relation of those two currents was exactly 100. The currents were made so that one was exactly 100 times the other, without any reference whatever to their universal shunt-box. Now let them consider the ordinary method. In the ordinary method they would send one micro-ampere through without a shunt, and would get a deflection of 590·6; then, putting on the 1/99 shunt, the deflection was 588·4. One current was thus 99·63 times the other. That was not so accurate. This shunt was made

† Prof. Ayrton points out that this figure was incorrectly given in our last issue. The letter c should refer to the point where the dotted line joins the wavy line, and r is the *whole* resistance, not a portion only as indicated.—[ED. *E.*]

more easily an accurate comparison of two condensers in this way than in the ordinary way. Mr. Hockin's mathematical analysis showed that the error in comparing capacities with the ordinary shunt depended on the position of the controlling magnet, and, therefore, the correction which had to be applied for one position of the controlling magnet, was quite different from the correction which had to be applied for a different position of the controlling magnet, but he doubted whether that difficulty was generally recognised. He thought, therefore, that they were justified in saying that this method was more universal and gave much more accurate results than the shunt which was specially prepared for a particular galvanometer. As to price, he thought the instrument maker's estimate, which he quoted of the prices for constructing different kinds of shunt boxes, afforded additional confirmation of the fact that the method of Mr. Mather and himself had many advantages.

*Mr. CHARLES BRIGHT said at present Prof. Ayrton's shunt had one doubtful feature. By his arrangement they would not have the full advantage of using a sensitive Thomson galvanometer for testing high resistances, because when they had this shunt permanently in multiple arc with a galvanometer they would do away with the usefulness of an exceedingly sensitive galvanometer. There were many cases where they wanted the most sensitive arrangement possible for testing high resistances.

*Prof. AYRTON said Mr. Bright was perfectly correct in cases where the current to be measured was so extremely small that to detect it at all bordered on the limits of the possible. It was certainly better, then, to have no shunt to the galvanometer, or to have the value of r very large. But that was very exceptional. Generally, with the delicate galvanometers of the present day, and having a fair number of cells, when testing the insulation of a condenser, or the resistance of a piece of gutta-percha cable, they were not measuring currents bordering on the limits of the power of the galvanometer, and in that case, if the resistance was fairly high compared with the resistance of the galvanometer, he did not see any objection to having the galvanometer, g, *permanently* shunted with any resistance, r, which was fairly large compared with g.

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UNDERGROUND MAINS.

The following is an abstract of the adjourned discussion on the papers on Underground Mains read before the Northern Society of Electrical Engineers, by Mr. J. H. Rider and Mr. S. V. Clirehugh, and published in our issue of March 16th last:—

Mr. WOOLER would have liked to have heard some more definite advocacy of a particular system of mains, and sound reasons given for such opinion, because it was patent that every class of mains had their advantages and disadvantages. For instance, bare copper conductors laid claim to economy in first cost. Well, that only applied where a large quantity of mains were required. One advantage which bare copper certainly did possess was the facility with which service connections could be made. A clamp sweated on to the leading, in wires, then bolted on to the bare copper and the work was done. Whereas with vulcanised rubber cables the minimum of time within which two men could attach a consumer was not within the range of an ordinary working day. What, however, he considered to be the most serious defect in the use of bare copper was the space required to build the concrete culverts and their having to be frequently intersected with lengths of cables where headway cannot be obtained for the conduit. Then, again, the copper tape of required cross-section was only manufactured in lengths something over 100 yards, so that it might be taken for granted that the average continuous length from street corner to street corner did not much exceed that, and one got a mixture of a length of copper strip, short length of cable, another length of copper strip, another bit of cable, and a number of joints, no matter how carefully made, must assuredly reduce the conductivity, and far more serious still, be calculated to engender a source of electrolysis by dissimilar metals used in the union. With conduit explosions, in the case of cables on the draw-in system, all the injured ones had to be pulled back to the next coupling box on either side, renewed, jointed and vulcanised, which was a lengthy occupation; but if bare copper was concerned, the strip and porcelain insulators might be blackened, which with cleaning and a little adjustment would soon be rectified. Much was said at the previous meeting upon the subject of vulcanised rubber joint making. He must reiterate that in actual practice that was a costly operation. Particular emphasis was laid upon the importance of extreme cleanliness; but, as was said at the last meeting, it was all very well to give a workman orders to go and do so and so, but the actual performance might be difficult. Imagine being stuck in a hole several feet deep, surrounded on every side with excavations, and the rain, perhaps, coming down, the water making puddle with which the men were besmeared, and nevertheless they were to be perfectly clean. Another point he wished to touch upon was Mr. Clirehugh's mention of soft soap to ease the cables when being drawn into the pipes. Very particular care should be taken to see that the pure neutral soap was used, otherwise the acids and other objectionable ingredients might have a very injurious effect upon the covering of the cables.

Mr. CORLETT said that since the last meeting he had obtained some reliable figures as to copper strip. In Hove in wet weather the average insulation resistance ran from 0·35 to 0·5 megohm per mile, and in dry weather from 2 to 3 megohms. With regard to the actual cost of laying and maintaining copper strip, he found from figures he had had from Kensington Station that the total cost for laying the system for Kensington amounted to £55,000. Of this amount upwards of £30,000 was spent in 1890, and nearly the whole of the remaining sum was spent in 1891. The figures for maintenance, including all repairs to surface boxes caused by wearing away of cement, trifling modifications in pavement, resetting of boxes caused by reflagging, &c., were as follows:—In 1888 the maintenance bill was £24, in 1889 £40, in 1890 £56, in 1891 £98, in 1892 £364, and in 1893 £280, making a total altogether of £862 for the six years. Taking the whole as spent in four years instead of six, and taking the capital outlay as £50,000, the cost of maintenance works out at 0·43 per cent. per annum.

Mr. CALLENDER said that previous speakers seemed to consider vulcanised rubber as the only material used for underground mains. This was hardly the fact, for when they looked into details it was astonishing how little rubber actually was used, and for distributing mains especially to what an extent it was being superseded. He found that up to date there were 82 stations in the United Kingdom under the Electric Lighting Acts which were either in actual work, or for which definite contracts had been given out for mains. Now these 82 stations had their mains insulated as follows:—

	39	Exclusively by materials other than rubber.
	6	Strip systems with bitumen cables.
	5	Network of cables other than rubber, but part of high-pressure feeders of rubber.
50——		
	19	Rubber insulated throughout.
	7	Strip systems with rubber cables.
26——		
	6	Common to all, the cables being insulated by rubber and bitumen, or of the lead-sheathed type.
—		
82		

Unlike most cable makers, he had laid a good deal of culvert, and knew exactly its weak points. The only town with which he was acquainted which was thoroughly suitable for culverts was Dundee. The station there was on a hill, and the lighting area close to the sea. Unfortunately, towns with such natural advantages for draining one's culverts were not often found, and he could not consider strip and culvert as universally applicable or advantageous.

Mr. E. H. NISBETT thought some account of their experiences in the City of London would be of interest. If low-tension mains were referred to by Mr. Rider, he (Mr. Nisbett) was quite in accord with the suggestion that a "built-in" system should be used for the distributors, and a "draw-in" system for the feeders, as in that case the cost of the conduits was a relatively small item, but for high-tension work the conduits might cost actually more than the cable itself. Suppose they took the case of a feeder having ultimately to transmit 200 kilowatts, and it was determined to put down for immediate requirements only one-third of the total quantity of copper. In the case of a three-wire distribution, they might then have to at once put down one-third of 1 sq. in. of copper, say 0·33 sq. in.; a triple concentric cable of this section would cost about £1,500 per mile and a conduit to contain it with two spare "ways" would cost £350 per mile, making an immediate outlay of £1,850 (neglecting trench work) and an ultimate expenditure of £4,850 per mile for the complete feeder. Against this an armoured cable of 0·33 sq. in. section would cost £1,600 per mile, showing a lower initial expenditure, but the ultimate cost would be £4,800 and £400 for second and third trenchings, making a total of £5,200 per mile, or more than the "draw-in" system. Now in the case of high-tension work it was different; the same feeder working at 2,000 volts would be 0·1 sq. in. section. A cable of one third of that section would cost £155 per mile, and the culvert to contain it £310, bringing the total immediate outlay to £465 and the ultimate outlay to £775 per mile. Now for £465 per mile one could purchase an armoured cable of 0·1 sq. in. section area, and so at once put down the whole of the copper estimated to be required. Mr. Rider mentioned the distance apart of feeding points as being not more than 250 yards if the distributing mains were to be kept of a reasonable size. He thought that was putting the feeding points very close together. In the City of London they had provided for an average demand of 4·5 8-c.p. lamps per yard of frontage. He had made some experiments in the City, from the results of which he was enabled to state that the impedance drop in the type and size of cable that Mr. Rider was using was about 10 per cent. over the ohmic drop at 200 volts, and the loss in the lead and iron sheathing about 50 watts per mile, not a large amount perhaps, but certainly worth taking into consideration. He must take exception to Mr. Clirehugh's statement that india-rubber cables "stand at the top from a scientific point of view." What was the scientific point of view of a perfect cable? He had there a sample of a cable which had been working only two years; when it was laid down in the City the india-rubber was apparently perfect; it had lately been examined and several lengths had been found in which the rubber was very badly cracked and unfit for further use. Impregnated fibre cables generally had the great advantage that they could not be adulterated. With rubber cables one never knew within 20 per cent. how much adulterant it contained. As regards flexibility, they lately tested a piece of 0·3 sq. in. triple concentric paper cable of 1½in. diameter, bending it to a 30in. radius, and straightening it again without damaging it. It then successfully withstood a pressure of 4,500 volts, although only designed to work at 200 volts. A piece of rubber cable sold to the City Company for low-tension work broke down under the same pressure. Mr. Clirehugh stated that under certain circumstances it was possible to draw 80 to 100 yards of cable in one length. In the City they had drawn as much as 185 yards of cable at one time, the length weighing 2 tons. Mr. Wilkinson was now putting down paper cable at Southport, and he had lately been testing them to 20,000 volts without any sign of a breakdown, the thickness of the dielectric being only [illegible]in. The cables supplied to the City of London Company, and having to work at 2,000 volts, were tested after being laid and jointed to 10,000 volts.

Mr. G. E. PREECE (Vice-President) wrote that amongst the various classes of conduit described, no mention was made of the form introduced by the "International Subway Company," and lately entirely used in Portsmouth for the town lighting. It figured up much cheaper than ordinary piping, and it had one very great advantage, that special facilities were provided for jointing and leading off from the mains to trenches or consumers' premises. One advantage of the iron pipe system which had not been mentioned was, that owing to the lengths of pipe used, and the excellence of the jointing, pipes did not give way owing to the inequality or subsidence of the ground, and the cables were not prevented from being drawn out as had occurred in many of the built-up drawing-in systems. In the lead-covered cable there was no doubt but that they had now arrived at a very high pitch of perfection. But he could not help thinking that whilst such important improvements have been made with the core itself, no improvement had been made with the lead covering, which was practically the vital point in that form of cable. Indeed, he was inclined to think that from what he had seen, and from information obtained, that the quality and durability of the lead used at the present time was not so good as that employed in the past. As regards the durability of vulcanised rubber, he showed two samples of aerial cable sent by Mr. Higgins, of the Exchange Telegraph Company. They were suspended in the air in November, 1873, and taken down in 1893, nearly 20 years after, on account of the house to which they were attached coming down, and not on account of any fault in the cables. The samples and letter were sufficiently explanatory. Some remarks had been made on the question of jointing vulcanised cores. There was really no difficulty about it, but for absolute perfection in a joint none but skilled workmen should be employed. Unless a jointer possessed absolute "cleanliness" he would never make a reliable jointer. That was the great secret in rubber jointing, and it was so in gutta-percha jointing. Some men were physically unfit for jointing. He quite agreed with Mr. Rider where he said in his Paper, "I venture to think that a combined system of drawn-in for the feeders and built-in for the distributing mains, offers a number of advantages." That plan was

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adopted with great success at Morecambe and would be applicable to a great many places.

Mr. RIDER, in reply, said: My chief point was using "drawing-in" system for feeders and armoured system for distributors. Mr. Mountain and several others agreed with that. Mr. Nisbett did not, and pointed out that an armoured feeder could be put down more cheaply. The Board of Trade had limited him to 100-H.P. for his transforming centres, with the result that a cable for 200 kilowatts was out of the question, and as he should only put down a feeder for one feeding centre, the advantage of an armoured system was not so apparent. My great point was a "drawn-in" system for feeders. Where they had to go to distant districts they had to put an entirely new feeder down, and that feeder had often to go through the district already lighted. Bristol had just started when an outlying district wished to be supplied, and there was a terrible hubbub because they could not tap on to their present mains. There was a fine row about it, and electric lighting could not afford to give any cause for heavy discussion in that way. Mr. Mountain spoke of splitting up a network, instead of joining the whole into one large network. In a big town if a fault occurred on the other side of the town in the same network, the whole system was jeopardised. In splitting up the network, they had the advantage of a break down in one part not affecting any other.

Mr. S. V. CLIREHUGH, in reply, said the main feature of the discussion had been the discussion as to the difficulty of vulcanising joints in india-rubber cables. There had been a certain amount of disagreement on the subject, even among manufacturers of rubber cables; but they had all stated that the difficulties of vulcanising had been over-rated, though they admitted that it was desirable, nay necessary, to send the jointers to the manufacturers to be taught to vulcanise properly, with the result that those men, upon whom one had no hold, were taught a trade at one's expense, and afterwards, of course, demanded very high wages. He believed the London supply companies were paying vulcanisers 10d. and 1s. per hour, and found it difficult to procure them at that.

THE CABLE-STEAMER "DUPLEX."

The trial trip of the cable steamer "Duplex," formerly the "Nentwater," took place over the measured mile off Hartley on Saturday, the 7th inst. She was originally built by Messrs. C. Mitchell and Co., of Low Walker, and in December last was purchased by the Eastern and South African Telegraph Company to be fitted and used as a submarine cable maintenance ship. The vessel was then completely dismantled of all her original fittings, including the old machinery, and the form and construction of the forward end of the ship was entirely altered to carry the bow sheave for the cable picking-up gear, by the construction of a clipper bow in place of the ordinary straight stem. The contract for the reconstruction of the vessel, including the building of three cable tanks, capable of containing 300 nautical miles of cable, and the fitting of the new machinery, was placed in the hands of the Wallsend Slipway and Engineering Company (Limited) on December 15, 1893. The new machinery is on the triple-expansion system, having cylinders 15½, 26½, and 44in. by 33in. stroke, the boilers being fitted with forced draught on Howden's system. Another Tyneside firm, viz., Messrs. Clarke, Chapman and Co. (Limited), supplied, in addition to the bow gear above mentioned, the picking-up and paying-out submarine cable gear, which is driven by compound engines of 200 I.H.P. The same firm also supplied the windlass, winches, donkey pumps, and donkey boiler, which were fitted on board the vessel. The cable gear and bow sheaves were constructed from designs supplied by Mr. P. L. Isaac, the Company's engineer-in-chief, and were made throughout of steel and phosphor bronze, so as to ensure efficiency, light weight and strength being special features. The vessel has also been fitted by Messrs. Clarke, Chapman and Co. with a complete electric light installation, including a very powerful search light projector, and electric bells and new loud-speaking telephones were fitted throughout the vessel in order to place the various parts of the ship in connection with the cable-laying operations in direct communication with each other. Amongst other adjuncts is an ice chamber to ensure the supply of fresh provisions to officers and crew when employed abroad, the machinery being supplied by Messrs. J. E. Hall and Co., of Dartford, Kent. The accommodation throughout the vessel for the officers and crew is replete with every comfort, and is noticeable for perfect ventilation to meet the requirements of the climate on the West Coast of Africa, on which this vessel will generally be engaged. The alterations have been carried out from plans received from the Eastern and South African Telegraph Company, under the personal superintendence of Mr. P. L. Isaac, assisted by Mr. Beckwith, another of the Company's engineers. At the trial a speed of about 11 knots was obtained, the machinery and its various adjuncts working perfectly throughout. The vessel sailed for London, after the trial trip, under the command of Capt. Gifford, and the Slipway Company have subsequently been gratified to receive from the Cable Company a letter expressing their entire satisfaction with the work that has been executed on the Tyne, and the expedition with which it has been carried out.

CORRESPONDENCE.

ELECTROSTATIC ERROR IN ELECTRO-MAGNETIC INSTRUMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: At the meeting of the Institution of Electrical Engineers on Thursday last Mr. Crompton suggested:—

1st. That the reason why I was able to produce such large deflections of the pointer of the voltmeter by rubbing the glass front with my pocket-handkerchief was because the glass had been dried in an exceptional way by the glow-lamp which I had placed in front of the instrument to enable its scale to be easily seen in the large lecture theatre at Great George-street.

2nd. That if the glass front were touched with the finger after being rubbed, no error on the reading of the pointer would occur.

3rd. That no deflection of the pointer would be produced if the glass were rubbed with a piece of *oily* waste (this last suggestion was made immediately after the close of the meeting).

As regards criticism No. 1, the glow-lamps in front of all the instruments were switched off at 10 p.m. Thursday evening, and all the wires disconnected. On the afternoon of the following day, however, 18 hours after the glow-lamps had been turned off, and after the voltmeter had been carried back to my laboratory, a touch on the glass with my pockethandkerchief deflected the pointer at once from 0 to 120 volts, where it stayed for some time, neither the glass nor my handkerchief being warmed nor dried in any way. This I repeated several times.

The voltmeter was then left on a table in a *north* room at the Central Technical College, no part of this building having been artificially warmed since April 6th. To-day, April 18th, after four days of rain, I again rubbed the glass cover with my pocket-handkerchief, which, like the glass, was neither warmed nor dried. It did not require much rubbing to deflect the pointer from 0 to 100 volts, where it stayed until I de-electrified the glass.

As regards criticism No. 2, it is correct that, if you know what is the position at which the pointer of the voltmeter ought to stand, it is possible, by judiciously dabbing the glass with the finger, after rubbing, to bring the pointer to its correct position; but if you do not know what is the true unelectrified position of the pointer, it is quite possible to leave it in a wrong position in spite of the glass being touched with the hand. Indeed, the engineer in charge of one of the principal London central stations wrote to me the other day:—"I find that earthing the glass with the fingers *after* rubbing, produced more marked effects than rubbing only."

As regards criticism No. 3, Mr. Mather and I dipped a piece of ordinary engine-room waste into oil and rubbed the glass cover of the voltmeter—the pointer at once went from 0 to the other end of the scale, where it stayed. Continued rubbing with the waste appeared to de-electrify the glass, but, on dipping the waste again into the oil, and smearing it on the glass, the pointer was again deflected *exactly* as if the glass were quite clean. Neither the glass, oil, nor waste were warmed or dried.

This idea that a layer of oil prevents glass from being electrified when rubbed is a common mistake, and is one that I was myself under until a few years ago. And I did not realise that it was a mistake until I saw Mrs. Ayrton experimenting on the action produced by light on the shape of electrified drops of oil. During these experiments she frequently dipped a stick of sealing-wax into oil and rubbed it with an oily piece of flannel, and she noticed incidentally that the sealing-wax was in this way as easily, if not more easily, electrified, than it was when it and the flannel were quite clean.

I think, however, that it may be quite possible to accidentally bring glass into a condition such that it cannot temporarily be electrified, for on first rubbing a glass rod with a piece of silk, it is not unusual to find the glass *negatively* electrified, the charge becoming reversed on continued rubbing. Hence, there

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may be an intermediate condition of the glass and silk when no electrification is produced. And our experiments made with the oily waste appear to show that with a certain thickness of the layer of oil on the glass it is in this intermediate condition. A voltmeter, however, ought to indicate, without doubt, the true pressure between the mains, and the dynamo attendant ought not to have first to divine it in some way, and then do enough rubbing of the glass cover with his oily waste to make the instrument indicate it.

In bringing the matter before the Institution we assumed, from the remarks that central station engineers have made to Mr. Mather and myself during the past four years, that this electrostatic source of error was recognised by them, and had been, at any rate, one of the reasons why certain types of voltmeters on the switch-boards of central stations had come to be regarded as untrustworthy, and were, therefore, no longer used. Our object, therefore, was not to prove that this cause of error existed, but to illustrate how the inner side of the glass cover could be coated in a comparatively simple way with a transparent conducting varnish, so that whether the glass were hot or cold, wet or dry, oily or clean, no attraction of the pointer could be produced electrostatically.—Yours, &c.,

The City and Guilds Central Technical College, April 18, 1894. W. E. AYRTON.

LEGAL INTELLIGENCE.

Meux's Brewery Company and Shelfer v. City of London Electric Light Company (Limited).

The hearing of this case was resumed before Mr. Justice Kekewich on Tuesday. It will be remembered that it is an action to recover £10,000 by way of damages for injury caused to the Waterman's Arms, Bankside, by the works of the defendant Company, an injunction also being sought.

Mr. Warmington, Q.C., Mr. Badcock, and Mr. Waight appeared for the plaintiffs, and Mr. Fletcher Moulton, Q.C., Mr. Renshaw, Q.C., and Mr. Braithwaite for the defendants.

Mr. SEWELL, the surveyor examined on the former occasion, was now cross examined by Mr. Moulton. He said when he went to the defendants' premises on the 2nd inst. several machines were running, but of the four nearest the Waterman's Arms only three were working, and they appeared to be under light loads; they were running slowly, and there did not appear to be so much vibration. A Laing, Wharton and Down machine at the extreme southern end of the premises, and furthest from the plaintiff's premises, appeared to be running at full load. The load was shifted on to the other machines for the purpose of a test, and he and Prof. Kennedy went to the public house. The vibration did not seem so great then as he had found it upon some former occasions. In October a similar test was made. He was struck then with the fact that the vibration seemed less than usual, and when they returned to the works they found that the Laing, Wharton and Down machine was still running, so that the other machines had not been carrying the whole load. He expressed his surprise at this, as it had been understood that the machine referred to would have been stopped. His assistant did not upon that occasion tell him that Mr. Jackson, the engineer, said he could not change the load entirely without affecting the lighting. He thought there might have been a slight parting of the walls before the defendants' works were begun, caused by the original settling of Sir William Rose's house, which was built some years after the plaintiff's. But that had been greatly increased since by the excavations for the defendants' foundations causing a further settlement of Sir William Rose's house, which dragged the party wall with it. The effect of the vibration would be to still further accentuate the fissure. He did not consider the neighbourhood a very noisy one.

Mr. JOHN WALDRON, architect and surveyor, gave similar evidence to that of Mr. Sewell. Mr. Alfred Johnson, member of a firm of builders, and one of his workmen, stated that the cracks in the wall spoken of were not there when they carried out repairs at the Waterman's Arms in October, 1891.

Mr. HENRY F. JOEL, electrical engineer, spoke of several visits to the plaintiff's premises, and his evidence as to the vibration corroborated that of the witnesses already called. He further stated that he had timed the vibrations, and found that they corresponded with the strokes of the engines at the defendants' works. The engines there were not all running at the same speed, and to that fact he attributed the intermittent character of the vibration. The engines were vertical engines, and were not provided with any form of cushion to break the force of the stroke, and this fact made them much more likely to cause vibration. Witness was cross-examined by Mr. Moulton as to his experience of electric lighting generally and of central-station lighting in particular, and also as to his acquaintance with different kinds of engines used for electric lighting. He said he had carried out central stations for the Pilsen-Joel Company in Holborn and Cannon-street, and more recently, for his present firm, had carried out the lighting of Barnet. He was not aware that the alternators in the defendants' station were running in parallel; if they were, of course, his suggestion as to the different speeds would be wrong. He further suggested as a cause for the vibration the fact that the engine foundations were not isolated, but were connected with the walls of the building. He could see this himself, and he was also told by Prof. S. P. Thompson that there was no isolation.

Mr. WALTER LEWIS, manager to Sir W. A. Rose and Co., oil and colour merchants, stated that until recently he had occupied the house adjoining the Waterman's Arms, but the effect upon his children and himself of the defendants' works had been such that he had removed to the suburbs. There was a vibration throughout the house, and his health had been seriously affected. One of his children was frequently sick, and remained subject to the ailment until she was taken away. He would himself have been incapacitated for business had he remained in occupation of the premises.

WILLIAM LOVE, a lighterman, and other customers who had used the house for a number of years, spoke of the vibration and the cracks being intirely new developments since the defendants' works had been in operation; and when the Court adjourned, Mr. Warmington said the case for the plaintiffs' was practically concluded.

WEDNESDAY, APRIL 18TH.

When the Court resumed on Wednesday morning, the defendants' counsel, without addressing his Lordship, proceeded to call their witnesses.

Mr. DAVID COOK, manager of the company, gave evidence as to the expenditure of the Company, and stated that the Acts of Parliament regulating the supply of electric light had all been complied with. It was the intention of the Company to concentrate its lighting machinery at the Bankside station, when there would probably be three or four times the number of engines and alternators in the part of the station nearest the plaintiff's premises. Large sums were being spent in putting in machinery for the condensation of steam, which would have the effect of lessening the noise from the exhaust pipes.

Mr. CHARLES THOMSON, architect to the defendant Company, said he supervised the excavations for the defendants' works. These were carried to a depth of 27ft. below the level of Bankside, and were at a distance of 75ft. from the Waterman's Arms. With regard to the isolation of the machinery, their foundations were entirely distinct from the wall of the building, so far as the lower part was concerned, but they were connected at the top along two races, one for the condensing pipes, and the other, 9ft. deep and 3ft. wide, for the cables. When he called at the plaintiff's premises on October 16th; he thought the cracks which were pointed out to him were old, as the edges were discoloured. He noticed no difference in the size of the crack on March 2nd. The house was a very old one, and cracks had developed all along the front. The working of the engines could be distinctly heard, but there was no more noise than might be expected in such a neighbourhood where there were several factories and works. The building was 3in. out of the level, sloping towards the east.

Cross-examined by Mr. Waight, WITNESS said the engine foundations were separate from the wall, but touched it. He did not measure the cracks, judging merely from the appearance to the eye. Mr. Shelfer said the crack was about eighteen months or two years old, and first occurred when Sir William Rose's warehouse was rebuilt, after the fire.

Mr. FREDERICK HENRY JACKSON, electrical engineer, who has charge of the Company's stations, corroborated the previous witness's statement with regard to the engine foundations. They were entirely isolated from the wall except by the floor. The pioneer station for public lighting was started further away from plaintiff's premises in June, 1891. The machines nearest the plaintiff's premises were first started in February, 1893. There were two A 20 machines with engines of 450-H.P. Later in the year three A 40 machines, with engines of 900-H.P., were started. There were also two Laing, Wharton and Down machines with four engines of 350-H.P. each; these were started in October, 1893. They were all the best and most modern machines that could be got. None of the engines were ever out of gear upon any occasion when Mr. Sewell was present. Generally three, or perhaps four of the machines were running in the evenings during February and March of this year; in the morning two machines were worked. On October 27th the maximum load was 450 amperes, at half-past five; at half-past four, the time at which Mr. Sewell was at the plaintiff's premises on that day, the load was about 300 amperes. Two of the machines nearest the plaintiff's premises were running at that time. Nothing was ever done on the occasion of joint visits for the purposes of testing the vibration to cause the effect to be less; on the contrary, more machines were put on. When he went to the Waterman's Arms on February 2nd he could not feel any vibration by putting his hand on articles of furniture, leaning against walls, or sitting in chairs; but he could see the light articles of clothing shaking slightly. Upon that occasion two A 20 and two A 40 machines, and one Laing, Wharton and Down machine, were running; these were more than were necessary for the load, but were put on to try and produce greater vibration. Mr. Sewell suggested that the Laing, Wharton and Down machine should be stopped and the whole load thrown upon the other machines; but it was explained to him that that could not be done without great disturbance to the lighting in the City, and he seemed at the time to be satisfied with the explanation. On March 2nd a large party was present at the works, amongst them Mr. Harris, Sir Frederick Bramwell's partner, who, he understood, attended as an expert on behalf of Messrs. Meux; he certainly was not there on behalf of the defendant Company.

Cross-examined by Mr. Warmington: He considered that the isolation of a foundation meant that it was not connected at its base with any other foundation. There were air-spaces around the foundations of their engines. The foundations did rest upon a bed of concrete 3ft. thick,

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and extended the whole length of the building, but he did not know whether it touched the walls or not. He was not sure what the effect would be if the number of engines and machines at the defendants' works were quadrupled; it would not necessarily, he thought, increase the vibration, as if the machines were run in opposition to each other, the pulsations from one set might counteract those from the other. He had never known sickness result from vibration in electric light stations.

Re-examined by Mr. Moulton: There was an air-space around the columns upon which the engines were built sufficient to enable a man to walk around them. There were substances suggested for the purpose of lessening vibration, but he knew of nothing more satisfactory than an air-space.

Prof. A. B. W. KENNEDY, examined by Mr. Moulton, said he was one of the consulting engineers of the defendant Company. The engines and dynamos at the works were properly constructed. On March 2nd he went to the plaintiff's premises about half-past five, and could detect no vibration. At that time nearly the highest load of the night would be going out, and at the request of someone on behalf of the plaintiffs the load was as much as possible thrown on to the machines nearest the Waterman's Arms. He did not know that any difference in vibration or noise would be made whether the engines were running with or without load. He had plumbed the wall at the back of the Waterman's Arms and found that it lay over to the east to the extent of 1⅝in. He measured the front of the building by means of a spirit level and found a drop of 3¼in. in the width of the premises, 26ft.

Cross-examined by Mr. Warmington: The excavations for the defendants' premises extended 20ft. below the level of the western wall of Sir William Rose's house. There were sub-strata of soft watery soil between. The withdrawal of the water from these strata would have a tendency to loosen the earth around. There were evidences of an apparently recent settlement of the western side of Sir William Rose's house. A person coming from an engine-room would be more, and not less, susceptible to vibrations.

Dr. SILVANUS P. THOMPSON, F.R.S., one of the consulting engineers of the defendant Company, said the foundations of the walls of the engine-rooms went down 10ft. deeper than the foundations of the engine beds. He was consulted as far back as 1891 by the defendant Company with special reference to the most suitable engines, and in consequence of his recommendations the present engines were employed. It was contrary to experience to say that a vertical engine vibrated more than a horizontal one. Other things being equal, he thought a horizontal engine was more likely to communicate vibrations to the soil than a vertical one. He did not attach any importance to the test with the garment on the bed as indicating vibration; in fact, he was indignant that it should be put forward as a fair test.

Cross-examined by Mr. Warmington: He had seen the crack at the plaintiff's house but once, but he should think it was an old crack which had opened within the past few months.

THURSDAY, APRIL 19TH.

On Thursday morning the cross-examination of Prof. S. P. Thompson was continued. WITNESS said the larger engines ran at the same speed as the smaller ones, but with a shorter length of stroke. The A 20 alternators revolved at twice the speed of the A 40 machines, but they kept step electrically. It was not the running of the alternators which caused vibration, but that of the steam-engines. He had seen no signs of damage to the defendant Company's own structure arising from vibration.

Mr. HOWARD CHATFIELD CLARKE, architect and surveyor, produced plans of Sir William Rose's house, showing the manner in which the settlement of the building had taken place. He stated that on the occasion of his visit to the Waterman's Arms, on February 2nd, he was unable to detect the slightest vibration downstairs, but in one of the upper rooms he did feel a slight trembling, but it was certainly not sufficient to cause structural damage to the building, or to interfere with the occupation or rest of persons living or sleeping in the house.

Cross-examined by Mr. Warmington: He did not admit that there was vibration in the house. There was an intermittent tremour of the bedsteads. When he sat in the window whilst a cart was passing, there was a distinct vibration of a much more distinct character. He did not think the excavations for the defendants' works drew water away from the ground sufficiently to cause a settlement and produce or increase the crack in the wall of the Waterman's Arms.

Several station assistants were called to prove entries in the log-book, and one of them, Mr. Dyson, stated that he visited the plaintiff's house, at the invitation of Mr. Shelfer, on the previous evening, and met Mr. Joel, Mr. Sewell, and others in the upper rooms there. He was asked to note whether he thought there was any vibration or not. When sitting in the room or leaning against the walls he could perceive no vibration, but there was apparently an intermittent quivering of articles on the bed. At a later hour, when he had other engines running, he asked to be allowed to inspect the rooms again. Mr. Shelfer first said he might do so, but afterwards sent to say that he had changed his mind.

Mr. RENSHAW, Q.C., addressing the Court for the defendants, said there was no suggestion that anything they had done was not done properly, in the best possible mode, and under their statutory powers. So far as any injury arising from subsidence was concerned, this subsidence being caused, as was alleged, by the subtraction of water, there was no ground for action at all. This was clearly shown by the judgment of Lord Chief Justice Cockburn in the case of "Popplewell v. Hodgkinson." Assuming that the subsidence was not caused in the way suggested, he contended that the plaintiffs were not entitled to damages, for it was stated and established that the building was caused to lean at the time of the building of the new warehouses eighteen years ago, and what had now been done, according to the plaintiffs' case, was to restore the building to the position it was in prior to that time. To entitle them to recover damages they must show that for 20 years preceding the action their house had been in a certain position, and had been, by the works complained of, disturbed from that position. With regard to the crack, if the allegation of subsidence and the claim based upon it failed, there only remained the assertion that it was caused by vibration. He asked his ordship to hold, on the evidence, that there was no such vibration as to cause within a few months a crack about 2in. wide. With regard to the action of Messrs. Meux, he contended that they, as reversioners, were not entitled to maintain an action at all, because the nuisance, if it were a nuisance, was a thing which could be removed at any time. Returning to the action of Shelfer, it was undoubted that there was at times some amount of noise, but not such as to be a nuisance or to cause injury to health or inconvenience. From first to last there had been a great deal of exaggeration of the plaintiffs' case. The vibration was greater in the upper part of the building and this, he thought, was evidence that it was to some extent due to the percussions of air from the steam exhaust, and this cause the defendants were spending large sums to remove by making arrangements for condensation of the steam. The granting of an injunction would have the effect of plunging the streets of the City into darkness, and he thought that, whilst the consequences of an injunction were not necessarily to be taken into account by the Court, there was no evidence of nuisance here sufficient to justify an injunction which would have such a serious result.

Mr. MOULTON, Q.C., followed upon the statutory authorities under which the Company worked. He said they depended upon both the provisional order, and also the Electric Lighting Act of 1882, for that Act ruled all provisional orders granted under it. The rights and privileges of the Act were sufficient to cover them; the order was not intended in any way to lessen the rights conferred on undertakers by the Act, nor did he claim that under the order they had any rights or privileges which entitled them to commit a nuisance beyond what the Act itself gave. The electric lighting companies were in the position that they had duties which were obligatory. Mr. Moulton proceeded to go through the Act clause by clause, and contended that nothing which they had done was more than they were authorised to do under the Act. So far as damage arising during the execution of works, he thought there was clearly an intention on the part of the Legislature that undertakers might be in a position to do things which would cause damage, for which there must be compensation.

Continuing his argument after luncheon, Mr. MOULTON contended that the Electric Lighting Company was entitled to the same immunities as were statutory water companies or statutory railway companies, and therefore no action could lie against them for annoyance caused by the working of their engines. There might be a claim for compensation for any damage done during the construction of the works; but with regard to the other points complained of, they formed part of the inconvenience that was borne by the public in return for the benefits they got.

Mr. JUSTICE KEKEWICH said, with regard to the point made on behalf of the defendants, that they were not liable to a common-law action, on the ground of nuisance, he was against them, and he did not think it was necessary that he should hear arguments on behalf of the plaintiffs on that point. He was now dealing with the question of injury caused to the building by the construction of the works. That was a question of evidence. What he was considering was, whether, assuming that there was noise or vibration existing, and found to be a result of the operations of the defendants as now conducted, the defendants were liable to action on the score of nuisance. It was urged that the defendants had done their very best to carry out their works in a proper way, and that they could not be charged with negligence. That was his view of the evidence, and had been throughout, except as regards the question of the exhaust-pipe. Upon that some complaint had arisen upon that, but with regard to that the defendants had not only shown that they had done everything reasonable to abate the nuisance thereby occasioned, but that they had in process of construction works which would abate the nuisance arising from that cause, and he should not in any case do more upon that point than give some nominal damages. But he was not now dealing with that point. The point was, assuming that either from this exhaust-pipe or by the vibration caused by the engines in work, there was a nuisance, were the defendants liable in common law? In his opinion there was nothing to take them out of the common law or to the liability to an action for nuisance. There was this section in the Provisional Order: "Nothing in this Order shall exonerate the undertakers from any indictment or action or any other proceedings for nuisance in the event of any nuisance being caused by them." It might be said that what the defendants were doing, and what was complained of, did not come within the Order, but came within the Act of Parliament. Was there anything in that Act which relieved the Company from liability for nuisance? The general law was perfectly plain. Power to do a particular thing, for instance, to construct a railway, did not justify the undertakers so to do that thing as to commit a nuisance, unless by express language or by necessary implication that must be inferred. Having referred to the case of the National Telephone Company v. Graf-Baker, which came before him, and also the case of the City and South London Electric Railway and others, his Lordship examined the Electric Lighting Act of 1882, and said there was nothing therein which could relieve the defendants of the liability to an action for nuisance; the Act did not say in so many words that they might or should do a particular thing, notwithstanding that in so doing they created a nuisance to their neighbours, nor did he see that there was the slightest ground for saying that there was a necessary implication. It was quite sufficient (the learned Judge thought) to base his opinion on the view, that unless they found express relief from the ordinary liability of the subject, whether a company or an individual, to an action at common law for nuisance that liability remained. He, therefore, held that the Company were not entitled to exempt themselves from an action for nuisance

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in working their engines and electrical appliances. He would hear plaintiffs' counsel on the rest of the case.

Mr. WARMINGTON, Q.C., confined himself to the contention that distinct and appreciable discomfort and injury had been sustained, that the defendant company had caused that discomfort and injury, and that Messrs. Meux had a right of action.

Mr. JUSTICE KEKEWICH, in giving judgment, held that the nuisance arising from noise and vibration in the case of Shelfer had been proved, and he was entitled to damages, but not to an injunction, and the damages must take the form of compensation for disturbance. He was also entitled to damages on account of the injury to the structure. Messrs. Meux had no right of action for an injunction in their position as reversioners, but they were entitled to damages, though probably small damages, for injury to the structure. The amount of the damages in each case must be the subject of inquiry. The action for injunction in the case of Messrs. Meux would be dismissed with costs, but they were entitled to costs in the action for damages. The plaintiff Shelfer had practically succeeded in his action, and was entitled to costs.

Ebbsmith v. Dawson and Others.

In the Queen's Bench Division, before the Lord Chief Justice and a Special Jury, an action has been heard, in which Mr. Joseph Ebbsmith, of 86, St. James's street, London, S.W., sued the defendants to recover damages for alleged libel. The defendants admitted publication, and pleaded that the words used were not libellous, and did not constitute a libel on the plaintiff. Further, they said that in their ordinary signification the words were true in substance, and a plea of privilege was set up.

Sir E. CLARKE, Q.C., in opening the case for the plaintiff, said the libel complained of was contained in a passage in a circular issued by the defendants, who had constituted themselves a shareholders' committee of the South Staffordshire Tramways Company. In this circular they professed to give the past history of the Company, and one paragraph was as follows :—" Whilst the shareholders were gradually being educated up to the idea of electric traction, and their authority obtained for the necessary Parliamentary measures, arrangements were being made in another quarter, apparently with the object of turning the result to good account, as on May 29, 1889, a company was registered in London, under the title of the Electric Construction Corporation (Limited), in which Mr. Joseph Smith [the plaintiff] appears as a managing director with a holding of £4,260, as against £200 in your Company ; and Mr. George Rose (Mr. Smith's former partner) as the registered holder of £20,000, as against the two shares held in your Company ; and your Chairman, Mr. Carruthers Wain and his wife, appear to have been interested as holders of £3,120, as against a total interest of £500 each in your Company. We find that Mr. Joseph Smith occupied the position of Managing Director until 1892, from the commencement of which his name ceased to be put forward in the report of the Corporation ; and it is curious to observe that the names of Mr. Jabez Spencer Balfour and Mr. Henry Granville Wright, of Liberator notoriety, disappeared from the Directorate at the same time ; and for some reason, which we have not at present discovered, Mr. Smith changed his name at the end of 1891, by adding the prefix Ebb, so that he is no longer Smith but Ebbsmith." Counsel stated that Mr. Ebbsmith changed his name, not at the end of 1891, but in the year 1890, by the regular process of royal license, and for family reasons, and it was not true that his name disappeared from the Directorate of the Electric Corporation at the same time as that of Jabez Balfour and Granville Wright. At the time he left the Directorate of the Corporation he had no reason to distrust either Mr. Balfour or Mr. Wright.

Mr. JOSEPH EBBSMITH said he was formerly a solicitor, but retired in 1889. He had formerly been Town Clerk of Wednesbury, but resigned in January, 1889. There was no truth in the suggestion that he had utilised the larger interest which he had in the Electric Corporation to the prejudice of the South Staffordshire Tramways Company, of which he was formerly solicitor. On August 10, 1891, he resigned his position as Managing Director of the Electric Construction Corporation, and was appointed an ordinary Director in the place of Sir Robert Fowler ; afterwards he resigned his ordinary Directorship. His resignation had nothing to do with Mr. Balfour or Mr. Wright. Just before she died, his mother, who belonged to an old family of which she was the last representative, requested him to prefix her maiden name to his own name of Smith. This he did by royal license.

On Thursday, while the plaintiff was continuing his evidence, Mr. MURPHY, Q.C., for the defence, said he was happy to say that the jury would not be troubled with the case any further. The whole of the circular had not been before his Lordship, and if it had been, it would have been found that its object was to show the exact condition of things in connection with the Company. Towards the end of the circular words were, however, introduced which Mr. Ebbsmith thought reflected upon him ; but having heard the statement of Sir E. Clarke, and having seen and heard Mr. Ebbsmith in the witness-box, the defendants desired him to say that whilst entirely reserving their right to comment on the conduct of their own Directors, and Mr. Ebbsmith, so long as he was their solicitor, they did not intend to convey that Mr. Ebbsmith's withdrawal from the Company or his change of name had anything to do with the determination of Balfour and Wright's connection with it, and they expressed regret if the words used in the circular had led to that impression. They accepted the statement of the plaintiff in the witness-box that he had changed his name for family reasons, and that the Electric Construction Company in no way resembled the other companies with which Mr. Balfour had been notoriously connected. They thought the Tramway Company had entered into a contract which they ought not to have entered into, but there was no cause of complaint with regard to that against Mr. Ebbsmith. He suggested that there should be a *stet processus*.

Sir E. CLARKE said the course proposed to be taken would be a satisfactory one to Mr. Ebbsmith. Mr. Murphy was, of course, entitled to say that his clients reserved the right to say that a certain contract, which had nothing to do with plaintiff, should not have been entered into, but he (Sir E. Clarke) should have been able to show that the Electric Corporation was a strong and sound one. The plaintiff, after the statement of Mr. Murphy, was glad to end the whole case.

The LORD CHIEF JUSTICE expressed approval, and a *stet processus* was issued.

Claim against a Trades Union Treasurer.

Edward Stallard, 6, Digby-street, was summoned at Bristol before Messrs. Robinson and Low, as treasurer of the Bristol branch of the Electrical Trades Union, for withholding £9. 10s. 4d. belonging to the organisation, the complainant being Mr. Walker, General Secretary of the Union.

The proceedings were taken under Section 20 of the Friendly Society Act, 1875, and the case had been before the Court on two previous occasions. It was stated in evidence that the branch was started in 1893, but was closed by order of the Council at the head office in London for refusing to comply with orders. All the members were in arrear, and there was none eligible for office. Defendant was appointed treasurer on January 12, 1894, and, according to the books, had a sum of £9. 10s. 4d. in hand, which he had from the out-going treasurer, to whom he gave a receipts.

For the defence it was stated that the members intended appealing against the decision of the council closing the branch, and by resolution had authorised the defendant to retain the money pending further inquiries. Stallard admitted having £8. 17s. 4d. in hand.

Several points of law were raised on behalf of the defence, one being that as the organisation was not registered under the Friendly Society Act the summons could not succeed.

Mr. ROBINSON said the magistrates were of opinion that they had no power to make an order under the Friendly Society Act, and they therefore dismissed the complaint, and awarded the defendant £1. 4s. 6d. costs.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

TENDERS INVITED.—The Committee of Visitors of the Devon County Asylum, Exminster, invite tenders from makers of electric light wires, casings, fittings and various supplies, the Committee having decided to carry out the wiring of the asylum by their own staff. Further particulars are given in our advertisement column ; and samples and prices of the materials should be sent in to Mr. Arthur E. Ward, Clerk to the Committee, 9, Bedford-circus, Exeter, not later than May 15th.

———— Tenders for the supply and erection of Willans engines, continuous-current dynamos, pipe work, spare armatures, &c., for the Council of the Borough of Brighton, have to be in by 10 a.m. on the 30th inst., to Mr. F. J. Tillstone, the town clerk, Town Hall, Brighton.

———— The tenders invited by the Southampton Harbour Board for the work comprised in the lighting by electricity of the Town Quay, Southampton, have to be sent in to Mr. A. H. Skelton, the Harbour Board Offices, Town Quay, Southampton, by May 8th.

———— The St. Pancras Vestry invite tenders for the buildings to contain the electric lighting plant at King's-road, Camden Town, N.W. The drawings can be inspected, and other information obtained, at the offices of Prof. H. Robinson, C.E., 13, Victoria-street, S.W. ; and tenders must be sent in to Mr. Albert E. Pycraft, chief clerk, Electricity and Public Lighting Department, Vestry Hall, Pancras-road, N.W., not later than noon on Monday, May 7th. Other particulars are given in our advertisement columns.

———— The tenders for working the tramways throughout the City of Leeds, which are invited by the Corporation, have to be in by May 5th. All particulars can be obtained of Mr. J. Harrison, town clerk, Town Hall, Leeds.

TENDERS ACCEPTED.—The Shropshire Electric Light and Power Company (Limited) have accepted the tender of Messrs. Edmundsons (Limited) for supplying and erecting the plant and apparatus for the electric light installation for Shrewsbury, including buildings, engines, dynamos, mains, cables, &c.

———— The tender of Messrs. S. H. Heywood, of Manchester, has been accepted for the supply of electric light fittings, switchboards, lamps, wiring, &c., for lighting the technical school now in course of construction at Broad-street, Bury, Lancs., for the Bury Corporation.

———— The Vestry of St. Pancras have accepted the tender of Messrs. Easton, Anderson and Goolden (Limited) for the supply of boilers for the electricity station at King's-road, for the sum of

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£2,837. 6s. 2d. The tender of Messrs. Doulton and Co. for water-softening apparatus for the same station, for the sum of £198, has also been accepted.

APPOINTMENT.—Mr. V. A. H. McCowen, of Tralee, has been appointed resident electrical engineer to the Belfast Corporation, at a salary of £250.

APPOINTMENTS VACANT.—The Technical Education Committee of the Portsmouth Corporation invite applications for the appointment of Principal of the Municipal Technical School. The Principal must devote his whole time to the work of the school, and to advise the Committee in reference to the appointment of assistant teachers. The stipend for the first year will be £250, and £300 per annum afterwards. Applications must be sent to Mr. Alex. Hellard, Town Clerk, not later than 10 a.m. on May 9th. Further particulars appear in our advertisement columns.

TRADES UNIONISM AND CENTRAL STATION PUPILS.—On Thursday evening last week a deputation of the Portsmouth Branch of the Amalgamated Society of Engineers waited upon the Chairman and Vice-Chairman of the Electric Lighting Committee of the Portsmouth Corporation, to complain that the remuneration offered to the mechanical engineers engaged for the electric lighting works was considerably below the current rate of wages, and was opposed to the resolution adopted by the Corporation. After hearing the views of the deputation, Alderman Ellis explained that the officials referred to were not mechanical engineers at all, but assistant superintendents. They probably had some knowledge of mechanical work, but were by no means trained to the use of tools like fitters, who have served an apprenticeship to their trade. Nor were they required to do the work of a fitter. They would have to deal with no fewer than thirteen dials and work out mathematical calculations, in order that the power might be properly given according to the varying requirements of the consumers. The Board of Trade insisted that scientific men should be employed upon such important duties, and he would not for a moment hold himself responsible for what might occur in the event of the work being placed in the hands of men who had not received that scientific education which could alone ensure their fitness for the work. The President of the Amalgamated Society replied that his Society did not recognise them as electrical engineers, because, in the opinion of the members, they were being drafted into certain positions with the object of robbing them of the work which should belong to their trade alone. Two of the deputation were electricians who could design, construct, and work the whole of the Committee's machinery. The men appointed might be able to make mathematical calculations, but the moment anything went wrong with the plant they would be compelled to fly to mechanics for the execution of the repairs. Was it right or just that men who could not be relied upon to set matters straight in case of emergency should be employed on work which properly belonged to fitters? Alderman Foster said the officials did not come under the rules of the Amalgamated Society. They had served as students, and now took positions at nominal salaries to gain experience and qualify for superior appointments. They were not mechanics but professional men. Alderman Ellis said the interview would be reported to the Committee, and no doubt the representations of the Amalgamated Society would receive every consideration so long as they were confined to men belonging to the Society.

SHOP AND WORKROOM LIGHTING.—The handsome premises just erected by Messrs. Redfern in Conduit-street, London, W., have been lighted throughout by electricity; and some considerable extensions to Messrs. Marshall and Snelgrove's huge block in Oxford-street have also had the electric light extended to all departments.

THE LIGHTING OF STAIRCASES.—The demolition of large numbers of dwellings until lately occupied by the poor in London has led to the erection of a considerable number of large blocks of "model" buildings, let out in tenements, and a Select Committee of the House of Commons has before it an Omnibus Bill promoted by the London County Council, one of the chief provisions of which is to fix upon the owners of these model dwellings the obligation to light the staircases from sunrise to sunset.

PUMPING MACHINERY.—A trial was recently made at the Newcastle works of Messrs. Ernest Scott and Mountain of two sets of large-size electrically-driven pumps now in course of construction for the Lothian Coal Company. The trial proved successful. The plant is probably the largest pumping plant electrically driven ever put down for colliery use, the electrical plant consisting of two "Tyne" dynamos, equal to an output of 60,000 watts at 600 revolutions; two 60-H P. electric motors; two sets of three-throw pumps capable of delivering 200 gallons per minute against a head of 650ft.; two 150-E.H.P. horizontal engines; conducting cables, &c.

STATION INDICATORS.—A demonstration of an automatic station indicator was given at Ealing recently, the object of the device being to indicate to passengers in the trains running on the Metropolitan and Metropolitan District systems the next station at which the train will arrive.

PROFIT SHARING.—The Newcastle-upon-Tyne Electric Supply Company (Limited) has a profit-sharing arrangement with its employés, and, under the system adopted by the Company, 27 shares have been appropriated for the benefit of W. McArthur, engine driver, and 25 shares for T. Purves, stoker.

ELECTRIC CONSTRUCTION COMPANY.—This Company has obtained the order for the electric plant for Stafford, and has secured the contract from the County of London and Brush Provincial Electric Lighting Company, for the lighting of the united parishes of St. James and St. John, Clerkenwell. These are in addition to the contracts for Wolverhampton, Halifax, and Aberdeen, which the Company has in hand. They are also busy with the equipment of the Madras electric tramways. An advance has just taken place in the price of the Electric Construction Company's shares. As already announced, Mr. A. B. Blackburn, M.I.C.E., late with Messrs. Mather and Platt (Limited), has been appointed chief engineer to the Company. Mr. Thomas Parker, the founder of the firm of Elwell-Parker, now known as the Electric Construction Company, severed his connection with the Company last week, and five members of the technical staff, most of whom had served the firm of Elwell-Parker, have, we learn, resigned with their late chief.

EDISON AND SWAN FITTINGS.—A very handy hanging sheet of plain and ornamental electric light fittings is issued by the Edison-Swan Company, and the trade can obtain copies on application. Illustrations are given of special new designs of electroliers, standards, brackets, pendants, hanging lamps, portable lamps, and ceiling fixtures, made in black bronze, polished brass, hammered copper, nickel-plated silver, or hammered iron.

MESSRS. MIX AND GENEST.—We are asked to state that the rumour that the Mix and Genest Agency in Manchester is given up is untrue, and has no foundation. Mr. C. A. Clarke has, since the commencement of their electrical business in England some years ago, represented Messrs. Mix and Genest, and will continue to do so, at 3, Delaunays-road, Crumpsall.

MESSRS. JOHN DAVIS AND SON.—This firm send us a copy of their catalogue, just ready, giving full illustrated particulars of the various apparatus manufactured by the firm. A principle section of the catalague is devoted to mathematical drawing instruments, of which the firm make a special feature. The catalogue consists of 70 closely-printed large 4to pages.

"ADRESSBUCH DER ELEKTRISCHEN ANLAGEN."—We have received a copy of this directory, the first part of which contains lists of the names of proprietors of electric light installations in Germany, Austria, Denmark, Great Britain, Italy, Netherlands, Norway, Russia, Sweden, and Switzerland, arranged alphabetically under the various cities and towns. If the Continental lists are better than the British, about which it were the kinder course to say nothing, the book may be of use to makers of electrical instruments, apparatus, lamps, &c. The concluding section of the book gives lists, similarly arranged, of German electrical firms.

SILVERTOWN CARBONS.—The India Rubber Company have just issued a revised list (No. 34) of Gray's patent carbons for electric lighting, for which it is claimed that they are stronger and more homogeneous than ordinary carbons, and, from the care used in their manufacture and the regularity of their composition, the points remain perfectly shaped while burning.

PATENT OFFICE LIBRARY.—This office is open free from 10 a.m. to 10 p.m. every week day, and contains English, Colonial, and foreign specifications and trade marks, text books, periodicals, &c., in all branches of science, English and foreign. The number of readers for the week ending April 7th was 2,396, and for the week ending April 14th, 2,330.

ACCRINGTON.—At the meeting of the Town Council the recommendation of the Legal and Parliamentary Committee that an installation of the electric light, to supply not less than 2,000 16-c.p. incandescents, with provision for extension, came up for confirmation. The minutes were, after discussion, referred back for reconsideration.

ALLEGED THEFT OF A TELEPHONE.—At the Sheffield City Police Court, on Thursday, George Emberley was charged with stealing a telephone, the property of the National Telephone Company. It appeared that the prisoner went to a subscriber's offices on the previous Monday and asked to inspect the telephone, representing that he came from the Company. He said the instrument was bad, and he would have to bring a new one, and took the old one away. The next day the man who was really in the employ of the Company called and the fraud was discovered. The prisoner had offered the instrument for sale to Mr. J. T. Sutcliffe, electrician, Sheffield Moor. Mr. Preston, the district manager to the National

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Telephone Company, stated that prisoner was not employed by them. He had obtained telephones in a similar manner before, and sold them. The prisoner was sentenced to four months' imprisonment with hard labour.

ASHTON-UNDER-LYNE.—It has been decided to refer to the General Purposes Committee the question of considering the advisability of lighting the district by electricity.

BASINGSTOKE.—The Lighting Committee of the Town Council have reported and ask permission to employ the services of an electrical engineer in reference to the lighting of the district by electricity at a fee not exceeding £21. The recommendation was adopted.

BEDFORD.—The Corporation have decided by a majority of four to carry out the provisions of their Electric Lighting Order (granted August 4, 1890) before January 1, 1895. It has been decided to appoint an electrical engineer, and the lighting scheme has been referred to the Electric Lighting Committee, with power to act.

BRADFORD.—The Gas and Electricity Committee of the Corporation have received requests from a number of the principal tradesmen outside the present electric lighting area, asking for an extension of the light, and a sub-committee has been appointed to consider the matter.

BRECHIN.—At the last meeting of the Town Council a resolution was moved that the Board of Trade be applied to for a Provisional Order, but after considerable discussion the matter was adjourned for a month, the Town Clerk in the meanwhile to make inquiries.

BRISTOL.—The Electric Lighting Committee of the Corporation have decided to purchase an engine and dynamo capable of supplying the demand for electric current during the day time, at an estimated expenditure of £613.——Mr. A. W. Ranken has resigned his appointment as Chief Assistant Engineer to the Corporation, and Mr. E. H. B. Tyler has been appointed to the position.

BUCKINGHAM.—The Town Council have been informed by the local gas company that unless the company be allowed to light all the street lamps with gas they will not undertake to light any. It has been decided to invite the Electric Lighting Company and the Gas Company to send in tenders for lighting the street lamps, excluding those already lighted by contract by the former.

BUXTON.—A long discussion took place at the last meeting of the Local Board on the question of the electric lighting of the town. No definite decision having been come to, it was ultimately decided that a special meeting should be held to consider the question.

CHURCH LIGHTING.—St. John the Baptist Church, Broad-street, Bristol, is now entirely lighted by electricity, the massive gas brackets, which formerly interrupted the view of the seatholders, having been removed. It is generally agreed that the change from gas to electricity is a great improvement.

CITY OF LONDON.—The Court of Common Council have decided to extend the electric light at the Guildhall to the Art Gallery at an estimated cost of £290, inclusive of fittings.

CLERKENWELL.—The County of London and Brush Provincial Company has notified to the Clerkenwell Vestry that work is about to be commenced for lighting the district by electricity so as to be in time for the coming winter demand. The whole of the 19,900 shares of £10 each, recently offered for subscription, are, it is stated, now subscribed and allotted. The order for the plant is, as stated elsewhere, in the hands of the Electric Construction Company.

DERRY.—The Local Government Board has agreed to grant to the Derry Corporation a further loan of £2,871 in excess of the original amount to enable the Corporation to complete the scheme for 160 arc lamps, the payment to be spread over a period of 25 years. A further sum asked for by the Corporation will probably also be granted.

DUBLIN.—Mr. Robinson, in presenting the report of the Electric Lighting Committee to the Corporation, showing the expenditure and receipts for the year 1893, said that the city accountant had informed him that if the Corporation were a private company they would be in a position to pay a dividend of 4½ per cent. upon their electric lighting undertaking.

EXHIBITION.—The Exhibition to be held in Bordeaux in 1895 is to be universal so far as regards exhibitors of wines and spirits, and of electrical plant and apparatus. The general, industrial, and agricultural portion of the Exhibition is to be open only to exhibitors from France and French possessions, from the United Kingdom, Belgium, Switzerland, Italy, Spain, and Portugal, but not from Germany!

EDINBURGH.—An important deputation has waited upon the Town Council to ask for a considerable extension of the electric lighting scheme, and after consultation with that body it has been decided to refer the matter to the Electric Lighting Committee for immediate attention.

HAMPSTEAD.—The Electric Lighting Committee of the Hampstead Vestry have reported that they hope to be in a position to supply the electric light in their compulsory area early in July next. At the last meeting of the Vestry a resolution was carried that application be made to the London County Council for permission to borrow a further £25,000 for the purposes of the electric lighting scheme.

HOTEL LIGHTING.—Mr. Matthew Buchan, of Portobello, has recently completed the lighting by electricity of the Grand Restaurant, Edinburgh.

KENSINGTON.—The Vestry have informed the Notting Hill Electric Lighting Company that they are prepared to consider any proposal the Company may make for dealing with an area larger in extent than that for which the Vestry's permission has recently been applied for to lay mains outside the area specified by the Company's Provisional Order. At the same time permission has been granted for certain extensions asked for by the Company.

LANCASTER.—The Corporation have notified intending consumers of electric current that continuous supply was commenced on the 17th inst.

LEITH.—The Leith Dock Commissioners have decided to proceed with the electric lighting of the old dock and the Victoria Dock at once, and the lighting of the Edinburgh Dock will be afterwards promptly proceeded with.

LIGHTING CONTRACTS.—Messrs. Baxendale and Co. send us a list of lighting contracts recently secured in the Manchester and Oldham districts.

MIDSOMER NORTON.—The Island Flour Mill at this place has recently been opened, and has been fitted throughout for the electric light, under the engineering superintendence of Mr. Charles H. Shearn.

MONTROSE.—A special meeting of the Police Commission was held on Thursday, when a lengthy report was submitted from the deputation appointed to make inquiries respecting the proposed introduction of the electric light into the burgh. The report stated that the Coatbridge station was that which the deputation suggested should be taken for the model for that at Montrose. It was ultimately decided that a deputation consisting of the whole Board should visit Coatbridge and inspect the installation.

NEWCASTLE.—The local gas company have notified the City Council that they have power, under their Act of Parliament, to charge for all public lamps, whether in use or not; and should the Council decide upon introducing electric lighting, the Company were determined to charge for any gas lamps which, in consequence, were extinguished. The Watch Committee of the Council have decided to contest this remarkable claim of the Company should they act as indicated.

NEWPORT (MON.).—At the meeting of the Town Council on Tuesday the various tenders accepted by the Electric Lighting Sub-Committee were finally agreed to, with some minor variations. An amended plan for the proposed electric lighting station was submitted, which would allow of a better arrangement of the plant, the area and the cost being slightly reduced, and making it possible to use Lancashire boilers instead of tubular.

SHEFFIELD.—It is stated that the new capital issued by the Sheffield Electric Light and Power Company (Limited) has been subscribed, and that letters of allotment are to be sent out immediately.

STAFFORD.—The Electric Lighting Committee of the Town Council have recommended that the following tenders be accepted:—For engines, Messrs. Robey, £2,288; boilers, Hick, Hargreaves and Co.; dynamos, the Electric Construction Company, £1,151; buildings, J. Lovatt, £3,030; ironworks and roofs, Rubery and Co., £197. Alderman Peach, in proposing the adoption of the Committee's report, said that owing to some misunderstanding about the tender of Messrs. Robey for the engines it would be necessary to refer the report back to the Committee.

STIRLING.—The Town Council on Monday resolved to instruct the Electric Light Committee to obtain all necessary information in view of the Council applying for a Provisional Order in November.

WINDSOR.—In reply to a question as to when the Electric Lighting Committee of the Urban Sanitary Authority would present their report, it was announced that communications had been received by the Committee, the nature of which it would be unwise to make public at present. A petition is in course of signature throughout the town to the Town Council, urging upon that body to take immediate steps to provide the town with electric light. Already a large number of influential signatures have been obtained.

YORK.—The Lord Mayor of York and the Electric Lighting Committee of the Corporation have visited Oxford for the purpose of inspecting the system adopted by the Oxford Electric Lighting Company. The party subsequently visited the Wolverhampton works of the Electric Construction Company.

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PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

March 20, 1894.

5,728. W. ROUTLEDGE. Newcastle-on-Tyne. Adapting electro-motors to dental purposes.

5,735. E. J. PATERSON and C. W. HILL. London. Improvements in electrical switchboards.

5,754. W. H. LANDER. Dublin. An improvement in electrical arc lamps.

5,796. H. A. F. PETERSEN. London. Improvements in underground conduit systems for electric railways.*

5,806. A. S. BAXENDALE. London. An improvement in dynamo-electric machines and apparatus for driving them.

5,807. THE EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY (LIMITED) and C. F. PROCTOR. London. A duplex electric safety fuse.*

5,816. H. H. LAKE. London. Improvements in electrical measuring instruments. (E. Weston, United States.)*

March 21, 1894.

5,863. H. REASON. Brighton. Improvements in fuse boxes for electricity supply mains.

5,913. J. S. RAWORTH. London. Improvements in alternators.

5,917. Sir C. S. FORBES, Bart. London. Improvements in and relating to telephone and telegraph systems.

5,918. S. S. ALLIN and W. H. WOOD. London. Improvements in arc lamps.

5,921. Sir C. S. FORBES, Bart., and THE DOMESTIC TELEPHONE COMPANY (LIMITED). London. An improved telephone combination.

5922. A. HOWARD. London. An improved automatic electric machine.

5,931. E. J. CLUBBE and A. W. SOUTHEY. London. Improvements in electrically propelled common road vehicles.

5,932. E. J. CLUBBE and A. W. SOUTHEY. London. An improvement in electrically-propelled vehicles.

March 22, 1894.

5,971. A. G. ADAMSON. Glasgow. Improvements in apparatus for the use of the electric light for photographic purposes.*

6,028. S. JEVONS. London. An improvement or improvements in electro-dynamo machines and in electromotors.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d. each.

1892.

23,101. SCHROEDER, C. A. J. H. and H. E. R. Galvanic batteries.

1893.

2,740. RATHBONE. Electric arc lamps.

4,685. BOTT. Recording and reproducing tapes for electrical ticker machines, &c.

4,874. FOSTER. Transforming, &c. electric currents.

5,198. HARGREAVES and BIRD. Electrolytic apparatus.

6,004. SUDDARD. Type-writers and printing telegraphs.

6,170. HOLLINS and MEIR. Earthenware electric switches, &c.

6,205. WOOD. Distributing electricity for lighting, &c.

6,684. MÜLLER and ADKINS. Gas, electric, &c., lamps.

7,082. KETKY. Brackets for electric lighting, &c.

7,266. WHITCHER. Distributing electric energy.

7,594. LYTE. Electrolytical decomposition of chlorides.

7,713. JOHNSON. Gland joint for electric conductors.

8,316. NEW and MAYNE. Electrical propulsion of boats and vessels.

8,571. EMERY. Cells for electric batteries.

8,812. ABEL (Soc. Générale des Telephones Reseaux Telephoniques et Constructions Électriques). Telephone indicators.

1894.

666. EVANS. Holders for incandescent lamps.

2,007. EDISON and SWAN UNITED ELECTRIC LIGHT COMPANY, and PROCTOR. Electric switch.

2,203. DURLACHER and OTHERS. Electric candle lamps.

2,514. WEST. Electric bells.

2,562. ASHLEY. Electric tramways and railways.

2,812. TESLA. Generating electric currents.

2,900. RUDHOLZNER. Electro-deposition of metals.

3,020. TUDSBURY. Induction electrical machines.

3,223. DONALDSON. Heating gases by electricity.

3,384. TURNBULL. Electric lamps.

COMPANIES' MEETINGS AND REPORTS.

Eastern Extension, Australasia, and China Telegraph Company (Limited).

Sir John Pender, G.C.M.G., M.P., presided on Wednesday at Winchester House, 50, Old Broad-street, over the forty-first ordinary general meeting of this Company.

The SECRETARY (Mr. F. E. Hesse) having read the notice calling the meeting and the minutes of the previous meeting, which were confirmed, the report of the Directors was taken as read.

The CHAIRMAN then said: Gentlemen, I have always at these half-yearly meetings gone over in detail some of the figures of the report, and as I think that the practice has been generally acceptable to the shareholders, I will continue it to-day. The gross receipts for the half-year under review have amounted to £251,000, against £247,000 for the corresponding period of 1892, showing an increase of £4,000. The working expenses have amounted to £76,000, against £91,000 for the corresponding period of 1892, showing a decrease of £15,000, which is entirely accounted for by the repairs to cables having cost only £21,000 during the past half-year, against £38,000 in the corresponding half-year of 1892. (Applause.) Comparing the figures for the whole year the results are as follows: The gross receipts for 1893 were £509,000, against £494,000 in 1892, or an increase of £15,000. The working expenses for 1893 were £155,000, against £171 000 in 1892, or a decrease of £16,000. The net revenue for 1893 was £282,000, against £250,000 in 1892, or an increase of £32,000 (cheers), half of which is due, as already explained, to the reduction in expenditure for cable repairs, and the other half to increased revenue resulting from the raising of the Australian tariff, which was done at the request of the Colonies, from 4s. to 4s. 9d. per word, and to the exceptionally heavy Australian traffic transmitted during the financial crisis last summer in connection with the numerous Bank failures and reconstruction schemes. But for this there would have been a considerable falling-off in revenue, as the working of the Australian Tariff arrangement for the third year of "guarantee" ending this month shows a loss estimated at between £11,000 and £12,000 notwithstanding these exceptional causes.

We have also experienced a further heavy loss on exchange during the past year, through the continued depreciation of the silver currency, although when we raised the rates of collection at the currency stations a year ago we thought we had fully protected the Company by the rates then fixed. The depreciation, however, has been far greater than was anticipated, and as there appears to be no prospect of any permanent substantial recovery, your Directors have reluctantly decided to further raise the rates, where they are free to do so, from May 1st next, so as to give the Company the equivalent of their sterling charges. (Hear, hear.)

The usual interim dividends have been distributed during the past year, making, with the dividend proposed to be paid to-morrow, a total payment of 5 per cent. for 1893. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the past year. (Applause.)

The balance of £107,830 has been carried to the general reserve fund, which now stands at £633,686, made up as follows:—Amount of reserve at end of 1892 £509,733, interest credited during 1893 £14,114, value of cable recovered after renewals to Hong Kong-Saigon and Madras-Penang sections £2,009, balance from revenue account (1893) £107,830, leaving the fund, as already stated, £633,686, after having expended £1,160,685 out of reserve on cable renewals, duplications and triplications since the formation of the Company, and thus greatly strengthened and improved the market value of your property. (Cheers.)

In terms of the trust deed a further drawing by lot of 371 of the Company's Five per Cent. Australian Subsidy Debentures took place on the 2nd instant, for payment at par on July 2nd next, when the Debenture Debt, which originally stood at £640,000, will be reduced to £248,400.

At the last general meeting I referred to the arrangements which we had entered into with Her Majesty's Government and the British North Borneo Company for bringing Labuan and North Borneo into telegraphic communication with Singapore, Hong Kong, and the rest of the world, and at the same time strengthen our China system by securing an alternative line between Singapore and Hong Kong. Since then we have had the cable manufactured and sent out, and the first section, viz., that between Singapore and Labuan, was last week completed and opened for traffic. The remaining section, from Labuan to Hong Kong, will be laid during the present month. The length of the new cable is nearly 2,100 nautical miles, costing about £300,000, and it will increase the total mileage of our system to a little over 18,000 miles.

For some time past we have been endeavouring to strengthen the service between Singapore and Banjoewangie, the station at the east end of Java where the three Australian cables are landed, without incurring the heavy expense which the duplication of the Singapore-Banjoewangie cable would involve. With this object negotiations were entered into with the authorities at the Hague and in Netherlands-India, with the satisfactory result that we have secured a special wire on the Government land-line through Java for the transmission of the international traffic by our own employés. This special wire gives us an efficient alternative communication to our Singapore-Banjoewangie cable, and consequently renders it unnecessary, at all events for the present, to duplicate this section. A small station has been opened by the Company at Sourabaya in connection with the new line, and we have been much gratified to learn that the telegraphing public in Java are greatly pleased at the marked improvement in the international service which this arrangement has effected. (Applause.)

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You will have observed from the newspapers that the agitation for a Pacific cable between Canada and Australasia has of late greatly increased, and that at the Postal and Telegraph Conference recently held at Wellington a resolution was passed recommending the Governments interested to offer any company willing to lay the cable a guarantee for fourteen years of 4 per cent. on a capital not exceeding £1,800,000, on condition that the tariffs are reduced to 3s. per word for ordinary telegrams, 2s. per word for Government telegrams, and 1s. 6d. per word for press telegrams. A deputation of Australasian and Canadian Government representatives has since waited upon Lord Rosebery and Lord Ripon at the Colonial Office to urge the Imperial Government to take part in the movement, and Lord Rosebery has announced that the Government will send a representative to the Conference to be held at Ottawa in June next for further considering the question, in order to watch the proceedings. Beyond this, however, the Imperial Government does not appear to have committed itself either one way or the other. This agitation, however, is almost entirely based on sentiment, an "all British cable," as its advocates are pleased to style it, having less chance of immunity from interruption in time of war than the existing cables which follow the principal trade routes, and could therefore be more easily protected. Moreover, it is a moot point whether a cable, if once broken, could be picked up from such great depths as are reported to exist in the Pacific Ocean. But apart from this, a Pacific cable is not wanted to meet commercial requirements, the existing service to Australia being acknowledged to be one of the most efficient and cheapest in the world, capable of transmitting a far greater traffic than it at present carries. Consequently, to put down another line of cables on commercial grounds at a cost of nearly two millions sterling, or four millions sterling if duplicated, would be simply throwing away money, and promoting unnecessary and ruinous competition; and as the existing system was established by private enterprise, without any Governmental assistance whatsoever, Her Majesty's Government could not in equity grant pecuniary aid to the proposed competing line without subsidising or guaranteeing our cables to at least the same extent. (Hear, hear.) If, however, a Pacific cable is required for strategic purposes, which I very much doubt, and the Governments concerned are prepared to provide the necessary subsidies to enable it to be carried out, then it would be better and cheaper for them to arrange with us to do the work. By this means our special facilities and large experience in cable matters could be profitably utilised, and the line worked in connection with, instead of in opposition to, the present service, thus avoiding injury to existing interests. To show how utterly inadequate the terms proposed by the Wellington Conference are, I may mention that a Pacific cable would require no less a sum than £237,000 a year to cover its working expenses, maintenance, amortisation, and interest on capital, so that a 4 per cent. guarantee, or only £72,000, would still leave £165,000 a year to be made up by the earnings of the line; and as the value of the whole existing traffic with Australasia, if diverted to the Pacific, would only produce about £90,000 at the proposed reduced rates, there would still be a deficit of £75,000 to be made up even if the Pacific cable carried the whole traffic. These figures speak louder than words, and show clearly enough that a Pacific cable is quite impossible unless the Governments interested are prepared to give a very large subsidy towards carrying it out. (Hear, hear.)

With regard to our relations with the Foreign Governments with whom we are associated, I am happy to state that, with one solitary exception, they are all that could be desired, but in China, where the land-lines are unfortunately competing with the cables, we have not yet succeeded in bringing about the friendly working between the Telegraph Administration and the cable companies which we have so long striven for. No effort will, however, be spared to secure a good understanding with the Chinese if possible. (Hear, hear.) The remarks which I have just made respecting the Pacific cable agitation, and which I purposely read, have been very carefully thought out and put clearly and distinctly, with the object of their being read by those who are talking and thinking about this Pacific cable. For myself I am bound to say that, looking to the nature of the agitation, and to those engaged in it, and looking at the peculiar pecuniary position both of our own country and the colonies, at the present moment, I do not regard this Pacific cable with anything like fear or dread. It is not wanted, I believe, for strategic purposes, and certainly it is not wanted for commercial purposes, and I am, therefore, satisfied that the project is very far off yet from being carried into effect; and although a conference is to be held at Ottawa, it is not likely to interfere with us in the next few years. (Applause.) If, after the hard times which have been experienced in the colonies, a great period of success comes, and the colonies go on developing in the future as they have done in the past, rendering necessary another line of telegraphy, we are prepared to deal with the matter, but on such terms as would not only protect existing interests, but also give us a fair return on any money that might be placed in it, whether it is carried out by the present route, or by the Pacific. (Hear, hear.) In regard to the new cable which we are laying at great expense between Singapore and Hong Kong, I am pleased to find that even in China they approve of the principle on which we have gone, and regard the privileges which have been granted to us as fair and just. (Cheers.) I may also say that our arrangements with the Governments with whom we are associated have always been based on sound commercial principles, and, therefore, anything that is brought against us must be something very extraordinary to upset a system which has been so carefully built up, and which is admitted to have been a marked success as regards our conduct of the business and the advantages derived from it by the public. People have called it a great monopoly. It is really no monopoly at all, except in this sense—that we have done the work so well and beneficially to the general public, that it would require a bold syndicate to attempt to compete with us. (Applause.) I think I have now said enough about the Pacific cable. We continue to pay you a fair dividend—not an extravagant one, but still a large one compared with the general run of dividends—and we have made your dividend more secure and your property more valuable by the reserve fund which we have accumulated. (Cheers.) You have approved of that policy in the past, and it will be our policy in the future to still further increase our reserve fund so that we shall be made more independent if competition should arise, or if we should require additional cables. (Cheers.) I now beg to move—

"That the report and accounts of the Directors, now submitted, be received and adopted, and that a dividend be now declared of 2s. 6d. per share, together with a bonus of 4s. per share, both free of income-tax, payable on the 19th inst., making, with the previous distributions, a total payment of 7 per cent. for the year 1893."

The Marquis of TWEEDDALE seconded the motion.

The CHAIRMAN invited discussion, but no shareholder rising to address the meeting he put the resolution, which was carried unanimously. Continuing, he proposed—

"That Francis Augustus Bevan, Esq., who now retires by rotation, be and is hereby re-elected a Director of this Company."

Mr. C. W. EARLE seconded the motion, which was unanimously adopted.

The CHAIRMAN then proposed—

"That Sir Albert J. Leppoc Cappel, K.C.I.E., who now retires by rotation, be and is hereby re-elected a Director of this Company."

Mr. G. G. NICOL seconded the motion, which was unanimously adopted.

On the motion of Mr. BRADNOCK, seconded by Mr. STARNES, the following resolution was also carried:—

"That Messrs. Deloitte, Dever, Griffiths and Co. and Messrs. Welton, Jones and Co. be and they are hereby elected auditors for the ensuing year, at a remuneration of £100 each."

The CHAIRMAN: That is all the business I have to put before you to-day. You have had the accounts in your possession for some time, and I think you will have been satisfied that we are not going back, but are rather improving, and, as I have said before, the more we increase our reserve fund the stronger will our position become. (Hear, hear.)

Mr. JOHN NEWTON: Mr. Chairman, I wish to move a vote of thanks to you, not only for the pleasure it will give me to do so, but also because it will afford me an opportunity of asking you a question which I did not put on the motion for the adoption of the report, because I think that the carrying of the report without any question being asked is a compliment to the Directors. (Hear, hear.) I think that the conferences which are held from time to time by the various Governments of Europe interfere with your tariff charges, and I think that it is very unjust that we should be subjected to the interference of Governments, and even of the English Government, and that we should afterwards be attacked as we are with this continual agitation for a Pacific cable. You have shown us good reason why that cable is not wanted, although there is one reason no doubt why it is wanted, and that is for jobbery and corruption. I am sure there is something in connection with the laying of that cable which will be beneficial to those who are agitating for it, although not for those who subscribe their money to it. Have you not in past years reduced your tariffs in deference to the opinions of Governments? If so, it is rather unjust that Governments should lend any countenance to a competing cable the great object of which will be to interfere with this Company, which has rendered such immense service to the world.

Mr. BURGESS: I have very much pleasure in seconding this vote of thanks. I think we owe a very great debt of gratitude to our excellent Chairman and Board for their administration of our affairs. (Cheers.) I think we may all feel very safe in leaving them in the hands of such an able Chairman as we have, and such business men as he has to assist him on the Board. (Applause.)

The resolution was carried unanimously.

The CHAIRMAN: I am always pleased, as are my colleagues, to find that the administration commands your approval and confidence. I am vain enough to think that the success which has attended our affairs entitles us to the goodwill and commendation of the shareholders, and it is gratifying not only to find that you appreciate our work, but also that we are all, as it were, sailing in the same boat. We believe in one another, and it is that unity which gives strength. (Hear, hear.) As you probably know, I am a very strong Unionist, and I apply that principle in this particular instance. I never knew divided camps or divided interests ever lead to the same satisfactory result as a united, compact, and straight-going policy and practice. Mr. Newton has referred to the Pacific cable agitation. Where there is a large cable going to be laid and where there are people who are looking out for contracts, you never can be other than suspicious. We are suspicious, and that makes us more attentive and more watchful. You may depend upon it that if this cable is laid, the men who are moving now in it will have very little to do with the carrying out of the work. I have many contracts with our Government, and I can truly say that they are about the hardest bargainers I have ever come into contact with, and I have had a good deal of bargaining in my life. But when a bargain is made they stand by it, and we have no trouble. We know that they are strong, and that increases our strength. I am quite satisfied that there is no immediate prospect of contracts being inquired for in connection with this Pacific cable, but when they are you may depend upon it that I shall take good care that I know all about the matter. (Applause.)

Mr. BLUNDELL: On behalf of the shareholders, I should like to propose a vote of thanks to the officers and staff of the Company. I think this only due to them (hear, hear), although, perhaps, in our case results do not depend so much on individual efforts as they do in other cases; still, I think we should not be right in passing our executive over on this occasion. To them a measure of the success which has attended your efforts must be due, and I think when the proceedings of this meeting are circulated, our officers and staff both at home and abroad will be gratified at seeing that they have not been forgotten by the shareholders. (Applause.)

The CHAIRMAN: The relations between the administration and our staff generally are all that could be desired. We have never forgotten

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our staff. We have never ceased to promote their welfare when we found it was desirable in the interest of the Company to do so. We have established for them a pension fund—a principle which Parliament has been talking about as regards old men for a very long time, and I believe that our action in this respect has given the greatest possible satisfaction. It affords me the greatest possible pleasure to be able to convey to the staff the expression of your approval and sympathy with them in their work. (Hear, hear.) I am always pleased when I find the services of the staff recognised, because, after all, we may have a very fine business, but unless there is the proper machinery to work it, it cannot go on satisfactorily. We have the proper machinery, I believe, in our staff. We value them, and I believe they value us.

The proceedings then terminated.

Metropolitan Electric Supply Company (Limited.)

The following is the report of the Directors, to be presented to the seventh ordinary general meeting, to be held at Winchester House, Old Broad street, E.C., on Monday next, the 23rd inst., at noon :—

The capital expenditure, which at the end of 1892 amounted to £550,859. 16s. 11d., now shows a total of £585,932. 8s. 9d., being an increase during the year of £35,072. 11s. 10d., principally owing to the continually growing extension of the Company's mains, to the cost of transformers and meters, and to providing connections to the premises of new consumers. The expenditure on buildings and machinery includes further payments on account of the Paddington plant, the sinking and fitting of a well for the more economical supply of water to the Sardinia-street station, and to works found necessary in connection with the foundations of the machinery at the Manchester-square station.

The gross revenue for the year amounted to £69,195. 4s. 4d., against £54,571. 19s. in 1892, being an increase of £14,623. 5s. 4d., as compared with the actual increase of £13,851. 19s. in 1892. A larger increase was fully expected ; but the exceptional brightness and absence of fogs during the winter months had a serious effect in diminishing the demand for light. In proof of this, it may be mentioned that while the revenue during each of the first three quarters of the year showed an increase of nearly 50 per cent. over the corresponding periods in 1892, the increase for the last quarter was only 8 per cent., although there was no falling off in the growth of the lamp connection.

The balance to the credit of the revenue account, before providing for depreciation, is £22,913. 15s. 2d. The Directors have set aside £7,000 as an addition to the Depreciation Fund, carrying to the credit of the net revenue account (No. V.) the sum of £15,913. 15s. 2d., which, with the balance brought forward from the last account, and other receipts, make a total of £18,512. 15s. 4d. After deducting bank charges and Debenture interest, there remains a balance of £14,548. 19s. 4d., of which the Directors, in pursuance of the policy commenced last year, have appropriated a further sum of £1,000 in reduction of the preliminary expenses account, which is now diminished to £3,052. 10s. 4d.

The Directors recommend that a dividend of 5s. per share on the Ordinary share capital be now paid, which will absorb a sum of £12,475, and leave a balance of £1,073. 19s. 4d. to be carried forward to the next account.

The number of 8-c.p. lamps supplied by the Company, increased during the year 1893 from 124,000 to 166,000. The present number of lamps connected is 175,000, and further applications continue to be received in satisfactory numbers.

A report from the Company's Chief Engineer shows that the satisfactory condition of the stations, machinery and plant has been maintained.

The Directors have to record, with the deepest regret, the death of two of their valued colleages, Sir James Anderson and Sir George Elliot, both of whom had been members of the Board from the commencement of the Company. It is not proposed at present to fill the vacancies thus caused. In accordance with the Articles of Association, the following Directors, viz., Admiral of the Fleet Lord John Hay, G.C.B., Joseph Charles Parkinson, Esq., and John Denison Pender, Esq., retire from the Board, and, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths and Co., also retire, and offer themselves for re-election.

NEW COMPANIES, STATUTORY RETURNS, &c.

CHADBURN AND SON (LIMITED).—This Company was registered on April 6th, with a capital of £30,000, in £1 shares, to enter into and carry into effect an agreement with William Chadburn for the acquisition of the business of a patentee and manufacturer of ships' telegraphs, optician, and nautical instrument maker carried on by him at Liverpool, and to carry on the said business in all its branches.

HOOPER'S TELEGRAPH AND INDIA-RUBBER WORKS (LIMITED).—This Company was registered on April 16th, with a capital of £50,000 in £10 shares, to enter into and carry out an agreement for the purchase of the business now carried on by the trustees of the late William Hooper at Millwall, and the property held in connection therewith ; to construct, manufacture, purchase, sell, deal in, lay down, let, work, maintain, repair, and keep in efficient working order submarine and land telegraphs and telephones, and telegraph, telephone, and electric lighting cables, wires, instruments, and appliances, and to carry on the business of electricians, telegraph and electrical engineers and contractors, submarine and other cable and instrument manufacturers, wire-drawers, wire ropemakers, suppliers of electricity for lighting, heating, and motive purposes, india-rubber and gutta percha manufacturers and merchants, asbestos manufacturers and merchants, &c. The subscribers are :—William E. L. Hooper (100 shares), Miss Alice L. R. Hooper (100), John P. Hooper (600), Mrs. Gabriel R. Moran (100), Miss Mary E. A. Hooper (100), Rev. Samuel F. Hooper (100), Mrs. Frank Marsh (100), C. A. Hooper (100), Mrs. A. M. Hooper (200), and Basil Gee (500). The first Directors are John P. Hooper and Basil Gee, who are the Managing Directors and managers.

SOUTH DEVONSHIRE GAS LIGHT AND COKE COMPANY (LIMITED).—This Company was registered on April 13th, with a capital of £10,000 in £1 shares, to enter into and carry into effect an agreement with Mr. Frank V. Thomas, and to carry on the business of a gas and electric lighting company in all its branches, and also the business of electricians, electrical and mechanical engineers, suppliers of gas and electricity, for the purposes of light, heat, motive power, and otherwise, electrical apparatus manufacturers, electrical contractors, &c.

JAMES TAYLOR (LIMITED).—This Company was registered on April 11th with a capital of £1,000 in £5 shares, to carry on the business of general ironmongers, electricians, &c., at Ramsbottom and elsewhere.

UNIVERSAL ELECTRIC LIGHTING COMPANY (LIMITED).—By an agreement made between John Tomlin, trading at 158, High-street, Camden Town, London, N.W., as "The Universal Electric Lighting Company," and the Company, the Company acquires the business carried on by the vendor, and in consideration agrees to allot to him or his nominees 6,000 shares, the nominal value of 10s. each, as fully paid.

HASTINGS AND ST. LEONARDS-ON-SEA ELECTRIC COMPANY (LIMITED).—The annual return of this Company, made up to April 3rd, has been filed. Out of a nominal capital of £50,000, in £10 shares, 2,261 have been taken up, and the full amount called upon each. As a result, £22,615 has been paid, which includes a sum of £5 paid on five forfeited shares.

WARD ELECTRICAL CAR COMPANY (LIMITED).—The annual return of this Company, made up to December 16th, was recently filed. The whole nominal capital of £300,000, in £10 shares has been taken up, and of these 29,993 were issued as fully paid to Michael R. Ward, of Trafalgar-buildings, Charing-cross, London, W.C. The full amount has been called and paid on the remaining shares.

WESTMINSTER ELECTRIC SUPPLY CORPORATION (LIMITED).—The annual return of this Company, made up to March 7th and recently filed, shows that the whole nominal capital of £300,000, in shares of £5 each, has been subscribed for and allotted, the full amount called, and £300,000 paid.

WOLVERHAMPTON ELECTRIC LIGHT AND POWER COMPANY (LIMITED).—In reply to a request for the usual return of capital and shares of this Company, the secretary stated that the Directors desire that the name of the Company be struck off the Register.

WOOLWICH DISTRICT ELECTRIC LIGHT COMPANY (LIMITED).—The annual return of this Company, made up to March 14th, was recently filed, when 5,435 shares were taken up out of a nominal capital of £10,000, in £1 shares. Of these, 150 were issued as fully paid, and £5,285 has been paid in respect of the remainder.

WREXHAM AND DISTRICT ELECTRIC SUPPLY COMPANY (LIMITED). The annual return of this Company, made up to February 19th, has been recently filed. The nominal capital is £20,000, in £5 shares, and of these 115 have been subscribed for. No calls have yet been made.

CITY NOTES.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended April 15th were £840, as against £861 in the corresponding period of last year, being a decrease of £21. The total receipts for the half-year amount to £13,726, as against £13,717 for the corresponding period of last year, an increase of £9.

DIRECT SPANISH TELEGRAPH COMPANY (LIMITED).—The following resolution has been passed by the Directors of this Company with regard to the £62,000 Six per Cent. Debenture debt, which falls due on May 1st next:—Resolved: "(*a*) To call up the balance of £1 unpaid on the Ordinary shares (£12,931). (*b*) To issue debentures for £30,000, having twenty years to run, and bearing interest at 4½ per cent. per annum. (*c*) To realise and take from the reserve fund the requisite balance, approximately £19,000, and pay off by those means the debentures falling due." The call for the unpaid £1 on the Ordinary shares is made payable on May 31st next.

HOBART ELECTRIC TRAMWAY COMPANY (LIMITED).—The traffic receipts for the month of March amounted to £1,416.

MIX AND GENEST (BERLIN).—The annual meeting of the shareholders of this Company took place on Monday last, when the report was submitted and adopted. The result of the year's trade showed a gross profit of 348,705 marks, and after writing off 78,192 marks for depreciation of plant, &c., and carrying to a reserve fund 10,000 marks, the Directors were able to declare a dividend of 8 per cent. on the paid-up capital. The constantly increasing business of this Company has necessitated the building of a new factory, and the orders, more particularly for telephone exchange work, have required the renting of two additional factories. With a view to centralise the manufacturing department the new building has been designed, the estimated cost of which would be 600,000 marks (£30,000), and the cost of acquiring the site (which is 6,653 square metres in extent) is 340,000 marks (£17,000).

ST. JAMES AND PALL MALL ELECTRIC LIGHT COMPANY (LIMITED).—The electric current sold by the Company for the quarter ended March 25, 1894, amounted to £10,375, as against £10,119 in the corresponding period of 1893.

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WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended April 13th (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,603.

WEST INDIA AND PANAMA TELEGRAPH COMPANY (LIMITED).—The traffic receipts of this Company for the two weeks ending April 15th were £2,486, as compared with £2,801 for the corresponding period of last year. The December receipts, estimated at £5,255, realised £5,282.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price, April 11.		Price Wednesday, April 18.		Rate per Cent. Yielded.	Dividend Due.	Business Done During Week Ending April 18. Highest	Lowest
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,134,640	Stock	9 0	Anglo-American xd	41	43	42	44	5 15 11	Jan., Apr., July, Oct.	43	..
£2,932,680	Stock	18 0	Do. Preferred xd	79	80	80	81	5 17 3		79½	78¾
£2,932,680	Stock	5/0	Do. Deferred	7¼	7¾	7¾	8¼	..	..	7¾	7½
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	100	103	100	103	3 17 8	January and July	..	..
130,000	£10	3/0	Brazilian Submarine	11¾	12¼	11¾	12¼	5 4 0	Mar., June, Oct., Dec.	12¼	11 13/16
£18,700	£100	5%	Do. 5 per Cent. Bonds	100	103	100	103	4 17 1	January and July	..	—
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	107	111	108	112	4 4 10	June and December	..	—
10,000,000	$100	$1¼	Commercial Cable Capital Stock	146	150	146	150	4 13 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12	13	12	13	6 3 1	February and August	..	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	—
12,931	5	1/7½	Direct Spanish (£4 paid)	2¼	3	2¼	3	5 6 8	April and October	2½	..
6,000	5	10%	Do. Preference 10 per Cent.	8½	9	8½	9	5 11 1	"	..	..
60,710	20	2 0	Direct United States Cable, 1877 xd	9	9½	9	9½	7 8 11	Jan., Apr., July, Oct.	9½	9¼
400,000	10	2/6	Eastern xd	15	15½	14⅞	15⅞	4 5 11	" "	15 1/16	14⅞
70,000	10	6%	Do. 6 per Cent. Preference xd	16	16½	16	16½	3 12 9	" "	16	..
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	116½	114½
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	107	110	107	110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	15½	15¾	15½	15¾	4 8 11	Jan., Apr., July, Oct.	15¾	..
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113	116	113	116	3 9 0	February & August	114¾	114
£62,700	100	5%	Do. 5 p. c. (Austin. Gov. Sub.) Debs 1900	103	106	103	106	4 14 4	January and July	103¾	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	103	106	103	106	4 14 4		..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	104	107	104	107	3 14 9	February & August	..	..
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	107%	110%	107%	110%	3 12 9	May and November	..	..
180,227	10	2 6	Globe Telegraph and Trust xd	8¾	9	8⅝	8⅞	5 1 5	Jan., Apr., July, Oct.	8⅞	8⅝
180,042	10	6%	Do. 6 per Cent. Preference xd	15½	15⅞	15½	15⅞	3 18 1	" "	15 1/16	15 1/16
150,000	10	5/0	Great Northern	21¾	22¼	21½	22½	3 15 7	Jan., April, and July	21⅛	..
£200,000	100	5%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 13 6	March & September	..	..
17,000	25	12/6	Indo-European	45	47	45	47	5 6 5	May and November	..	..
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	..	" "	..	—
£100,000	100	6%	Do. 6 per Cent. Debentures	106	109	106	109	5 10 1	March & September	..	—
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red 1942	102	105	102	105	3 16 2	..	..	..
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	—	—
3,381	£100 Cert.	35/0	Submarine Cables Trust 6 per Cent.*	113	118	112	117	5 2 7	" "	—	..
15,609	10	5/0	West African Telegraph	3	5	3	5	..	January and July	..	—
£249,900	100	5%	Do. 5 per Cent. Debentures	100	103	100	103	4 17 1	March & September	100⅞	..
30,000	10	2/0	West Coast of America	2½	3	2½	3	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	102	106	102	106	7 10 11	June and December	..	..
88,321	10	1/0	West India and Panama	1½	1½	1½	1½	..	..	1 7/16	1 5/16
34,563	10	6%	Do. 6 per Cent. 1st Preference	10¼	10¾	10¼	10¾	5 11 7	May and November	10½	10⅜
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9	10	9	10	6 0 0	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	107	110	107	110	4 10 11	June and December	..	..
64,242	15	4/6	Western and Brazilian	7½	8	7½	8	..	May and November	7 3/16	—
33,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	6	6½	6	6½	..	..	..	..
33,129	7½	4/6	Do. 5 per Cent. Deferred	2	2½	2	2½	..	..	2⅜	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105	108	105	108	5 11 1	February & August	108	—
£222,700	100	6%	Do. 6 per Cent. Mort. Debs., Series "B" 1910	105	108	105	108	5 11 1	" "	106¼	..
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	—
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	100	104	100	104	5 15 5	March & September	..	—
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	1½	2½	1½	2½	..	—	..	—
224,850	10/0	3¼d.	Consolidated Telephone Const. & Maintenance	1/16	3/16	1/16	3/16	..	May and November	..	—
220,000	£1	6d.	Oriental Telephone and Electric	..		..		..	Yearly	..	—
484,597	5	2/6	National	4⅝	4⅞	4⅝	4⅞	5 2 7	June and December	4⅞	4 11/16
15,000	10	6%	Do 6 per Cent. Cumulative 1st Pref.	14½	15½	15	16	3 15 0	" "	15½	..
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	14	15	14½	15½	3 17 5	" "	4 11/16	4⅝
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅝	5⅞	5⅝	5⅞	4 8 11	..	..	—
925,017	£100	4½%	Do. Deb. Stk. 4½%	115	117	116	118	3 16 3	January and July	116½	116⅛
58,000	5	1/0	United River Plate	1½	2	1½	2	..	" "	..	..
£146,370	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	—	—
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11¼	12¼	11¼	12½	—	—	12½	12¼
20,000	10	6/0	Do. 6 per Cent. Cumulative Pref. (fully paid)	13¼	13¾	13¼	13¾	..	—	13⅝	13¼
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	—	—	—
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	—	—	—
£50,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		—	—	—	—
8,322	£5	—	House to House Electric	..		..		—	—	—	—
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid)	..		..		—	—	—	—
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	—	—
30,000	£5	1/9	Liverpool Electric Supply (£4 10s. paid)	5⅞	6⅛	5⅞	6½	..	—	—	—
15,000	£5	2/6	Do. (fully paid)	6 7/16	6 9/16	6¼	6¾	..	—	..	—
111,000	5	..	London Electric Supply	⅜	⅝	⅜	⅝	..	..	..	—
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	7½	8	7½	7¾	2 11 7	..	8	7½
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	106	109	106	109	4 11 9	June and December	..	—
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½	—	—	—	—
19,980	£5	4/6	St. James' and Pall Mall	6¼	6¾	6¼	6¾	..	—	6 11/16	6½
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	—	..	..
59,900	5	2/6	Westminster Electric Supply (fully paid)	5¾	6¼	5¾	6¼	3 4 0	—	5 11/16	—
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	3	3¼	2⅞	3¼	5 15 2	—	3¼	2¾
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅜	2⅝	2⅜	2⅝	5 1 1	—	2 3/16	..
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	108	111	108	111	4 1 1	March & September	109½	..
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	3½	4	3½	3¾	..	January and July	3 3/16	..
12,139	5	..	Edison and Swan United	—		—		—	—	—	—
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	—		—		—	—	—	—
120,000	2	..	Electric Construction	½	1	½	1	..	—	—	..
12,845	2	..	Do. 7% Cumulative Pref.	1½	2	1½	1¾	..	..	¾	..
91,195	2	10/0	Elmore's Patent Copper Depositing	½	¾	½	¾	—	..	..	—
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	—	..	..
50,000	10	15/0	India Rubber, Gutta Percha &c., Works	23	24	23	24	5 4 2	February & August	23¾	23¼
£200,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	101	103	101	105	4 5 9	March & September	—	..
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	—	—	—	—
16,000	£10	—	Do. 8 per Cent. Preference	—		—		—	December and June	—	—
20,000	9	..	Manchester Edison-Swan "A" (£1 paid)	—	½	—	½	..	—	—	..
78,949	5	3/6	Swan United (£3. 10s. paid)	2	2½	2	2½	7 0 4	May and November	..	..
37,350	12	36/0	Telegraph Construction and Maintenance	39	41	38	40	6 0 0	March and July	40	39
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	—		..		..	January and July	—	—
37,514	£5	—	Woodhouse and Rawson Ordinary (£3. 15s. paid)	—		—		—	—	—	—
41,098	£5	—	Do. Preference (fully paid)	—		—		—	—	—	—
			RAILWAYS AND TRAMWAYS.								
£630,000	Stock	5%	City and South London Railway	27	32	27	32	4 5 11	May and November	..	—
87,500	£10	1%	Liverpool Overhead Railway	7½	7¾	7⅝	7⅝	—	—	—	—

* Ex- 35/0 on account of Coupon due April 15, 1894.

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NOTES.

Much as we should like to see an extension of really good arc lighting in our most important thoroughfares, we are glad to learn that the Highways Committee of the London County Council have deferred further consideration of the lighting of the Victoria Embankment. The suggestions already made, and which happily have not been accepted, would simply ruin this masterpiece of the Metropolitan Board of Works. High posts down the middle of the road are questionable improvements to Tottenham Court-road and the Euston-road, which make no pretensions whatever to beauty, and would be hideous eyesores on the Embankment, though each one were a work of art in itself. The next idea was a row of posts alternating on each side. This arrangement, good enough for narrow streets, spoils even Queen Victoria-street at night. It has a niggardly appearance, being plainly enough the result of eking out, as far as possible, the few lamps allowed per mile. The finest feature of the Embankment is its splendid sweep, and at night this is emphasised rather than obliterated by the long single line of lamps on the parapet. An alternating hop-and-go-one zig-zag of widely-spaced high posts would be the very antithesis of the present system. The last suggestion was to widen the footway and plant posts on the new kerb, to clear the trees. As in its other proportions, the present width of the footway and of the carriage-way of the Embankment is admirable, and in this, as in other respects, it holds its own against the *quais* of Paris or any similar work.

The only objection that has been raised to the use of the posts on the parapet is that the trees would screen the light from the roadway. But does this objection really hold? The leaves have only begun to show during the past week, and light is not now wanted until after seven o'clock, when the bulk of the traffic, never very large, is over. Later in the evening, light is only wanted for purposes of public safety and morality, and for the return of a well-dined gourmet or two from a City feast. The leaves might interfere a little for an hour or so in October and November; but with a decent amount of lighting this would not be felt. From an intimate acquaintance with the Victoria Embankment, after walking its length several times a week for some years, we are convinced that the present standards on the parapet, perhaps the best of their kind in London, would be excellently adapted for arc lighting. The alternate posts might suffice, and the arc lamps should be specially selected, with compact or inverted mechanism, for the sake of appearance. While the County Council are naturally desirous of putting down a special plant for this work, it would be surely worth while to make an experiment, since it could be carried out at a very moderate expense. No less than five electric supply companies include parts of the Embankment in their districts, and some of these have mains almost up to the subway, and perhaps in it, for all we know. The wiring of the lamp posts is as easy a matter now as it was with the Jablochkoff lighting in 1884, and if there is any difficulty or objection to hiring lamps, why not have a competitive test of lamps and of carbons? If each maker sent only three lamps, three different kinds would suffice for more than a quarter of a mile of experimental lighting.

We are glad to see that the Postmaster-General has promised to give his careful consideration to the "plea for liberty" recently advanced on behalf of the boy-messenger service by a deputation of members of Parliament. That all State departments exist expressly for the public convenience and not for the express purpose of inconveniencing the public, is a truism which needs reiterating even in these days of triumphant collectivism, and especially is this the case in the matter of the Postal and Telegraph services. The deputation pleaded for a reduction of the sundry royalties now levied by the Post Office from the Company which stepped in where that stately department feared to tread. It would have been well to have also called the Postmaster-General's attention to the many vexatious hindrances still imposed by the Department over which he temporarily presides upon the full utilisation of the boy-messenger organisation by the public. Great, for instance, would be the convenience of being able to *telephone* a message to the office nearest the point of delivery, instead of being obliged, as at present, to ring up the office nearest to the starting point, and then send a boy half across London to the point of delivery. We confess to feeling that the petty, useful, almost domestic, functions which a free well-organised boy-messenger service would be called upon to perform, are perhaps scarcely compatible with the majesty of a State department, and, even putting aside all sentimental considerations of dignity, we doubt the possibility of making a State department sufficiently flexible. As we urged in the far more important matter of the telephones, so we say with regard to this purely local need, let the Post Office either perform the

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service itself, or give a generous and a free hand to those who will do so, taking advantage of its undoubted legal rights to levy n the name of the State a purely nominal tax. An almost prohibitory tax levied by a department which does not care for the job, upon a concern which is enterprising enough to undertake it, is in the highest degree impolitic and inequitable.

THE recent meeting of the Metropolitan Electric Supply Company is one more instance of the fact that, whilst a concern is growing, and things are not going exactly to the liking of the ordinary shareholder, a chairman's speech is decidedly more interesting reading to the engineer and outsider than is the case when nothing but mutual congratulations upon a fat dividend have to be exchanged. "Ill blows the wind that profits nobody"; and we now learn that the fogs and dull days which usually adorn a London winter mean an extra 1½ per cent. dividend to the shareholders of the Metropolitan Company. Again, the inveterately economical habits of the British householder have, it seems, reduced the revenue per 8-candle lamp connected to the mains from the 25s. or 30s. anticipated by experts to a modest 8s. 9d. In the statement that the present plant of the Metropolitan Company, running day and night at full load, could generate the entire year's output in less than two months, we have yet another graphic illustration of the fortune awaiting the man who may be lucky enough to hit upon an electrical analogue of the gasometer, quick enough to take out a patent and shrewd enough to sell it on the crest of a big "boom." But to electrical engineers, perhaps the most interesting announcement made by the Chairman of the Metropolitan Company was that the time had arrived for "the institution of transformer sub-stations in some of the more crowded districts." The term transformer sub-station may mean anything from a pit in a pavement to a hollowed-out London square, and it is to be hoped that before the Metropolitan Company changes over irrevocably to one species or the other, figures will be available, setting forth their relative working values.

WE publish this week an abstract of a Paper describing the Glasgow electric supply station, which was recently read by Mr. W. ARNOT, the Corporation electrical engineer. A considerable portion of this Paper deals with the boiler and engine plant, and with the losses which occur in this section of the machinery. Some very instructive figures, the results of careful trials by Prof. KENNEDY and others, are given. There are station losses which Prof. KENNEDY has elsewhere characterised as "losses about which we engineers feel very sore, and which have no kind of respectable existence whatever;" and it is worth noticing that these constitute a large proportion of the station losses at Glasgow. No one will dispute the great reduction of risk of breakdown which results from the use of ring steam-mains, or any other duplicating system of steam distribution; and the arrangements in this respect at Glasgow are as perfect as may be. But, that it should ever be necessary to maintain the entire system of steam-mains under full pressure continuously, quite irrespective of the load on the station, or of whether the engines are or are not running, can only be regarded as deplorable. Scarcely any better encouragement for steam to liquefy could be devised than is offered by the by-ways and alleys of a system of steam-pipes shut down only at the engines. Condensation must take place on a wholesale scale, and there is little wonder that the stand-by boiler losses amount to practically 15 per cent. of the total fuel consumption at full load. This is a high price to pay for the security of a ring main; and, we may here remark, there is no need whatever for such a figure to be paid. The only plan which is consistent alike with security and economy is to shut down the remote sections of the main, and all the branches, whenever these are not actually required; and to shut down all the steam mains while the station is idle. The only alternative is to combine in the station the function of electric supply with that of a distilled water factory.

IT is very difficult to make a comparison, with any approach to accuracy, between the cost of a windmill plant and that of a gas or steam engine for electric lighting. In the estimate we made last week we said nothing about storage batteries, though we alluded to the highly complicated devices used in connection with them. Mr. ROLLASON, in his letter, which will be found elsewhere, takes a mean of 3 H.P. for 10 hours a day, giving 30 H.P. (he means, of course, horse-power hours), and "assuming the light is required for three hours a day, a gas engine, to accomplish this (direct lighting) would have to be of 10 H.P. working for three hours. . . ." But in this simple case no batteries would be wanted, while with the wind motor storage for two or three days would be needed. Mr. ROLLASON is fortunate in having meteorological records to refer to, and is doubtless able to make a very good estimate of the annual output to be expected from a windmill; but we think he will meet with much more success if he directs his attention to such work as pumping. In attempting to produce electric light he chooses the most difficult possible task to which a windmill can be applied, and one for which it is very unsuitable.

WE have received, this week, from Mr. MATHER a letter in reference to our remarks made in our last issue on the new form of shunt-box recently described. As regards the first point to which our correspondent refers, we see no reason for any modification of our statement. The assumption that the galvanometer had a serious amount of damping is justified simply by the fact that the working ratio of the shunt for quantity measurements sometimes differed from the corresponding ratio for current measurements by as much as 12 per cent. This difference can only be caused by the damping of the galvanometer swings, and is quite large enough to be called "serious." Moreover, in quoting our statement that the galvanometer was "badly suited for ballistic purposes," our correspondent has omitted to add the words, "if the ordinary form of shunt is to be used." This proviso greatly alters the meaning of the assertion. A ballistic galvanometer may behave well on open circuit, and yet its indications when used in a circuit metallically closed,

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may not be comparable until certain corrections are applied. These correcting factors can, in such cases, be ascertained only after considerable trouble, and they vary with the resistance of the shunt, and the strength of the controlling field. The necessity for making these corrections justifies the assertion that such a galvanometer is badly suited for ballistic work when used with a shunt. In stating that such a galvanometer when used with the new form of shunt for the comparison of condenser discharges, gave no further trouble in this way, we were putting the case for the new shunt in the most favourable light. With a galvanometer whose damping does not vary much when the external circuit is altered, there is not so great an advantage over a shunt of the ordinary form.

The other statement alluded to by Mr. Mather, that the slight shunt error made in comparing currents could be explained by the want of proportionality in the galvanometer, we find, on re-examination of the numbers given in the Paper, to be erroneous, and the difference between the deflections must be attributed to an error caused by the shunt. The difference in question is, however, so small that the experiments do not show up the advantage of using the new form of shunt as much as would have been the case if the shunt selected had yielded a ratio differing more from its nominal value of 100 than 99·63.

Obituary.—The death is announced of Herr Paul Robert Kummer, of the well-known German electrical manufacturing firm of O. L. Kummer and Co., of Dresden.

Chicago Exhibition Buildings.—A Mr. Garrett, of St. Louis, has purchased the Chicago Exhibition buildings for £15,100, undertaking to have them cleared away by May 1, 1896.

Royal Institution.—Prof. Dewar will on Thursday, May 3rd, begin a course of lectures on "The Solid and Liquid States of Matter." On Saturday, May 5th, Capt. Abney delivers the first of the Tyndall lectures on "Colour Vision."

Cable Interruptions:	Date of Interruption.
Cayenne-Paramaribo	Oct. 25th, 1893.
Bissao-Bolama	Nov. 24th "
Brest-St. Pierre (P.Q. Co.)	Mar. 29th, 1894.

Old Students' Association.—We have been requested to announce that on Friday evening next the Old Students of the City and Guilds of London Institute will hold a smoking concert at Mason's Hall Tavern, Mason's-avenue, Basinghall-street.

The Society of Engineers.—We have received a copy of the recent Inaugural Address of the President of this Society, Mr. G. A. Goodwin. The Address consists in a somewhat lengthy and diffuse review of the present position of mechanical engineering progress, and discusses briefly each of the most important questions relating to the economical production and utilisation of mechanical power.

American Patent Office.—The business of the American Patent Office for the year 1893 shows total receipts of £248,574, against an expenditure giving a balance in the office's favour of £20,366. There were 38,473 applications for patents, against 25,102 in this country, and 23,670 patents were issued. Up to January 1, 1894, 521,700 patents have been granted by the United States, against 817,362 by all other countries.

The London Telephone Service.—The National Telephone Company announce that, in order that the telephonic service in London may be brought to a state of the highest efficiency, they have decided to introduce the twin-wire system, and for some time past have been making the necessary alterations and erecting new plant so as bring this system into use. The rearrangement of the Company's exchanges is said to render necessary alterations in the exchange numbers.

The Art of Definition.—The following is the definition of electrolysis which the *Mercury and Daily America*, of New York, supplies to its readers :—"Electrolysis is the name for the disintegration and destruction of gas and water pipes, caused by the electricity which escapes from trolley wires into the surrounding earth." After this we shall be told that electro-chemistry is the name for the exhibition in chemists' shop-windows of magnetic needles moved by "electrolysis."

An Electro-Chemical Journal.—We learn that a new monthly journal has been started in Berlin specially intended as the organ of the electro-chemical and electro-metallurgical industries. The new journal, which is entitled the *Electrochemische Zeitschrift*, is edited by Dr. Neuburger, and is published by Dr. N. von Klobukow through Fischer's Technologischer Verlag, Berlin. A long list of contributors has already been prepared, and includes the well-known names of Dr. Aron, Dr. Dürre, Prof. Goppelsroeder and Dr. Ostwald.

A Union of Incandescent Lamp Manufacturers.—An important meeting was held in Berlin last week at which representatives of all the leading makers of incandescent lamps in Europe assisted. The subject under discussion was the formation of a union of European incandescent lamp makers, and it was decided to take steps to form the same. At the same time the minimum prices of incandescent lamps were fixed at 75 pfennigs each to direct consumers, and 65 pfennigs to merchants and dealers.

The Hermite Process of Sanitation.—We have received a copy of a translation from the French of a report on some experiments relating to electrolysed sea-water prepared by the Hermite system. The experiments have been carried out by Dr. Piton, of the French navy; and the conclusion to which Dr. Piton arrives is, "that electrolysed sea-water is a perfect deodorant, and an excellent antiseptic, which rapidly destroys the most hardy micro-organism, always assuming a good contact between the micro-organism and the electrolysed solution."

India-Rubber.—The *Madagascar News* of March 17th announces that a rubber concession has just been granted to the Hon. John L. Waller, ex-United States Consul for Madagascar. The concession area measures 15 miles square, in the district of Fort Dauphin, on the south-east coast, and is conceded to be one of the richest rubber districts in the island. The discovery of rubber in this district is of recent date, and the article is of excellent quality. Mr. Waller states that he will stop the destruction of the rubber trees and vines by the natives so far as his concession is concerned, and preserve the product by having the milk extracted in a scientific manner.

Christiania Central Station.—This station, says our Scandinavian correspondent, has given an unusually good result for 1893. The estimated receipts were £7,335, and the estimated expenditure, including 5 per cent. interest on the whole of the cost, left an estimated surplus of £500. The actual result, however, is a surplus of £2,100. According to the estimate, it was thought that the average demand for private lighting would not exceed 6,000 lamps, but even by the beginning of February, 1893, 6,030 were connected up, and at the end of the year the number was 9,930. In addition to these, the central station supplied electricity to seven motors for hoisting, eight for ventilators, three for workshops, and three for various uses. Including the street lighting, the aggregate connection was 11,663 normal lamps. Of the 250 consumers, 100 were shops, 56 private offices, 9 municipal offices, 6 banks, 6 schools, &c. The average number of burning hours varied considerably for the different consumers; for public lighting the figure was 2,644 hours, railway stations 1,823, bodegas 1,391, printers 917, down to 129 hours for private residences, 184 for banks, &c. The average lighting hours have, on the whole, been very low.

Morecambe and its Water Gas. — According to the *Lancashire Evening Express*, the Morecambe people have got

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the electric light, and yet they are not satisfied. They complain that in the making of it there is much that is offensive to their olfactory nerves, and a deputation has waited on the Local Board to complain. It seems the unused water-gas is let off for a few minutes at a time, frequently during the day and night, and the smell is very bad. Visitors complain, and say they will come no more. The property owners are so much in earnest about it that they say they will provide an inspector lodgings for a fortnight, so that he can judge for himself that what they say is true.

International Electrical Units.—*Electricity*, of New York, announces that the work of the International Congress in defining a set of standard electrical units has been embodied in a Bill to legalise the same introduced in Congress. The bill is entitled "An Act to Define and Establish the Legal Units of Electrical Measure." The second section of the Bill provides: "It shall be the duty of the National Academy of Sciences to prescribe and publish, as soon as possible after the passage of this act, such specifications of details as shall be necessary for the practical application of the definitions of the ampere and volt hereinbefore given, and such specifications shall be the standard specifications herein mentioned."

The People's Palace.—The Drapers' Company, supplementing their former benefactions, have just granted a special donation of £4,000 to the governors of the People's Palace so as to enable that body to construct and equip a separate engineering laboratory with workshops. The need has long been felt, but the lack of resources has hitherto prevented the governors from supplying it. Now, however, it will be possible to put into effect the scheme prepared by Prof. Holt, and erect a machine-shop—capable of accommodating 60 students—a pattern-making shop, a smithy, and an experimental workshop. We hope the benevolence of the patrons of this Institution will, on the next occasion, be directed to the electrical department, which, like the engineering department, is in need of assistance.

A Meter Box Arrangement.—We have received photographs of a Ferranti meter and fuses ensconced in a wooden box. The door is provided with a small glazed window. By way of preface to a description of this invention, it is hinted with a good deal of mystery that there are certain reasons and conveniences "neither necessary nor wise to explain," why meters should be thoroughly protected. "Every manager of an electricity supply company," we learn, "will doubtless understand the advisability of keeping an intelligent public from that little knowledge of electricity which is apt to be a very dangerous thing as far as the interests of the supply company are concerned." As long as the company have a locked-up main fuse, the intelligent consumer may surely do what he likes with his own fuse, and if any intelligent inhabitant of Hull, where this "combination" has been invented, knows how to dodge a Ferranti meter, he is to be credited with a good deal more than "a little knowledge of electricity."

The Grafton High speed Steam Engine.—At the meeting of the Institution of Mechanical Engineers, on Thursday last, a Paper was read by Mr. E. W. Anderson, describing the Grafton high-speed steam-engine. As at present built, this engine is single-acting and non-compound, being of the vertical type, with steam admission on the down stroke. The arrangements for the distribution of steam are decidedly novel, and are designed to give high speed with low engine friction. The cylinder liner is in two parts, an upper and a lower part, and through the annular orifice between these two liners, steam is admitted from the steam-chest. There are two pistons, one above the other, working in the cylinder, which is open at both ends, and the cranks of these two pistons are usually set at 135°. The upper piston controls the distribution of steam, and thus serves the double purpose of a piston valve and a working piston. The cranks are loaded to balance the inequality of piston loads, and thus to obviate vibration. One feature of the engine is the large amount of compression which takes place after exhaust. Diagrams of a 12in. engine, with an effective stroke of 6¼in. were shown. This particular size is designed to run at from 600 to 650 revolutions per minute, indicating 40 H.P. with 100lb. steam, but smaller sizes are constructed to run up to 900 revolutions per minute.

Hanover.—The report of the Hanover Electric Supply Station for the year 1892-93 has resently been published. The total costs, including taxes, cost of working and superintendence, repairs and sundries (omitting only interest and depreciation), amount to 20·76pf. per kilowatt hour, approximately, 2·60d. To this are added 17·88pf. = 2·24d. for interest, and 26·13pf. = 3·26d. for depreciation, &c., a total of 8·1d. per kilowatt hour. The receipts for current are 69·07pf., and sundries 6·66pf., a total of 75·73pf., or 9·46d. per kilowatt hour. The following table summarises other details. It must be remembered that this is a direct-current station with accumulators, dynamos by Schuckert, of 400 and 600 H.P. :—

Year.	No. of kilowatts on mains.	Energy supplied kilowatt hours.	Av. Price	Ex-penses.	Re-ceipts.	Written off.	Profit.
			d.	£	£	£	£
1891-92..	643·4	355,364	8·8	7,708	14,743	4,534	2,500
1892-93..	738·9	365,114	8·6	8,078	14,847	4,769	2,000

In connection with these costs, we note that the coal, which burned quite smokelessly and left 9·8 per cent. of ash, cost, delivered at the works, about £7. 10s. per 10,000 kilogrammes (22,000lb.), or, say, 15s. a ton.

Electricity Meters.—A descriptive Paper on this subject was read at the last meeting of the Northern Society of Electrical Engineers, by Mr. R. P. Wilson and an interesting discussion followed. Mr. Wordingham remarked that there was one point worth mentioning in testing watt-hour meters, "one must either cheat the consumer or the Company Of course, what the consumer should pay for is the current through his lamps multiplied by the pressure at the lamps. Now, if the shunt winding be connected on the main side of the meter, the company is supplying a higher pressure than they get paid for. If on the other hand the shunt winding is connected to the consumer's side of the meter, the consumer pays for the current used in the shunt coil of the meter, which is, of course, no benefit to him." Mr. F. P. Bennett stated that some time ago he had made a test of the different shunt meters, viz., the Frager, Thomson, Reckenzaun, &c., and he found that the average current absorbed was about 10 milliamperes. If there were 1,000 such meters installed in a town, the current absorbed by the shunt would be equal to one Board of Trade unit per hour, and as there were 8,736 hours in the year, that number of Board of Trade units would be wasted, the total exceeding 11,000 E H.P. hours. He considered that a very substantial objection to shunt meters. In his reply, Mr. Wilson pointed out that the shunt current of a meter was used for the specific purpose of overcoming initial friction. In doing so, all its energy was absorbed, and, therefore, could not communicate itself to the dials. There was no doubt, he said, that the manufacturers who used shunts in their meters were quite alive to the objections raised against them, but they were of opinion that the shunt had advantages which more than compensated for the annual consumption they involved.

An Electrical Method of Heating Oxygen for Spectrum Investigations.—In a recent communication to the Académie des Sciences, M. J. Janssen described an apparatus devised by him for the purpose of investigating the spectrum of oxygen when the gas is submitted to a high temperature and pressure, with a view of determining the nature of the spectrum, which one might expect to find in the case of any oxygen existing in the lower solar atmosphere. M. Janssen's great difficulty was to heat the oxygen in the ordinary way to the required temperature whilst the gas was under great pressure. To overcome the difficulty, however, he resorted to electricity, and the following is the arrangement used by him. A steel rod 2·2 metres long and 6 centimetres in diameter was bored out to a diameter of 3 centimetres. The tube so formed is capable of resisting a pressure of more than 1,000 atmospheres. Its extremities are closed by screw sleeves containing glass or quartz plugs. The column of gas contained in this tube is heated by means of platinum spiral, traversing its entire length,

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and insulated by means of asbestos lagging which assists, moreover, in preventing the transmission of the heat through the walls of the tube. At the ends of the tube the spiral passes out through copper plugs which are insulated from the tube by means of a ring of ivory or compressed fibre. By means of this arrangement the spiral can be brought to any temperature between red and white heat, and communicates these temperatures to the column of gas without sensibly heating the walls of the tube. M. Janssen remarks that the whirls and motions taken up by the column of gas when submitted to the action of the white-hot spiral, often diminishes to an enormous extent the amount of light transmitted through the tube. He points out, however, that if the tube is arranged in a vertical position, the layers of the gas tend to arrange themselves horizontally, and to become, therefore, normal to the rays of light, and in this way the amount of light absorbed is diminished by an unexpected amount.

American Bell Telephone Company.—The report of the American Bell Telephone Company for the year 1893 shows an increase of 13 per cent. in the gross earnings, which now stand at £1,156,000, and of 15 per cent. in the net earnings, which aggregate £785,000. The following statistics are of interest:—Instruments under rental December 20, 1893, 566,491, an increase of £13,771 in twelve months. Exchanges January 1, 1894, 838, an increase of 26 in a year; underground wire mileage, 120,675; increase, 30,459. Total miles of wire, 353,480; increase, 45,689. Employés, 10,421. The largest amount of underground wire in use in a single city is 30,397 miles in New York, 18,554 in Chicago, 8,361 in Boston, 6,972 in Brooklyn, 5,719 in Pittsburgh, 5,242 in Milwaukee, 4,409 in Detroit, 4,345 in Cincinnati, 4,314 in Baltimore, and 4,047 in San Francisco. At the close of 1893 more than one-third of the exchange wire mileage was underground. The metallic service subscribers increased 23,053 to 37,648. The report says further: "The general system of the operating companies throughout the country has been to charge the subscriber a fixed sum for exchange service, graduated according to the class of equipment which he selects, and leaving him free to use the service as much or as little as he chooses. On the whole, this plan appears to have worked to the satisfaction of subscribers, and in a measure distributes equitably the charge which the public pays for telephone service, since in the smaller exchanges, where the average use is the least, the charges are correspondingly small, while in the great cities, where of necessity the rates are highest, the average use is also greatest. It is by no means certain, however, that, in time to come, the companies and their patrons may not find a system of tariff rates, that is, the charging the subscriber according to the number of times his telephone is used, more equitable than the present system of uniform charges. Some experiments are in hand to see if in the great cities the case of those who want only a limited use of the telephone at a less rate than is fixed for an unlimited use can be met."

Lubricants.—At the last meeting of the Junior Engineering Society, held at the Westminster Palace Hotel on the 13th inst., a Paper on "Lubricants: Their Use, Testing and Analysis," was read by Mr. W. F. E. Seymour, of Swindon. The necessity of efficient lubrication and importance of being able to judge the utility of various lubricants for different kinds of work was first pointed out. Lubricants might be classed into solids, semi-solids, and liquids. The composition of vegetable, land animals, fish and mineral oils was considered and their proper applications referred to. The author next gave an extended account of the more important lubricants, tallow, rape, olive and castor oils, and detailed the uses to which they were each best adapted. Of mechanical testing appliances, Ingram and Stapfar's oil-tester, and Thurston's machine were illustrated, and the mode of working and of recording the results were shown. The suitability of a lubricant for any particular duty could be judged by its viscosity and specific gravity, in the determination of which various forms of instruments were employed. The principal viscometers used were Boverton Redwood's and Sackar's; these were described and the process of working with them explained. Passing on to chemical analysis, the methods adopted for the determinations of free acid, drying properties, flashing point, mineral matter, congealing point, total fatty acids, mineral oil or unsaponifiable matter were given. An appendix to the Paper was devoted to Maumené's test, Pontet's classification of Valenta's acetic acid test, Dalican's method for congealing-point of tallow, and Gray's flash-point apparatus. In illustration of the Paper, specimens of the various oils were shown for examination, and there were also a number of instruments exhibited which had been sent by Messrs. Baird and Tatlock. Mr. L. W. Gates opened the discussion, the other speakers being Mr. W. B. Clarke, Mr. H. M. Rounthwaite, Mr. G. E. Brown, Mr. R. W. Newman, and the chairman, Mr. Percy J. Waldram.

Electric Power in Engineering and Iron Works.—At the meeting of the Cleveland Institution of Engineers, on the 9th inst., at Middlesbrough, Mr. J. Phillips Bedson, of the new Cleveland Wire and Ironworks, Middlesbrough, read a Paper by Mr. D. Selby-Bigge, of Newcastle-on-Tyne, on this subject. The following is an abstract:—The writer desired in his Paper to draw the attention of engineers to short-distance transmission, or concentration of power. In order fully to grasp this idea, he would take the case of any large engineering works in which the motive power was derived from a number of scattered and auxiliary steam-engines, which in some cases were used for driving shafting in fitting-shops, and in other cases were applied to various machine tools, hot saws, cold saws, rolls, forge blowers, punching, and shearing machines, straightening machines, planing machines, and the numberless other apparatus which were daily employed in engineering establishments. Cases were often found in which numbers of pumping and shearing machines were driven by means of belts and pulleys, receiving their power through long lines of main shafting and countershafting. In many cases the boilers necessary for producing steam for all these engines were situated at a considerable distance from them, and the steam had to be conveyed through long lengths of pipe. The boilers, instead of being all concentrated together in one battery, were scattered about the works. Such were the conditions daily met with when looking through engineering establishments. The writer then set himself to show how short-distance electric power plant could be advantageously adopted, and what great economies could be realised by a concentration of all that scattered power. (1) Taking the case of separate engines for driving individual machinery, it would readily be admitted by all engineers that much better steam economy could be obtained from the employment of one large highly-efficient engine than from a large number of small engines, which for many reasons were not of so efficient a character, the steam consumption in each of the small engines being proportionately four to six times greater than it would be in a large engine of a triple-expansion condensing type. (2) Taking the case of a machine-shop driving-off shafting, there was considerable loss incurred in transmitting power through long lines of mains and countershafting with all the attendant gear wheels, bearings, pulleys, belts, &c, this loss varying from 20 per cent. up to 60 per cent. of the power transmitted. (3) The disadvantage of having boilers at long distances from the engines they had to drive did not need to be recounted, nor the inconvenience of having boilers scattered about, and the efficiency of working at a low pressure. All these disadvantages could be obviated by a well-considered application of electric power With an ideal electric-power plant there would be self-contained electric machine tools, in which the motor would be embodied as part of the machine; but in existing works this was difficult to realise, and the method was either to drive by belt on to existing fly-wheels, or else couple the motors direct by means of gearing. The very small loss in distributing the power through cables was a matter which must be evident to all engineers, when compared side by side with long lengths of shafting or of steam pipe, in which condensation and loss of power were bound to take place. The writer mentioned that three large works in Middlesbrough had already adopted or were adopting the use of electricity as a motive power, and several other manufacturers had the matter under consideration. In Belgium and Germany large works were operated exclusively by electricity, and had been running for three years with very remarkable results as regarded economy.

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MOTIVE POWER AND GEARING.*

BY E. TREMLETT CARTER.

(*Continued from page 667.*)

Steam.

Steam Equations.—The properties of saturated steam represented by the set of curves in Fig. 9 may be approximately represented by a series of empirical equations. In the following equations the symbols refer to the same quantities respectively as the symbols on the curves:—

$$H = 1081{\cdot}4 + 0.305\,t \quad . \; . \; . \; . \; . \; . \; . \quad (69)$$

$$t = \frac{2938{\cdot}1}{6{\cdot}19935 - \log p} - 371{\cdot}85 \quad . \; . \; . \quad (70)$$

where log p is the common logarithm of the absolute pressure in pounds per square inch.

$$L = 1115{\cdot}2 - 0{\cdot}708\,t \quad . \; . \; . \; . \; . \; . \; . \quad (71)$$

$$V = \frac{330{\cdot}36}{p^{0{\cdot}941}} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \quad (72).$$

This last equation may conveniently be expressed as follows—

$$\log V = 2{\cdot}519 - 0{\cdot}941 \log p \quad . \; . \; . \; . \; . \quad (73).$$

Curves (e) and (f) are, of course, most simply represented by equation (67).

Isentropic Expansion of Saturated Steam.—In order to study the behaviour of any mass of saturated steam when expanded isentropically, it will be simplest first to consider what happens when we arrange to expand the steam in such a way that the whole of it is just saturated throughout the expansion. The expansion in this case will take place along the curve (d) in Fig. 9; and the work done per pound of steam, in expanding between any two limits of volume, will be represented by the area subtended by the portion of the curve between these two limits upon the axis of volume. Integrating this area in any case, we may compare the work done by the steam with the amounts of its energy before and after the operation. We shall always find that the work done per pound of steam will be greater than the difference between its original and its final heat. Now this can only arise from the fact that heat has been supplied to the steam during its expansion; for if no energy is supplied it is impossible that more work can be done than is equal to the difference between the initial and final energy. Therefore, to obtain expansion of steam along the saturation line, heat must be continually added to the steam while it is expanding.

As a direct result of the foregoing facts, we may infer that if saturated steam is expanded and does work, without having any heat supplied to the steam during the operation, it is impossible that the whole of the steam can continue in the state of saturated vapour. The work will be done at such a rate that there will not remain enough energy in the steam to keep the whole of it saturated; and a portion of the steam will condense to water. The remainder of the steam will, of course, be in a condition of saturation; but its pressure and its temperature will both be lower than in the corresponding volume with saturation expansion. The work done by the steam will also be less than in the former case; but the efficiency is not necessarily less, as less heat need be supplied to the steam. The adiabatic expansion of saturated steam follows approximately the following law:—

$$P\,V^{\frac{10}{9}} = \text{a constant} \quad . \; . \; . \; . \quad (74)$$

or, $$\log P + 1{\cdot}111 \log V = \text{a constant} \quad . \; . \quad (75)$$

Liquefaction.—The production of water, by the liquefaction of steam during adiabatic expansion, is an important phenomenon; especially when we remember that in high-speed engines this condition of expansion is approximately attained. When we remember that steam is only water with energy added to it, and that it is the business of the steam engine to take as much of that energy as possible out of the steam, we shall be prepared to look on this form of liquefaction as a necessity, and not as a thing to be avoided. Practically, as we shall see later, the liquefaction of steam on this account is complicated by other considerations. But the fact remains that, in proportion as we utilise the intrinsic energy of the steam in an engine, so we must expect to find a certain amount of liquefaction taking place; that is to say, the further the isentropic expansion is carried the larger will be the percentage of steam liquefied.

Prevention of Liquefaction.—For practical reasons it is sometimes, though not always, advisable to take special precautions to prevent the liquefaction of steam during expansion. Theoretically, all such devices are inferior to the practice of allowing liquefaction to go on; and they must yield a lower value of theoretical efficiency. There are two such practical expedients in general use: the steam jacket and the superheater.

Steam Jacket.—The former of these consists of an envelope of hot or "live" steam surrounding the cylinder in which expansion takes place; in some instances the jacket being supplied with hotter steam than that used in the cylinder. Between the jacket space and the cylinder space there is a highly conducting liner of iron or steel; and, except under unfavourable circumstances, heat will pass from the jacket steam to the expanding cylinder steam, and will more or less perfectly prevent liquefaction in the cylinder, though an equivalent amount of liquefaction will, of course, take place in the jacket. Owing to the piston speed, the heat will not pass from the jacket fast enough to maintain a constant temperature in the cylinder; and the rate of fall in temperature of the cylinder steam increases as this speed is increased. Thus, it may happen that the jacket may keep the whole of the steam exactly saturated. Or, on the one hand, it may happen that more than the amount of heat requisite for this may pass, and the steam may be slightly superheated, or water may be evaporated into the steam; or, on the other hand, during the more rapid motion of the piston heat may pass too slowly, causing liquefaction, while later, when the piston is moving more slowly, the flow of heat may be sufficient to re-evaporate some or all of the water thus produced. The steam jacket has another duty, which will be considered later; but all its duties may be summed up by saying that it is designed to so supply heat to the cylinder steam that that steam shall not leave the state of vapour until it has been exhausted from the engine.

Superheating.—It is possible, however, to supply the steam beforehand with the extra stock of heat which is necessary to prevent it liquefying in the cylinder. This may be done by giving the steam a certain number of degrees of superheat, arranging that the amount of heat added to each pound of steam shall be sufficient for its expansion without liquefaction. The proper limit of superheating has been attained when the exhaust steam is neither superheated nor wet, but is just saturated. Any excess of superheat above this is heat directly thrown away; and any deficiency in the amount will lead to liquefaction. The steam is superheated on its passage from the steam generator to the engine. Considered as devices for letting the working substance carry away as much energy as possible into the exhaust, both the steam jacket and the superheater are admirably adapted to the purpose; and there is no doubt that, from this point of view, they both increase the thermodynamic inefficiency of the steam engine. Considered as necessary evils, they may stimulate engineers to endeavour to so modify the conditions of steam practice as that they shall no longer be necessary.

Wiredrawing.—Steam is said to be wiredrawn when it flows from any pressure to a lower pressure against the frictional resistance of a constricting conduit, such as a steam pipe or orifice. The term *throttling* is sometimes applied to the operation of wiredrawing steam through a constricting valve in such a way as to considerably lower the pressure of the steam. Owing to the imperfect elasticity of steam, its expansion under wiredrawing is accompanied by loss of energy by internal work; but if the ratio of expansion is small this loss is practically inconsiderable, and in any case it must occur either in the conduits or in the engine. If dry saturated steam is wiredrawn, the heat developed in overcoming the friction is partially absorbed by the steam and partially, but to a much less

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extent in good systems, absorbed by the metal of the pipe. The result is the formation of a low-pressure superheated steam but little lower in temperature than the high-pressure saturated steam from which it was wiredrawn. Apart from the loss just mentioned, the only source of inefficiency in this wiredrawn steam is the loss of availability of heat due to the lowering of its temperature. If wet steam is wiredrawn, the heat developed in overcoming friction will also partially be absorbed by the steam. But the presence of water will prevent superheating, and will cause the temperature of the steam at the lowered pressure to correspond to that of saturation at this pressure; while the heat absorbed by the steam will evaporate some of the water. Wiredrawing wet steam, therefore, has the effect of more or less completely drying it; but the large fall in temperature which will occur with excessive wiredrawing must result in a large loss of heat-availability, especially at low pressures. It will in most cases be more efficient to separate the water from the high-pressure steam before wiredrawing it, than to allow the wiredrawing to take place with very wet steam; and this is the more particularly the case where wiredrawing or throttling is adopted for the purpose of running an engine on a light load. Thermodynamically, wiredrawing wet steam is equivalent to bringing dry steam into contact with a small mass of cold water in an expanded chamber.

Furnaces and Boilers.

Principal Details of Steam Generators.—The purpose of the steam generator is the efficient production of the working substance, namely dry saturated or superheated steam in a state as nearly as possible that in which the engine requires it, allowance being made for unavoidable changes in the quality of the steam during its transit from the generator to the engine. Steam generators may be considered to consist of two principal details; the furnace and the boiler. The parts of the furnace comprise: the grate, combustion chamber, fire-door, ash-pit and door, bridge, internal and external flues, economiser, superheater, chimney, and the draught regulating and producing apparatus. The duty of the furnace is to produce economical combustion of the fuel, to distribute the heat of the hot gases to the useful heating surface and to reject the waste gases in a proper and efficient manner. The parts of the boiler comprise: the useful heating surface, the water space, the steam space, the enclosing shell, feed apparatus, steam pipes, various discharge pipes, safety apparatus, indicating apparatus, valves and steam drying apparatus. The prime duty of the boiler is to abstract as much heat as possible from the furnace gases, consistently with the proper working of the furnace, and to utilise as much as possible of this heat in producing steam at the requisite pressure and of the requisite quality. The whole generator is sometimes fixed in brick setting, and is always surrounded with a lagging of non-conducting material. The arrangement of these details differs very much in different types, and many of them are modified according to the nature of the fuel to be burned. Except where otherwise stated, it will be assumed throughout this series that the plant is arranged for steam-coal consumption.

Types of Boilers.—In ordinary language the term boiler is applied to the whole steam generator. Without going back into ancient history, we may consider the following types of boilers, all of which are in use for electrical purposes at the present time:—(1) The Cornish boiler; consisting of a cylindrical shell of riveted wrought iron or steel plate, with flat ends, one internal cylindrical flue containing at the front end the grate, and various arrangements of setting forming the external flues. For electric power purposes, these boilers are made up to 28ft. in length and 7ft. diameter of external shell. (2) The Lancashire boiler; which differs from the Cornish boiler only in having two internal cylindrical flues, each with a separate grate, and in certain small alterations in general proportions. There is a greater proportion of useful heating surface in the Lancashire than in the Cornish boiler, for the same size of shell. These boilers are made for electrical purposes up to 28ft. in length and 8ft. 6in, in diameter; though even larger sizes are occasionally used where land is cheap. (3) The locomotive boiler, which is self-contained, in that all the heating surface is comprised within the boiler and independently of external setting. This type of boiler is not solely used for locomotive purposes, and is commonly met with in small electric-power stations. From the fact of its having originated as a boiler for locomotives, it has derived the name which has clung to it. In this type of boiler there is a cylindrical shell fitted at the fireplace end with a double fire-box and at the other end with a smoke-box and chimney; while the inner fire-box is connected to the smoke-box by a large number of small horizontal fire-tubes. The inner fire-box contains the grate at its lower end; and the space between the two fire-boxes is used as water space. The amount of heating surface in this type of boiler is very large indeed, in comparison with other types. (4) The return tube boiler, which closely resembles the marine type in its best examples. This consists of a horizontal cylindrical shell, fitted in the lower part with one or more cylindrical flues, each with a separate grate, and in the part immediately over those flues fitted with a large number of fire-tubes, as in the locomotive boiler. The hot gases pass to the back along the lower flues, and return to the front through the numerous fire-tubes; they then, as a rule, pass through a system of external flues, as in the Cornish and Lancashire types. (5) Water-tube boilers, which consist of a combination of a furnace and external flues with a large number of tubes filled with water, these tubes being in communication with a cylindrical shell partly filled with water and partly with steam. One of the most important electric power boilers, namely, that manufactured by Messrs. Babcock & Wilcox, belongs to this class. Besides these well-defined types, there are important electric power boilers which are combinations of two or more types, such as the Galloway boiler; and in addition to these, there is a heterogeneous collection of boilers for small motive power, which it is not in the province of this work to notice.

(To be continued.)

MAGNETIC QUALITIES OF IRON.*

BY J. A. EWING, F.R.S., AND MISS HELEN G. KLAASSEN.

(Continued from page 672.)

Experiments on the Heating Effect of Reversals of Magnetism.

In another section of our experiments direct measurements were made of the amount of heat generated by reversals of magnetism.

Some of the rings employed in the tests which have just been described were again used in these experiments, and under precisely the same conditions.

The method employed (a short account of which was pub lished in *The Electrician* of October 9, 1891), depended on the use of two exactly similar rings, one of which had its iron core subjected to magnetic reversals, while heat was developed in the other by the passage of a steady electric current. This steady current was adjusted until the rate at which heat was generated by the current in one ring became the same as the rate at which heat was generated by reversals of magnetism in the other ring, equality of temperature as between the two rings being tested by means of a thermo-electric circuit with a pair of junctions, one embedded within the core of each ring. The current which was used to magnetise the one ring passed also round the other, in a coil which had the same dimensions as the magnetising coil of the first ring, but which was wound non-inductively. Hence, whatever heating effect the magnetising current had on one ring, it also had on the other, though one ring only became magnetised. Both rings were subjected to precisely the same thermal influence, except that in the active ring the magnetism of the core was periodically reversed, and in the inactive ring a special heating current was used to balance the heat generated in the other by these magnetic reversals. The arrangements were in all cases such that the inactive ring could be made magnetically active and *vice*

* Abstract of Paper read before the Royal Society.

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versâ, without any change in the winding or structure of the rings, by merely changing the electrical connections of the divided coils which were wound in identical fashion on each. In those of the experiments that dealt with rings which had a core of insulated iron wire, the heating current was caused to pass through the wire of the core itself in the inactive ring—a particularly satisfactory arrangement, inasmuch as the heat generated by this current in the inactive ring was then distributed throughout the core in just the same way as the heat generated by magnetic reversals in the active ring. In experiments dealing with sheet metal cores a special coil was wound as close as possible to the core of the inactive ring to take the heating current.

This method of measuring the heat due to magnetic hysteresis by securing a thermal balance between two rings, alike in all respects, was originally devised to give an answer to the question whether, when a transformer is in action, the heating of the core through magnetic hysteresis is the same when the transformer is "loaded," or when it is not; in other words, whether the taking of current from the secondary coil has any influence on the amount of heat generated in the core, the limits of magnetisation and the frequency of the reversals being unaltered. Independent experiments by Prof. Ryan, Mr. Morley, and Prof. Ayrton, on the efficiency of transformers, had apparently agreed on showing a marked reduction in the loss of energy due to magnetic reversals when the "load" was put on. Adding a secondary coil to each of our rings to make it into a transformer, we applied the above balance method to compare the rate of magnetic heating when the secondary was open with the rate when the secondary was closed through a low resistance, so as to apply a heavy "load," arrangements being at the same time used to keep the magnetic range and frequency unchanged. The result was that no change could be detected in the rate at which heat was produced by the reversal of magnetism when the "load" on the secondary coil was varied from nothing to an amount greatly in excess of any "load" used in practical transformers.* The conclusion being of this negative kind, a very short account of the experiments will suffice.

The electrical connections are shown in Fig. 24. On each ring of the pair a primary coil was wound in two layers, and a secondary coil, also in two layers. In each coil the two layers had the same number of turns, and the number was the same on both rings. The two layers, both of primary and of secondary, could be connected either inductively or non-inductively. They were each wound uniformly round the whole of the ring. On one ring they were connected inductively, and were respectively in series with the non-inductive primary and secondary of the other ring. Hence all direct thermal action of primary and secondary currents was the same for both rings. The magnetic reversals were caused by passing through the primary circuit the current from an alternating dynamo, which could be run at various speeds, and the strength of this current was adjusted, by means of a liquid rheostat, R_1, in its circuit, to secure that the magnetisation should have the same limiting value when the secondary circuit was closed (through the resistance R_3) as when it was open. To test the constancy in the limit of magnetisation a voltmeter, V_1, of special construction was used, which was connected to a special induction coil of a few turns wound on each ring. The voltmeter was of the hot-wire type; it consisted of a piece of very fine platinum wire, stretched between supports, but deflected sideways, after the manner of the wire in Profs. Perry and Ayton's voltmeter, by a light spring pulling transversely in the middle of the wire's length. The middle portion of the wire stood in the field of a microscope, and its transverse movements were read on a micrometer scale in the eye-piece. This was found to form a very convenient means of reading alternating electromotive forces of one or two volts and under. Owing to the small section of the wire and the freedom from friction which was secured by having no mechanical indicating gear, the instrument responded quickly and exactly to change of electromotive force, and allowed the necessary adjustment of the primary alternating current to be made with great nicety. In most of the experiments a Cardew voltmeter, V_2, was also connected across the terminals of the primary circuit. Its response to small changes was much less rapid and certain, but its absolute graduations furnished a convenient means of estimating the intensity of magnetisation from the amount of back electromotive force.

The heating due to magnetic reversals in the active ring was determined by seeing what strength of steady current in the core of the inactive ring would maintain a balance in the thermo-electric circuit. The heating current was adjusted by means of R_2, so that, after both rings had been brought to the same temperature, the two temperatures remained equal while both rose. The thermo-electric junctions were connected to oppose each other through a sensitive galvanometer, but an alternative connection could be made in which one junction only acted on the galvanometer, so that the temperature of the ring might be estimated at any stage in the experiment. It was necessary, in fact, to record the temperature of the ring from time to time to allow for change in the resistance of the iron wire forming its core.

The following will serve as an example of the readings taken. It refers to an experiment upon a pair of precisely similar rings, one of which was the Ring VII. of the tests already described.

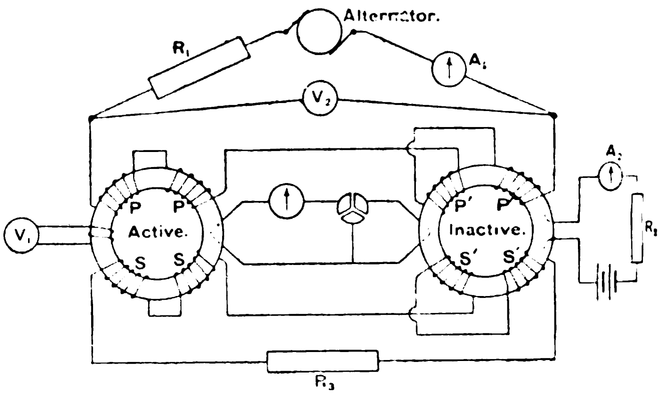

FIG. 24.

The core consisted of iron wire, insulated with cotton. The frequency in this experiment was 133 periods per second, and the greatest value of **B** was about 7,500.

(*a*) With secondary open:—

Heating current, in amperes.	Reading of Cardew voltmeter.	Resistance of iron core.
0·75 (too strong)	22	5·85
0·65 (too weak)	22	to
0·7 (balance)	22	5·90

(*b*) With secondary closed through a low resistance:—

Heating current, in amperes.	Reading of Cardew voltmeter.	Resistance of iron core.
0·75 (too strong)	24½	5·80
0·65 (too weak)	to	to
0·7 (balance)	24	5·90

The reading of the microscope hot-wire voltmeter was the same in both parts of the experiment, the difference in the Cardew readings being due to the greater volume of magnetising current that was required when the secondary circuit was closed. It will be seen that no difference could be detected in the amount of balancing current necessary to maintain equality of temperature. Other experiments gave confirmatory and quite conclusive results. One more may be quoted:—

Frequency 69 periods per second. Greatest value of **B** about 13,500.

(*a*) Secondary open. Balancing current 236 on arbitrary scale.

(*b*) Secondary *short circuited*. Balance with current between 231 and 244.

* Since these experiments were made (and briefly published in *The Electrician* of December 4, 1891), later tests of transformers, by Prof. Fleming and others, have borne out our conclusion that the amount of "load" has no influence on the waste of energy through magnetic hysteresis.

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The heating effect of reversals is, of course, due to Foucault currents, as well as to magnetic hysteresis. An attempt was made to compare the total heating effect, measured directly by reference to the balancing current in the inactive core with the value of $\int H\, dI$, as found in the preceding experiments, with the view of estimating the influence of Foucault currents. But the value of such a comparison depends on our being able to estimate the maximum of magnetisation in the cycle, and this is by no means a simple matter. The observed E.M.F. gives the mean value of $(d\,B/d\,t)^2$, and to calculate B from this it is often assumed that the mode of variation of B may be treated as simply harmonic, in which case we should have—

$$\text{Maximum } B = \frac{10^8 . E}{\pi n N A \sqrt{2}},$$

where E is the observed electromotive force in a coil of N turns, the area of curve-section of the iron being A and the frequency n. But even if the magnetising force were simply harmonic it is otherwise with B, whose increment and decrement is largely affected by magnetic hysteresis. The relation of maximum B to mean $(d\,B/d\,t)^2$ could be determined if the form of the curve of B and t were known. Recent experiments—amongst others, those of Dr. John Hopkinson and Messrs. Wilson and Lydall,* in which B as well as $d\,B/d\,t$ has been determined as a function of t in a ring submitted to alternating magnetic forces—exemplify how wide the variation from a sine-function is likely to be. In view of this consideration, and of the fact that no such data were at hand in the case of our own tests, we have not followed up this method of directly measuring the heat produced by reversals.

Experiments made with the Magnetic Curve Tracer.

When the magnetism of a piece of iron is reversed rapidly more work is spent than when the reversal takes place slowly. Whether all the extra work done in the former case is to be set down to Foucault currents is, perhaps, an open question; there may be a genuine time-lag in the process of magnetisation, independent of the effect of Foucault currents, though not readily distinguishable experimentally from their effect. This quasi-viscosity, distinct from Foucault-current effects, will, if it exists, require higher values of H to be applied than would otherwise be necessary when any assigned limits of B are to be quickly reached. At high speeds of reversal the curve which shows the relation of the externally-applied magnetising force to B becomes swelled out and encloses a larger area, corresponding to the greater amount of work then done, whether in generating Foucault currents or in overcoming this other possible source of quasi-viscous resistance. That an increased amount of energy is expended is clear from experiments of the kind which have just been referred to, even if the exact interpretation of these results is somewhat doubtful through uncertainty as to the value of B. Direct evidence of the change in form of the B—H, or rather B-current, curve is furnished by the magnetic curve tracer.

This instrument, which was exhibited by one of us at the Edinburgh meeting of the British Association (1892), draws the magnetic curve by giving to a small mirror two component motions, one (horizonal) proportional to the magnetising current, and the other (vertical) proportional to the magnetism of the metal under examination. The metal is arranged to form a magnetic circuit which is complete except for a narrow gap between a pair of opposed poles. In this gap a wire is tightly stretched, through which a constant current passes. The wire consequently sags up or down in the gap as the magnetism of the circuit varies, and this gives movement in altitude to the mirror. At the same time, the varying magnetising current passes through another similar wire tightly stretched between the poles of another magnet. The magnetism of this second magnet is kept constant, and hence the sagging of its wire depends on the varying strength of the current which the wire carries, namely, the magnetising current of the other magnet. This gives azimuthal movement to the same mirror. A spot light reflected from the mirror to the screen consequently traces out the curve of magnetism and magnetising current. The movements are so dead-beat that with a light mirror and tightly stretched wire a magnetic cycle of double reversal may be traversed ten times or even twenty times per second without material distortion from the inertia of the working parts. The variation of magnetising current must not, however, be sudden, and to secure this a commutator is used in which a revolving boss carrying two zinc plates turns within a cylinder containing a weak solution of zinc sulphate, in which there are two other (fixed) plates of zinc. As the revolving pair of plates reverse their position between the fixed pair, the potential of a battery connected to the fixed plate becomes reversed on the revolving pair, and from them the current is taken to the magnetising coil.*

By the slow manipulation of a rheostat of any form the magnetising force may be carried throughout any desired series of changes, and the character of the corresponding process of magnetisation be studied. The instrument affords a ready means of testing the comparative magnetic quality of given samples of metal. It also allows features in the magnetising process to be examined which it would be difficult to observe in other ways. We have made a number of experiments with it, some of which may be cited as showing the application of a novel method in magnetic research, and also as bearing incidentally on points that have been already spoken of in connection with the ballistic tests.

* Roy. Soc. *Proc.*, 1893.

* For diagrams and description of the magnetic curve tracer, see *The Electrician* of May 26, 1893.

PROF. A. B. W. KENNEDY'S PRESIDENTIAL ADDRESS TO THE INSTITUTION OF MECHANICAL ENGINEERS.

It is a well-known difference between engineering practice in this country and in most others that the conditions of our work seldom allow us to carry specialisation to any such great extent as is common, for instance, all over the Continent. With us, the belief that a man is "a thorough practical engineer"—whatever that may mean—is very generally taken as evidence that it is safe to ask him to do anything whatever which may be included within the vague general term "engineering." Of the extent to which this feeling is carried, as well as—I must say—of the essential truth which lies at the bottom of it, no better illustration could possibly be found than the position now held, with so much advantage to the public service, by my distinguished predecessor in this chair, Dr. Anderson. Some of us have occasion to examine continually the epitomised professional histories of engineers who wish to belong to, or be promoted in, our Institutions. It is quite noteworthy in how many cases, especially in our own Institution, a man of 35 or 40 is found to be working with great success in a line totally different from that in which he gained his first experience.

The existence in the minds of the public, who are in fact our employers, of the feeling which I have mentioned, no doubt brings us very often into temptation—temptation to undertake work or responsibility in directions where our own common-sense only, unaided by past experience, must be our guide. He is a wise man who can tell, as each opportunity presents itself, whether it is really a tide to be taken at its flood, or whether it is one in which his swimming powers will not be sufficient to carry him on to fortune, but may only leave him, and those who trust to him, still short of *terra firma* when the ebb commences. The consideration of this point has probably caused many of us more anxious moments than the actual working out of any of the knotty engineering problems which come upon us after the plunge is taken. I speak in the matter from hard enough experience, for I myself have had all too often to decide such questions, sometimes in one sense and sometimes in the other. So it happens that having served my time with marine engineers, I have had in the last 25 years to busy myself with half-a-dozen varieties of mechanical and structural work (including what I may call the academic variety during many happy years at University College) and of late years also with the newest variety of all—electrical engineering. I trust that my electrical friends—those of them, that is, who are 20 years younger than I am—will forgive me for calling electrical engineering a variety of mechanical work. I mean nothing disrespectful, of course; but even to those who are much more thoroughly electrical engineers than I can ever hope to be, but who have had the chronological misfortune, like myself, to have become engineers before technical electricity existed (if I may be allowed so to speak), I think it must always be so. To such of us, electrical work has been grafted on to mechanical; and any success we have had in the one we trace back to its foundation in our knowledge of the other. And further—although I know that in this I lay myself easily open

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to an accusation of mere conservatism—I believe that even now the only really safe road to success in electrical work lies through the old routine of mechanical training, modified of course by the excellent means for studying the scientific side of the work which now exist in so many directions.

It is common on occasions like the present for the speaker to lay before the members such matters out of his own personal knowledge or research or experience as he thinks may be most generally useful to them, as some small acknowledgment of the honour which he has received at their hands in his election as their President for the year. In thinking how best I could fulfil this honourable obligation and pleasant duty it occurred to me, in connection with the train of thought which I have just put before you, that, as I happen by some chance to be the first of your Presidents who has been actively connected with electrical work, it might be of interest to you, and possibly also of use to some, if I endeavoured to put before you as clearly as I could the way in which the electrical problem of to-day in this country presents itself, when looked at from the mechanical engineer's point of view rather than from the electrician's—in other words, from your point of view and mine.

Practical electrical problems divide themselves probably into three main sections, in which electrical energy is used respectively for :—

i. Lighting.
ii. Power.
iii. Physico-chemical processes.

The third section—where energy is used for the deposition of metals, for the reduction of chemical compounds, &c.—falls outside my own knowledge. From what I know of the success with which it is being worked, I cannot doubt that it has a great future. But its problems only touch engineering very indirectly as yet, and therefore hardly come within the subject which I have prescribed to myself. In this section may be included, at least for present purposes, the application of electricity to heating. So many active and competent workers are at present engaged on this matter that it is greatly to be hoped that success may soon attend their work. Not only the difficulty of producing the heat but also that of producing it in a convenient fashion, have been overcome to a very large extent. The remaining difficulty is the purely commercial one of producing the heat sufficiently cheaply to allow of its general use. This, I am afraid, has not yet been overcome; and until it has been, electrical heating unfortunately hardly comes within our ken except for very special purposes.

Remembering that something like 95 per cent. of all the energy that goes to incandescent lamps appears only as heat, and not as light, there appears to be an ample opening here for another "thermal storage" process, at least until the present lamps are superseded by the less wasteful type which the future will doubtless reveal to us in good time.

The use of electrical energy for power, *i.e.*, for transformation into mechanical energy, is a matter which lies obviously in the closest possible connection with mechanical engineering. It divides itself broadly into three sections, viz., (1) Transmission from a distance for whatever purpose, (2) Transmission to a number of isolated points comparatively near together, as the tools in a factory, and (3) Transmission for the purposes of traction on railways or tramways.

The *transmission* comes in in every case because we have as yet no electric prime-mover analogous to a steam-engine. The electric motor pre-supposes the existence of a dynamo, which must itself be driven by some prime-mover. From the dynamo to the motor, whether near or far apart, there must always be transmission of electrical energy. In a recent extraordinary aberration it seems to have been discovered that there was some positive advantage in using steam-engine, dynamo and motor all in one place to do work hitherto done by the steam-engine alone. This wonderful locomotive, however, forms, and no doubt will continue to form, a class by itself!

As to the transmission of power from a distance I shall not say anything, mainly because I could say nothing so well as it has quite lately been said by Prof. Unwin in his Howard Lectures. The whole matter is there discussed with so unusual a combination of impartiality, scientific accuracy, and mechanical common sense as to make the lectures, short as they are, into one of the most important contributions to engineering literature which have appeared in this country for a very long time. In particular, one cannot help being struck with the judicial way in which the author has kept clear of the fatal fascination which this matter possesses over many minds otherwise sane—a fascination which in some cases goes so far that one finds the whole matter discussed, perhaps unconsciously, on the basis that it is a positive advantage to transmit power from the longest possible distance! There are several towns in the United Kingdom where the use of water power for the purpose of electric lighting will have some day to be seriously considered, but I hardly think that beyond these the present generation is likely to see any great development in this direction at home. In other parts of the world the conditions are, of course, very different, and English engineers who wish to secure their share of work in this direction will rather have to study it beyond the limits of their own country.

The question of driving the tools in a factory by electric motors instead of through countershafting is one which has recently come to the front. The carrying out of such work is obviously purely a matter of mechanical engineering. Its advisability in any particular case is partly a question of economy and partly one of convenience, and is undoubtedly dependent on the conditions of each particular case. I have found from information very kindly given me by several large engineering firms, that the actual cost to them of power, including coal, stores, wages and depreciation, generally lies between 2 and 5 per cent. of their total costs.

In any given factory running on the ordinary system there is a large continuous waste of power due to the running of the whole shafting, no matter how many or how few machines are at work. Under such conditions the waste work in shafts and belts may well be even 25 per cent. of the average useful work, and the distribution of total work may be approximately :—

	H.P.
Average useful work	100
Wasted in belts and shafting	25
Wasted in engine friction, the engine being supposed large enough to give 150 H.P. at tools as a maximum (at about 10 per cent of max. H.P.)	20
	145

Now, if the machines in such a case were driven by separate motors, each having an electrical efficiency of 88 per cent., and these motors worked from a dynamo having an efficiency of 92 per cent. (both of which are high figures for ordinary work at two-thirds output), the figures would stand as follows :—

	H.P.
Average useful work	100
Wasted in motors and dynamo	24
Wasted in leads (say 2 per cent.)	2
Wasted in engine friction (as above)	20
	146

It will seen that the two sets of figures are practically the same as to amount of power required. As the electrical efficiencies which I have assumed are not likely to be exceeded, I think it may be said that there is no saving to be obtained in horse-power, and none, therefore, in any of the items of costs directly dependent on horse-power in cases where the power wasted in shafting and belts does not exceed 25 per cent. of the whole average useful power. This is a ratio which any engineer can most readily obtain for himself if he is not afflicted with that sense of the insuperable difficulty of making any simple and exact experiment which still remains one of the obscure diseases of our profession. I have no doubt cases can be found where the waste in large factories with very widely distributed power is very much greater than the proportion assumed, and in such cases no doubt a saving in power costs would occur.

But at the root of the matter there probably lies one ultimate determining point, far too often neglected in such calculations as I have just been making. This point is, of course, the real absolute saving to be made as distinguished from the proportionate saving. It is of little use to show an engineer that he can make even 20 per cent. saving in some one item of expenditure if that whole item only represents 3 or 4 per cent. of his costs, and if at the same time he has to expend a considerable amount of capital in making the change. One does not make important and expensive changes, especially changes whose result is by no means very certainly to be predicted, to bring about an estimated saving of half of 1 per cent. in one's total expenditure. I fear that this is a matter which may prove a more serious difficulty in the way of the success of the great Niagara scheme than any of those described by Prof. Forbes. In reference to our present point, it will prove sufficient to prevent the adoption of isolated motors in engineers' works in all cases except the waste in belt and shaft transmission is exceptionally great, or where for other reasons electrical driving *per se* is desirable.

But the whole matter is certainly not concluded either one way or the other by this single consideration. There can be no doubt, on the one hand, of the practical convenience of getting rid of the huge mass of shafting, gearing, and belting which fills up the upper half of many engineers' shops, although it is difficult to fix any money value for this advantage. There is no doubt also that a properly-arranged motor may give a much larger range of speed to each tool than can be readily obtained in the ordinary way, and will thus enable more and better work to be got out of it with skilful management. Were it not that such magnificent work has often been turned out in this country from such dirty and apparently disorderly shops, I should also say that it was self-evident that every change which improved the general orderliness and tidiness of the shop must—reacting upon the men employed—improve the output both in quantity and quality. Under the actual circumstances one hesitates

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to be dogmatic on this point, but I incline to believe that it is true, and that the good work to which I have referred has been turned out in despite of its environment, and has been due to exceptional excellence in workmen or managers or both, and that with the same men it might even have been still better under better working conditions.

On the other hand, it has to be pointed out that the cost of dynamo, leads and motors, is very greatly indeed in excess of the cost of shafting in almost every case. It is also hardly certain as yet how the costs of attendance, lubrication, renewals and repairs to the electrical plant compare with the similar costs in the case of shafts and belting. Probably, on the whole, they would be less, but no satisfactory data on this point exist.

There arise two special cases which should be mentioned. In cases where electrical energy can be obtained from public mains the comparison is quite different. The working of the printing machines, for instance, in the office of the *Pall Mall Gazette*, is carried out electrically, the current being derived from the mains of the Charing Cross and Strand Electric Supply Company. The works in this case get rid of all costs of engines and boilers with all their many inconveniences, and also gain in space most of the room occupied by their old plant. Moreover, they have a better security against breakdown than they could otherwise very well afford to have without most costly duplication of plant. The matter then becomes simply one in which increased space, convenience and security are to be balanced against increased cost, and each case has to be considered on its own merits. At present it is not very certain how the engineer supplying the electric energy ought to look at such a case. His chief business is, and will be, to supply energy for lighting purposes. As is sufficiently well known, the demand for lighting energy varies enormously throughout the twenty-four hours, so that in fact, a plant which is giving 2,500 H.P. for a couple of hours every day, and which of course must be large enough for this purpose, leaving still machines in reserve, will only be giving an average of 350-H.P. taken over the whole week, and not even half this for many hours every day and night. It is, of course, very desirable to increase the load during the hours of light load, and, if this could only be done without also increasing its present maximum, that is, without necessitating increase of plant, engineers could afford to sell the additional energy at a very low rate indeed. Unfortunately the condition I have mentioned is impossible. There will always come hours when, through fog or other special causes, the power load will coincide in time with the lighting load. And even if this were to happen only once or twice a year, the engineer must none the less provide plant for it and keep the plant ready. The case is not met by differential charges at different hours. The plant must be provided all the same, and the additional outlay will not be met by the extra payment for a few hours' work per annum. It may, however, very well be met by the value of the additional work done on 360 days out of 365 at times when otherwise nothing would be done. This point I shall deal with later on.

A second special case occurs when the cost of power forms a very large instead of a very small proportion of the whole running costs of the works, and no doubt in several industries this is the case to a very much greater extent than in engineering works.

I will ask you particularly to notice that in the case where electrical driving supersedes belts, the work is not done any less directly than before. Between the engine and the tool there stand, in the one case belts and pulleys and shafts twice or thrice repeated, and in the other case dynamo and leads and motor, with or without a small belt from motor or machine. It is quite possible that the actual mechanical efficiency of the belts is greater than that of the two electrical machines and the leads between them. But in the case of the shafts and belts the losses are continually going on whether or not useful work is being done, whereas there are no losses in the motors unless they are actually running and driving tools. This brings the total losses equal in the case I have supposed and in other cases may make the electrical method more economical. But the change is merely a substitution of one indirect method for another equally indirect method.

In the third great case of electric transmission of power, for the purpose, namely, of driving trains or tramcars, we have a state of affairs which is entirely different, and which, I am afraid, is by no means so favourable to the use of electricity as is sometimes supposed. In the case of a train drawn by an engine in the usual way, we have the whole of the net power of the engine, exclusive of that spent in internal friction and in actually hauling itself along—say 80 per cent. of the gross indicated horse-power—available for pulling its load along the line. In the case of an electric railway we have truly a somewhat lighter locomotive to be moved, but against this advantage and the fact that a stationary engine can have a greater economy than a locomotive, we have the uncomfortable state of affairs that only some 35 per cent. of the whole indicated horse-power, as against 80 per cent., is available for the useful work of pulling the train. It seems, moreover, hardly likely that this low percentage will be much increased. The cause of the loss is, of course, the extreme indirectness of the process, that is, the very great number of transformations through which the energy has to pass, in each of which there is always a loss. We may take the figures approximately somewhat thus, always remembering that the average power would be less, probably very much less, than three-quarters of the full power of the plant at work :—

	Per cent.
Mechanical efficiency of engine	85
Efficiency of belt-driving (if employed)	94
Efficiency of dynamo	90
Efficiency of line	85
Efficiency of motors	85
Efficiency of gearing on locomotives	75
Total efficiency	39

From this is to be deducted say 10 per cent. for driving the locomotive, leaving 35 per cent. for pulling the train.

I think it may fairly be said, that, to a mechanical engineer, the greatest enemy to all economy is frequency of transformation, and that it is, or ought to be, a fundamental rule in all engineering work that every unnecessary transformation, whether mechanical or electrical, should be avoided.

Notwithstanding this terrible drawback, the absence of foul gases is of such overwhelming great importance in some cases that the working of the City and South London Line has only been possible at all because electricity has been employed instead of steam. This, of course, is a case where mere economy of power was not the only or even the most essential thing sought for. In the Liverpool Overhead Railway also the same conditions of the case rendered the use of steam locomotives impossible, as the line runs along a route on which they are prohibited.

The case of tram lines along streets differs altogether from that of an underground or indeed any other railway. Here the steam engine with its boiler is a bulky and objectionable affair, very apt to cause smoke and other disagreeables, and very unsuitable for trains which consist of one vehicle only, weighing less than its locomotive would have to weigh. I have often wondered why the Serpollet boiler and engine have not been introduced for tram work. They take so little space that they might very possibly be put on the car itself (the car being made reversible as at Manchester), but I suppose some difficulties have been found ; at any rate the proposal has not been made, so far as I know. But apart from this, and not forgetting the steam cars which are actually at work in certain places in the North, there is probably no form of steam car which would be generally endured by the public. Here again, therefore, electricity would appear to come in regardless of cost, in the same way as with the underground railway, although for another reason. But here we are met at once with the mechanical difficulty (not existing of course, in the tunnel or on the overhead railway) of getting the current to the motors on the car. In America, the knot is cut, rather than untied, by the use of overhead wires, and in country places it is probable that this may be here the best solution of the problem. But in our cities, where the bulk of the tramway traffic of the country is really carried on, I am still conservative enough to think and also to hope that this is impossible. Without forgetting the much-quoted case of Buda-Pest, therefore, I fear that the introduction of electricity for car-driving in this country will still wait until a practicable underground system has been devised. Meanwhile it is being hard pressed by its rivals—cable and compressed gas. Of the two I think the latter, although the younger, is far the more formidable. It has the advantage of being even more direct than a steam-engine (the boiler being absent) ; it can be applied to each individual car even more easily than an electrical motor, and it enables the car to run freely on ordinary lines without their reconstruction, and without any mains either above or below ground. It has, as yet, had but short trial, but what I have seen of it makes me sanguine as to its ultimate possibilities.

Before speaking more particularly about the mechanical aspect of electric lighting problems, I feel bound to touch upon a matter which arises directly out of the question of supplying electric energy for power and for light concurrently, to which I have just drawn attention. It is a favourite bit of cheap criticism indulged in by those who have not to supply energy on a large scale, at the expense of those who have, that the former class of folk show their ignorance of their own work and interests by neglecting to obtain that enormous demand for motive power which would come on them if only they reduced their prices low enough. The criticism is really as absurd as that other which censures the gas companies because they do not supply heating gas at a few pence per 1,000ft., which, apparently, they would be perfectly able to do if only they knew their own business half as well as their critics do ! In both cases the criticism is mere words, "signifying nothing." We have simply to remember the fact that the mere possibility of driving something by electricity does not of itself create the things that want to be driven. There are isolated districts in London—Clerkenwell, for instance, and the neighbourhood of Fleet-street—in which there is a considerable

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amount of power of a kind which might be furnished electrically if the cost were made sufficiently low. In most parts, however, the whole energy expended in doing mechanical work is but a very small percentage indeed of the energy required for light, and it would not be increased in the least even if it were supplied for nothing. When the inhabitants of Mayfair and Kensington, for instance—to take these districts only as typical of many others—take to brushing their boots, washing their faces, and serving their meals by electricity, a demand will have arisen which may perhaps be fostered into something worth considering. Until this happy state of affairs comes about, I fear that the demand for motive power in English residential and semi-residential districts must remain a factor practically negligible in the calculations of the engineer.

Whether in a purely manufacturing district it may ever be found to pay to put down a central power station and transmit power to factories, each of which would replace its steam-engine and boiler by an electric motor, is a question about which there is a good deal to be said on both sides. I have already indicated the lines along which I believe this matter will settle itself.

(To be continued.)

SECOND REPORT OF THE ROYAL COMMISSION ON ELECTRICAL COMMUNICATION WITH LIGHTHOUSES AND LIGHT-VESSELS.

[Abstract.]

Since the issue of our first report* we have made a further tour of inspection of lighthouses and light-vessels. On July 10, 1893, we assembled at Glengariff, Bantry Bay. On the following morning we embarked on board the steamer "Moya," which was placed at out disposal by the Commissioners of Irish Lights, and inspected the Bull Rock and the Fastnet. Leaving the "Moya" at Baltimore, we proceeded to Cork, and thence to Kingstown, where we embarked on board H.M.S. "Enchantress." On the morning of July 13 we proceeded to the Isle of Man, landed at the Chicken Rock Lighthouse, and, passing Langness Lighthouse and the Bahama Bank light-vessel, anchored in Ramsey Bay. On the following day we crossed from the Isle of Man to Bangor, county Down, passing the South Rock and Skulmartin Rock Light-vessels and Mew Island Lighthouse. On July 15th we proceeded to Lamlash, landing on the way at the Maidens and Ailsa Craig Lighthouses. After having visited Pladda Island Lighthouse, we landed on July 17th on Sanda Island and Rathlin Island, inspecting the lighthouses on those two islands, and anchored for the night in Lough Foyle. From Lough Foyle we proceeded to Oban, after having inspected the lighthouse on Inishtrahull Island, and from Oban we steamed through the Sound of Sleat to Stornoway. Returning to the mainland, we anchored at Loch Inver, and visited the Ru Stoer Lighthouse, and on July 24th we left Loch Inver for Longhope in the Orkney Islands, whence we paid a visit to the Cantick Lighthouse and to the Look-out Station of the Commissioners of Northern L ghthouses on Brough Ness, opposite to the Pentland Skerries Lighthouses. On July 26th we inspected Stroma and disembarked at Scrabster. Then proceeding south by train to Seahouses, we embarked on board the Trinity House steamer "Argus," which conveyed us round the Farn Islands. The tour of inspection ended with the visit to the lighthouses on those islands. We reassembled in London in September, and have since held several meetings.

Although the general question of signalling had not been directly referred to us, it appeared to be so intimately connected with the subject of electrical communication that we felt ourselves justified in considering it, and in our First Report we stated that in cases "where the distance from the shore is not great, an improved system of distress-signals (distinct from the usual fog-signals) might, both at rock stations and on light-vessels, prove an effective temporary substitute for the more costly expedient of electrical communication." This view has been confirmed by the experience which we gained during our last tour of inspection, and we are now prepared to go further and recommend that the General Lighthouse Authorities should be invited to consider the subject with the view of instituting a universal system of visual and sound signals at all the various light stations on the coasts of Great Britain and Ireland.

A member of the Commission, Sir Edward Birkbeck, having occasion last spring to visit the United States of America, we requested him to take the opportunity of inquiring into the systems of coast communication in force in Canada and the United States. On his return to this country, Sir Edward Birkbeck, submitted to us a report, a copy of which will be found in the Appendix. From that report it will be seen that, while both Canada and the United States possess an efficient system of electrical communication round their coasts, none of the light-vessels belonging to those countries had been electrically connected with the mainland.

We have received and considered particulars of a number of inventions for effecting electrical communication between light-vessels and the shore, but none of these are, in our opinion, preferable to the "sunk" system, which is now being applied to the Goodwin (North Sand Head) and Kentish Knock Light-vessels.

We have again to express our obligations to the Admiralty for the loan of H.M.S. "Enchantress," and to the Trinity House, the Commissioners of Irish Lights, and the Commissioners of Northern Lighthouses for the assistance which they have rendered to us.

* See *The Electrician*, Vol. XXX., p. 396, February 3, 1893.

Recommendations.

We recommend that electrical communication by aërial wires be established without delay between the telegraphic system of the country and the following shore lighthouses and lighthouse stations:—

Name of Lighthouse.	To be connected by telephone with	Estimated cost (approximate).
Falmouth Harbour	Portscatho C.G.S.	£160
South Point	Whitburn C.G.S.	100
Montrose (Scurdy Ness)	Usan C.G.S.	85
Covesea Skerries	Lossiemouth P.O.	83
Tarbet Ness	Portmahomack P.O.	55†
Look-out Station at Brough Ness for Pentland Skerries Lighthouses.	St. Margaret's Hope P.O.	233
Fair Isle (North end)	Fair Isle P.O.	128
Sumburgh Head (Shetland Islands)	Sumburgh P.O.	65
Cape Wrath	Durness P.O.	20†
Ru Stoer	Stoer P.O.	20†
Rhynns of Islay (Oversay Island)	Bruichladdich P.O.	330
Turnberry	Maidens P.O.	48
St. Bees	St. Bees P.O.	76†
Langness	Castletown P.O.	103
Menai	Beaumaris P.O., & Life-boat Coxswain's house at Penmon.	72
South Stack	Holyhead C.G.S.	15
Galley Head	Dunny Cove C.G.S.	150
Loop Head Kilcradan Point	Carrigaholt P.O.	61†
	Total	£1,804

† If Admiralty wire is used.

It is with regret that we have decided to confine our recommendations in this Report to Shore Lighthouses, but, until more has been done towards effecting the connection of those light-vessels and lighthouses, which were selected in our First Report as having the strongest claims to immediate attention, we hesitate to add to the list of the light-vessels and island and rock lighthouses, with which we consider that electrical communication should be established.

(Signed) Mount-Edgcumbe (Chairman); Henry Lyle Mulholland; Edward Birkbeck; F. L. M'Clintock; G. S. Nares; W. H. Preece; J. C. Lamb; John A. Kempe; R. Munro-Ferguson; Ernest G. Moggridge (Secretary).

APPENDIX.

Report of Sir Edward Birkbeck on the System of Coast Communication in Canada and the United States.

I have the honour to report that, in accordance with the desire expressed by the Royal Commission on Electrical Communication with Lighthouses, &c., at their meeting held on March 20th, I proceeded, after the termination of my official visit to Chicago, to obtain, both by inquiry and by personal inspection, some information in regard to the telegraphic and telephonic system of coast communication now in force on certain portions of the coast of Canada and the United States. The request addressed by the Secretary of the Royal Commission to the Colonial and Foreign Offices that those departments should ask that facilities might be given to me by the Governments of the Dominion of Canada and of the United States secured for me great assistance in my work of investigation.

Canada.

On my arrival at Ottawa Mr. William Smith, Deputy Minister of Marine, give me a most exhaustive explanation of the working of the coast telegraphic system of the Dominion. He was desirous that I should visit the life-saving station on Sable Island, but thought it still more important that I should inspect a first-class lighthouse signal station commanding, during the navigation season, the largest amount of passing shipping.

The s.s. "La Canadienne" was, therefore, ordered to meet me at Dalhousie on the coast of New Brunswick, and to convey me to any portions of the coast that I desired to visit. I accordingly proceeded from that place early on the morning of May 25th in a north-easterly direction up the Gulf of St. Lawrence, passing the lighthouse signal stations on Macquereau Point and Cape Despair, and landing the same evening at Cape Rosier, a first-class lighthouse signal station. This lighthouse, which was established in 1858, is situated on a low cliff, and has a fixed white light 136ft. above high-water mark with a range of visibility of 17 miles. The position is one of great importance for a signal station, and a large amount of shipping passes within signalling distance, bound either to or from Europe, Nova Scotia, or the United States, including in the summer season, steamers proceeding through the straits of Belle Isle to Quebec and Montreal. The lighthouse keeper at this station receives 800 dollars per annum, and has to pay his assistant out of this sum. He is allowed to employ more than one assistant, if he desires, but he must do so at his own cost. During the time the navigation is open—generally from about April 1st to December 10th or 20th—the keeper and his assistant are responsible for the performance of the following duties:—(1) Lighting and cleaning the lamps. (2) Managing the boiler and engine for sounding the steam horn. (3) Painting the inside and outside of the lighthouse.

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(4) Taking entire charge of the telegraph (Morse) instrument. (5) Reporting to Quebec twice a day the state of the weather. (6) Reporting all ships passing the station. (7) Telegraphing for tugs to assist disabled vessels. (8) Forwarding any public or private telegrams which may be handed in.

Private messages handed in can be paid for either by the sender or receiver, and at some of the signal stations a very considerable amount of telegraph business is transacted during the summer months for trade purposes.

At night we steamed passed Fame Point Lighthouse Signal Station, and proceeded to the Island of Anticosti, situated 65 miles from the mainland of the Province of Quebec, 107 miles from Newfoundland and 40 miles from the coast of Labrador. The island is connected by cable with the mainland near Cape Rosier, and also with the coast of Labrador. I landed at West Point Lighthouse Signal Station at 4 a.m. on May 26th, and inspected that lighthouse, which was established in 1858 and is situated on low land. It is furnished with a fixed white light 106ft. above high water-mark, visible 15 miles. This is one of four first-class lighthouse signal stations, all situated on the south-west coast of the island. They are much needed on this dangerous coast, and are of great importance both as signal stations and for furnishing reports regarding the weather, and also regarding the state of the ice at the beginning and end of the navigation season. The lighthouse keeper at West Point has two assistants, both paid by himself, with duties similar to those at Cape Rosier Lighthouse, except that a large gun is used in foggy weather instead of a foghorn. The signal station at Heath Point Lighthouse is the most important of the four for signalling purposes, but on inspecting the return of commercial messages handed in during the year at West Point Station, I found numerous entries proving that, even at that most out-of-the-way-station, coast communication is of importance to the trading community.

A westerly gale, accompanied with snow and rain, made it impracticable to land at the East Cape Lighthouse Signal Station; but I was informed that the arrangements there are similar to those at the West Point Station.

The Canadian Government have established a complete and thorough system of telegraphic coast communication, and have also provided cable communication with every island of importance, with the exception of Sable Island,* which will be connected in due course. The telegraphic, instead of the telephonic, system has been adopted on account of the number of commercial messages which have to be sent, and the long distance which the messages have to be transmitted.

Many of the Canadian light-vessels have to be moved from their stations during the winter on account of the ice, and the question of cable communication with them has not been taken in hand.

United States.

On Wednesday, May 30th, I called on Capt. Charles A. Abbey, Inspector of Life-saving Stations for the United States, at his office in New York. Capt. Abbey, who had been instructed by the Government at Washington to render me assistance during my visit, gave me all possible information respecting the telephonic service at the life-saving stations, as well as regarding the life-saving service itself.

In accordance with the suggestion of the United States Government, which I received through Sir Julian Pauncefote, I proceeded on the following morning with Capt. Abbey to the coast of New Jersey State. We landed near Sandy Hook, and went thence by rail to Seabright Life-saving Station.

It is important to observe that, with the exception of the ten stations on the Pacific coast, and those round the shores of the great lakes during the season of open navigation, the staff at the life-saving stations are, from May 1st to September 1st, all disbanded, the keeper alone being left in charge to work the telephone.

Orders had, however, been given by the United States Government to summon the surfmen at Seabright Station, in order that I might see everything in full working order. I found this first-class station thoroughly organised and fully equipped in every detail. A very commanding place of look-out is provided on the roof, from which vessels in distress can be seen for a considerable distance, and telephonic communication can be effected with any one of the stations on the coast within 70 miles, by means of switches. The keepers were loud in their praises of the advantages of the system for life-saving purposes, and stated that in the winter, distant stations are often warned in advance to be prepared for an emergency.

The wire is carried on iron poles from the stations to the nearest system of wires—generally following the coast line—and where telegraph poles are not already available, iron ones are erected in close proximity to the shore, and to the life-saving stations on either side. The cost of running a wire from station to station is on an average (according to information given me by the district superintendent of telephones), say 75 dollars a mile, without the instruments. Great importance is attached to the principle of running the wires direct from station to station, and not using existing lines many miles inland, and then returning to the coast, as has been done in many cases in England, thus making it necessary to call up the postmaster at night.

The United States Government allow the station telephones to be used by the general public in cases where there is no telegraph office near, and messages are forwarded by the station keepers to the telegraph offices, payment being collected from the receivers of the messages.

Among other duties performed by the surfmen when on patrol in out-of-the-way districts is carrying letters in order to expedite their delivery.

I visited three other stations, viz. (1) Monmouth Beach, (2) Long Branch, (3) Deal. The arrangements, so far as coast communication is concerned, at these and at all the other stations are very similar to those at Seabright, which I have described.

* See *The Electrician*, Vol. XXVI., p. 244, December 26th, 1890.

I may add that the system of telephonic communication in connection with the life-saving service on the shores of the great lakes during the navigation season is of an equally efficient character, and the necessity for this is apparent when the extent of the lake trade is considered, the annual import and export tonnage for the port of Chicago alone, on Lake Michigan, being larger than that of New York. No cable communication from the shore to light-vessels has yet been established; but wires are laid to the electric buoys wherever they are placed, no ships being allowed to anchor near them. I have, however, reason to believe that the United States Government are about to consider the desirability of cable communication between the mainland and some of the light-vessels and rock and island lighthouses, with none of which does communication at present exist for life-saving purposes.

In conclusion, I would remark that the Canadian telegraphic coast communication arrangements appear to me to be carried out in a most efficient manner, and to be of great use to the Government and general public, and considering the many duties which the lighthouse keepers have to perform with so small a staff to assist them, it was most striking to see the great interest they take in their extra work of telegraphy and how cheerfully they perform it.

These facts lead me to venture to think that the Royal Commission will have no hesitation in recommending that more lighthouses be telephonically connected with the Post Office system on certain parts of our coasts.

From the inquiries I made in the United States, at the Government establishment at the World's Fair under Lieutenant Charles H. McLellan, from the information I gained from Capt. Abbey, and from my inspection of the stations on the New Jersey coast, to which I have referred, I am convinced that the system of telephonic coast communication now in force in the United States is a very admirable one, and I am of opinion that the maximum of efficiency would be secured if in due course the system of direct lines running along the coast could be adopted in this country, instead of the zigzag system of communication through inland post offices, which necessarily at night involves loss of time, a matter in some cases of vital importance.

MEETINGS OF SCIENTIFIC SOCIETIES, &c.

(TO-DAY) FRIDAY, April 27th.

PHYSICAL SOCIETY.

5 p.m. The following Papers will be read:—(1) "The Mechanism of Electrical Conduction," by Dr. C. V. Burton. (2) "A Graphic Method of Constructing the Curves of Current in Electro-Magnets and Transformers," by Major Hippisley, R.E. (3) "The Design and Winding of Alternate Current Electro-Magnets," by Prof. S. P. Thompson, F.R.S.

JUNIOR ENGINEERING SOCIETY.

7:30 p.m. Visit to the new Mechanical and Electrical Engineering Laboratories at University College.

MONDAY, April 30th.

SOCIETY OF ARTS.

8 p.m. Cantor Lecture: "Typewriting Machines," by H. C. Jenkins.

TUESDAY, May 1st.

ROYAL INSTITUTION.

5 p.m. Annual Meeting.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Ordinary Meeting. Paper to be read:—"The Manufacture of Briquette Fuel," by W. Colquhoun.

WEDNESDAY, May 2nd.

IRON AND STEEL INSTITUTE.

10:30 a.m. General Meeting of Members at 25, Great George-street. Presidential Address.

SOCIETY OF ARTS.

8 p.m. Ordinary Meeting. The following Paper will be read:—"Nickel," by A. G. Charleton.

THURSDAY, May 3rd.

IRON AND STEEL INSTITUTE.

10:30 a.m. General Meeting at 25, Great George-street.

ROYAL INSTITUTION.

3 p.m. Afternoon Lecture: "The Solid and Liquid States of Matter," by Prof. Dewar, F.R.S.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Second "James Forrest" Lecture:—"The Relation of Mathematics to Engineering," by Dr. John Hopkinson, F.R.S.

FRIDAY, May 4th.

LONDON CHAMBER OF COMMERCE.

2:30 p.m. Meeting of the Electrical Trade Section at Botolph House, Eastcheap, to consider the Locomotive Acts in relation to the Traction industry.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Students' Meeting at 28, Victoria-street. Paper to be read: "A Description of the Electrical Type-Printing Instruments as used by the Exchange Telegraph Company," by F. Digby Latimer.

SATURDAY, May 5th.

ROYAL INSTITUTION.

3 p.m. Tyndall Lecture:—"Colour Vision," by Capt. Abney, F.R.S.

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The Electrician.

(The Oldest Electrical Journal, 1861—1878.)

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SPECIAL NOTICE.

The present number of "THE ELECTRICIAN" completes Vol. XXXII. With next weeks Number will be issued (Gratis) the Index to the Volume.

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STATUTORY PROTECTION AGAINST ACTIONS FOR NUISANCE.

In February, 1893, we reported the case of "National Telephone Company *v.* Graff Baker," in which Mr. Justice KEKEWICH held that, although the working of the Leeds Tramway constituted a nuisance to the Telephone Company, yet the fact that the tramway was constructed and worked by electricity under statutory powers precluded the Telephone Company from obtaining the redress which he would otherwise have granted them. Last week we reported another decision of the same judge in the case "Meux's Brewery Company *v.* The City of London Electric Light Company," where the plaintiffs were awarded damages for the nuisance caused by noise and vibration due to the machinery at the Bankside Station of the defendants, whose statutory powers were pleaded in vain. Since these two judgments might at first sight appear to be at variance, it may be useful to make a few remarks upon them.

The question of how far acts, injurious to individuals, but done in pursuance of statutory powers, are exempted from the ordinary law of nuisance, has, like most other important legal doctrines been the subject of numerous judicial decisions. Two of these, both pronounced by the House of Lords, may be quoted as illustrations of what kind of powers will, and what will not secure such immunity, assuming in both cases that the operations complained of are conducted with proper care, and in the manner sanctioned by the statute. In "Hammersmith and City Railway Company *v.* Brand," decided

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1869, it was held that the Railway Company, having constructed their line according to the route laid down by Parliament, were under no liability for any nuisance due to vibration caused by running their trains upon this line in the absence of negligence in the method of working. In the case of "Metropolitan Asylum Managers *v.* Hill," decided in 1881, complaints were made of the injury caused to neighbouring residents by the erection of a small-pox hospital at Hampstead. The Asylum Managers were authorised by statute to build the hospital, and acquire land for the purpose without restriction as to locality. It was almost impracticable to build it anywhere, without some risk of causing depreciation to adjoining property, having regard to the fact that it must be easily accessible for the London poor. Yet it was held that the site chosen not having been expressly approved by Parliament, the Managers were liable to be restrained by injunction from continuing to use the hospital for small-pox patients. In the Leeds case, Mr. Justice KEKEWICH followed the first of these two decisions of the House of Lords, holding that the tramway, having like a railway a route defined by Parliament, no one could complain of electricity being employed with reasonable care for driving the trams, since that mode of traction was expressly authorised by the Company's statutory powers. The Telephone Company, as is well known, are protected by special clauses in the Electric Lighting Provisional Orders; but apart from any special protection of this kind, electric lighting mains would, no doubt, be held entitled to the same immunity as a tramway line. Generating stations, however, stand on a different footing. The Electric Lighting Acts authorise supply companies "to acquire such lands by agreement. . . . construct such works thereon. . . . and do all such acts and things as may be necessary and incidental to their supply," but no compulsory powers are granted in respect of any particular site, the companies being left to select any they can obtain suitable for the purpose, subject to the ordinary rules of common law as regards any nuisance they may cause. The distinction between these two kinds of statutory powers is clearly put in the judgment of Lord HALSBURY in the House of Lords in a case of the "London and Brighton Railway Company *v.* Truman," where he speaks of the Hampstead case as follows: "Broadly stated, the distinction taken amounted to this, that a small-pox hospital might be built and maintained if it could be done without creating a nuisance, whereas the Railway Acts were assumed to establish the proposition that a railway might be made and used whether a nuisance were created or not." Electric Lighting Provisional Orders contain the following clause, which emphasises this distinction: "Nothing in this Order shall exonerate the undertakers from indictment, action, or other proceedings for nuisance, in the event of any nuisance being caused by them." This clause does not, in fact, add anything to the liability of the undertakers, being nothing more than a warning against an erroneous assumption that the Order gives wider powers or greater protection than is expressly stated therein.

Counsel for the City of London Company, in the recent case, failed to satisfy Mr. Justice KEKEWICH that the statutory powers possessed by his clients differed in kind from those of the Hospital in the Hampstead case, and, consequently, their operations, notwithstanding due care in conducting them, were held amenable to the ordinary law. It is noticeable, however, that on the ground of public convenience the Judge refused to grant the injunction asked for by the plaintiffs, but exercised his discretionary power of awarding damages instead.

REVIEWS.

The Inventions, Researches and Writings of Nikola Tesla. By THOMAS C. MARTIN. (New York: Offices of the *Electrical Engineer.* 1894.)

Not only the interest of the electrical profession and of the scientific world, but also that of the general public, both here and in every part of the civilised world, has been keenly excited by the brilliant researches and the ingenious experiments of Nikola Tesla. Scientists everywhere have been charmed, and the outside world has been dazzled, besides being misled by the untimely and illogical interpretations which the general Press has put upon Tesla's researches. It is not to Tesla that the blame is due for having deluded the public into believing that the present systems of electric lighting are on the eve of annihilation, and that in a matter of a few months, or even less, the soft refulgence of "light without heat" will spread itself over whole cities. The blame lies mainly, if not entirely, with those incompetent interpreters who have rushed into print with a garbled and unscientific yarn, based upon misapprehension. Tesla, the scientist, with a prophetic eye capable of gauging the possibilities of the future, has been mistaken by these journalists for the practical man of business with a cut-and-dried system of electric lighting up his sleeve. Everyone, therefore, must welcome the appearance of a reliable account of Tesla's researches, in the compact and readable form in which it now lies before us. It is true that the whole of these researches has been already published in the electrical Press, and is available in that form to anyone. But those who have tried it know the difference between hunting out researches in several volumes of a heterogeneous collection of British and foreign journals and reading a carefully-compiled account of those researches in a handy book. Most of Tesla's work has been done in America, and the publication of it has had priority in the American electrical Press. Into no better hands, therefore, could the compilation of the work before us have fallen than into those of the editor of our American contemporary, the *Electrical Engineer* of New York.

But Mr. Martin's book is something more than a reprint of Papers already published. It commences with a short but interesting biographical sketch; and it is interspersed with several expository chapters, which will be valued by the reader who has not the time to study the detailed accounts of the researches given by Tesla in his lectures and Papers. The work consists of nearly 500 pages, divided into four parts, and is in one volume. Part I. is devoted to Polyphase Currents, and fills 113 pages. Commencing with Tesla's earliest work on alternate currents, the author traces, in the course of some 24 chapters, the evolution of the polyphase systems and of the rotary magnetic field generators, transformers and motors associated with Tesla's name. This part contains some useful account of Tesla's patents and scientific Papers on this subject. We may remark that in this part the researches are in touch with existing electrical engineering practice in a way that they are not in the succeeding parts. It is not in his researches upon electric lighting so much as in his inventions and patents in the transmission of power that Tesla has influenced electrical engineering of the present day. Part II. deals with the "Tesla Effects with High Frequency and High Potential Currents," and, in the course of eight chapters, covers the ground of the Tesla lectures upon his system of lighting by alternating electrostatic fields. The commencing chapter is a very useful *résumé* of the ground thus covered, under the title of the "Scope of the Tesla Lectures." The lectures at the Royal Institution, London, and at New York, Philadelphia and St. Louis, are printed practically, if not entirely, *in extenso.* The compiler has not, we feel sure, adopted this course without having some good reason for doing so. But we cannot refrain from commenting upon the large amount of repetition which it has involved. There is not, about Tesla's researches, that continuity and logical sequence which we look for in the work of our best men of science, and the scope of Mr. Tesla's fascinating lectures in London was pretty much the same as the scope of his no less attractive lectures in America. If it had been the case that in the latter we had the successive steps in

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a line of research initiated in the former, the omission of one or even of part of one lecture might have proved fatal to the clear statement of what it is that Tesla has really done. But this is by no means the case, and we are at a loss to see why all these lectures should have been reprinted so fully. With regard to the substance of these lectures, we must warn the reader against giving it the popular interpretation. In the brilliant experiments on lighting by alternating electrostatic fields—although far from brilliant in regard to the amount of light evolved by the process—we *may* have the germ of a method of practical illumination in the unmeasured future. But those who know the amount of power that must be expended in the generating plant in order to produce these effects, and have compared this power with the net result in useful light, can hardly be in a hopeful state of mind as regards the present practical value of producing light in this way. "Light without heat" is the desideratum, but a little light in one part of the circuit and a lot of heat in another part of the circuit can scarcely be considered to attain unto it. Part III. consists of nine chapters, devoted to some discussion of Tesla's miscellaneous inventions and writings. Of the inventions described in this part we may notice a method of obtaining direct from alternate currents—the dear desire of the "alternate-current man"; condensers with plates in oil; an electrolytic registering meter; thermo-magnetic motors and pyro-magnetic generators, interesting mainly on account of the inherent inferiority of these methods to better known methods of obtaining power; a direct-current arc-lighting system; and improvements in unipolar generators. Part IV. is in the form of an Appendix, and concludes the work with two chapters, one on Tesla's personal exhibit at the Chicago Exhibition, and the other on the quite recently-invented mechanical and electrical oscillator, in which a reciprocating alternator coil is fixed to the rapidly reciprocating piston of an engine.

Throughout the book the various sections are illustrated by numerous well-chosen diagrams and pictures, and there is an artistic portrait of Tesla on the frontispiece. Altogether, this work is a credit to the compiler and author, and we have much enjoyed its perusal.

Erläuterungen zu den Vorsichtsbedingungen für Elektrische Licht- und Kraft-Anlagen des Verbandes Deutscher Privat-Feuerversicherungs-Gesellschaften. By Dr. OSCAR MAY. (Leipzig: F. W. V. Biedermann.)

The fire-risk rules drawn up by Dr. Oscar May for the Associated German Fire Offices are commendably brief and free from rigidity. Considering, however, that the author has found it desirable to publish the above explanatory volume of over one hundred pages, and that in his fear lest he should unnecessarily hamper wiring firms, he has omitted any and every rule relating to insulation, it will, perhaps, be thought that both brevity and flexibility have been carried a trifle too far. Rules sufficiently precise to prevent all jerry work, and at the same time in no way hindering good work, being in Dr. May's opinion impossible, he prefers to make none at all, and to leave everything to the competency, honesty, and conscientiousness of the inspecting officer. This may be all very well so far as the householder and fire-office are concerned, but it is rather hard on the wiring contractor, who must perforce carry out the job with an eye rather to synchronising with the inspector's fads than to intrinsically good work; a rule specifying a certain percentage leakage of current would seem to meet the difficulty better than any other. The rules, two and twenty in number, are based upon those of the Phœnix Fire Office, and appear, with the exception of the omission referred to above, to be of the ordinary character. Instead, however, of simply limiting the current density by specifying a maximum permissible fall of potential, a sort of sliding scale is laid down beginning with a current density of 3,225 per sq. inch for conductors up to $\frac{7}{1000}$ths of a sq. inch cross-section, and ending with a current density of 1,290 for all conductors over $\frac{7}{100}$ths of a sq. inch cross-section. The smallest conductor allowed is about No. 20 S.W.G. The volume of explanations should be of considerable use in making clear the exact intention of the rules.

HERTZ'S EXPERIMENTS ON CATHODE RAYS.

BY DR. OLIVER LODGE, F.R.S.

The translation of Dr. Lenard's most interesting Paper developing one of Hertz's minor discoveries, that the molecular bombardment from the negative terminal in vacuum tubes can penetrate thin metal films, suggests the propriety of also publishing a translation of Hertz's original brief Paper.

It will be observed that with his customary caution Hertz only asserts transparency for films that are thin enough to be transparent to light, whereas Lenard finds the transparency of metals for "cathode rays" immensely greater than their transparency for light. He also finds that everything is transparent if thin enough, and not only metallic films as Hertz at first thought. Lenard's success in getting the rays out of vacuum into ordinary air, through a plate thick enough to stop every trace of light, makes experiments on the phenomenon very much easier.

I agree with Prof. Fitzgerald in thinking it extremely improbable that in these rays we have any directly ethereal manifestation. Everything points to action of residual matter.

ON THE PASSAGE OF CATHODE RAYS THROUGH THIN METALLIC FILMS.*

BY H. HERTZ.

Cathode rays differ from light chiefly with regard to capacity of penetrating solid bodies. Even such bodies as are the most transparent for light of all kinds, offer an impenetrable obstacle to the passage of cathode rays even in the thinnest procurable films. It is all the more remarkable that the metals, opaque as they are to light, should transmit cathode rays, if only to a very small extent. Thicker metallic films are, indeed, opaque to cathode rays as well as to light, but metallic films thin enough to allow of the passage of a portion of the incident light, also allow a portion of the cathode rays to penetrate; in fact, the percentage of cathode rays transmitted appears to be somewhat larger than the percentage of light. This may be shown by the simplest experiments. A plane phosphorescent glass plate, preferably a piece of uranium glass, is partly covered on one side, which we will call the face, with real gold leaf; a few fragments of mica are fastened on to the gold, and the face is exposed to cathode rays proceeding, say, from a plane circular aluminium cathode 1 cm. in diameter, say, at a distance of 20 cm. from the cathode. As long as exhaustion has not proceeded very far, and the cathode rays fill the whole discharge tube in the form of a dense blue light cone, the glass only phosphoresces outside the area covered with gold. Phosphorescence is at this stage chiefly due to the light of the discharge, of which light the gold leaf only transmits a very small portion. But as exhaustion proceeds and the interior of the discharge tube becomes darker, the cathode rays proper begin to strike the covered glass, and the latter commences to phosphoresce also behind the gold film; this luminosity increases, and when the cathode rays have attained their maximum development, the gold leaf, as seen from behind, only appears as a faint veil on the glass plate, chiefly distinguishable at the rims, and by the minute folds in it; so we can hardly say that it casts a shadow. But the thin mica plates placed upon the gold film cast their intense black shadows through it upon the glass. The cathode rays, therefore, penetrate the gold leaf, apparently with little loss. The same experiment I performed with equal success upon real silver leaf with aluminium foil, with various kinds of imitation silver and gold leaf (tin, zinc, and copper alloys), also with chemically precipitated silver films, and with layers of silver, platinum, and copper deposited in a vacuum by the discharge. These last films were much thinner than the beaten metal foils. I found no characteristic differences between the different metals. The best material for the experiments appeared to be the beaten aluminium as obtained commercially. It is almost completely opaque to light, transmits the cathode rays well, is easily manipulated, and is not attacked by the cathode rays, while a sheet of silver foil, for instance, is quickly disintegrated by them in a peculiar manner.

The assumption that in these experiments the cathode rays have penetrated the substance of the metal might meet with the objection that metal sheets of such thinness are full of small holes, and the cathode rays might have penetrated these instead of the metal. In the case of the beaten metals, in which the phenomenon is most striking, the presence of a multitude of pores cannot be denied; but the total area of the openings would surely not exceed a small fraction of the surface of the metal, and is insufficient to account for the bright luminosity of the covered glass. Besides,

* *Wied Annalen*, 45, p. 28, 1892.

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the covered portion of the glass appears perfectly dark when we look at the face of the glass as seen from the cathode. The cathode rays must, therefore, have arrived at the glass along a path which cannot be retraced by the light they produce ; they cannot, therefore, have entered through the openings in the metal film attached to the glass. Further, if we superimpose one metallic film upon the other, the number of coincident openings will be infinitesimal ; but the cathode rays produce strong phosphorescence in the glass even under a double layer of metallic films ; we may, in fact, perceive the phosphorescence of the glass and the shadows of objects in front of it under a three or fourfold layer of gold leaf or aluminium foil. It is curious that a double layer weakens the luminosity much more than might have been expected after the slight weakening due to a single layer. I believe that the following consideration affords a sufficient explanation. The metal covering represents a reflecting surface from which the light of phosphorescence is reflected. Since this surface prevents the light from radiating in the direction of the cathode, it doubles its intensity for the surface away from the cathode. If we now suppose that the metallic film only allows one-third of the cathode rays to penetrate, yet the luminosity is not reduced to one-third, but to two-thirds of the original value ; the second layer, however, will reduce it to two-ninths, and further layers will rapidly extinguish the phosphorescence. If this assumption is correct, metal plates transmitting more than half the cathode rays should not diminish the luminosity at all, but the glass should phosphoresce behind such films even more strongly than at the uncovered portions. I think I have found this surmise justified in chemically precipitated silver films of suitable thickness ; but the observation is somewhat doubtful since the greyish-blue light of the gas is seen through the uncovered portions of the phosphorescent glass, and the luminosity of this light cannot with perfect certainty be distinguished from the green phosphorescence.

Finally, if the cathode rays passed through the openings of the metal, they should proceed on their rectilinear paths after this passage. But they do not ; the rays are, in fact, diffused by the passage in about the same manner as light is diffused by passing through a turbid medium such as ground glass. We divide off the whole section of the cylindrical discharge tube by a metal plate, place in this a circular opening some millimetres in diameter, and close this by a piece of aluminium foil. If we now hold a phosphorescent glass plate just behind the opening, we obtain, as might have been expected, a clear and bright image of the opening on the glass. But if we remove the glass plate by one or two millimetres the image appears considerably enlarged and its brightness correspondingly diminished, its rim at the same time appearing foggy. On increasing the distance to several millimetres the image of the opening appears exceedingly foggy, enlarged, and feeble, and on further removing the plate the discharge tube behind the diaphragm simply appears dark. That this is solely due to the faintness of the cathode rays dispersed by the small aperture is at once evident when we make several such holes closed by aluminium foil in the diaphragm. The simplest diaphragm for this experiment is a wire grating just beaten, and covered with a piece of aluminium foil. Behind such diaphragms the whole discharge tube glows with an evenly-distributed, moderately-bright light. The phosphorescence is strong enough to allow of the separation of pencils of rays out of the diffuse cathode rays by means of further diaphragms, and enables us to prove that even after their passage through the metal foil the cathode rays have not lost their properties of rectilinear propagation, of deflection by the magnet, &c.

The phenomenon of diffusion of the cathode rays during their passage through thin bright metal films may be connected with the other fact established by E. Goldstein,* that the portion of the cathode rays reflected by the front surface of such layers is diffused.

COST OF ELECTRICAL ENERGY.†

BY R. E. CROMPTON, M.INST.C.E., VICE-PRESIDENT.

I address this Paper to all who are interested in electrical supply, but especially to the engineers who design and who work electrical supply plant. It is almost exactly six years since I read a Paper before this Institution‡ on this subject, and three years since I read a similar Paper before the Institution of Civil Engineers.§

I should be glad if those who are really interested in the subject would find time to glance over these two Papers after reading the present one, as there is much contained in them which might have been repeated here with advantage if I had not feared to unduly lengthen the Paper.

* E. Goldstein, "On the Reflection of Electric Rays," *Wied. Ann.* 15, p. 246, 1882.

† Paper read before the Institution of Electrical Engineers, April 26th.

‡ *Journal*, Institute of Electrical Engineers, Vol. XVII., p. 349.

§ *Proceedings*, Institute of Civil Engineers, Vol. CVI., p. 2

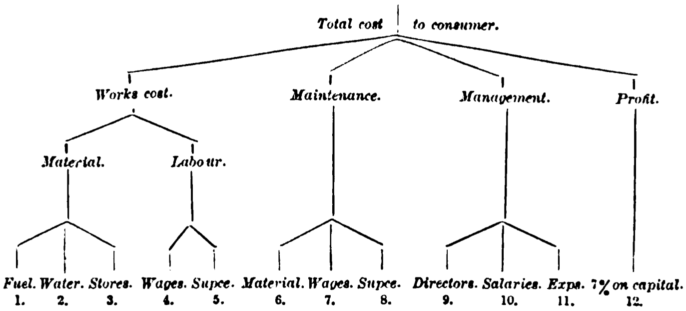
For convenience and brevity I use the word "works" for the whole plant of an electric supply company ; such works may have several generating stations. I use throughout the word "energy" for the electrical energy, and I speak of the two well-known systems of distribution as "direct" or "converted" systems. By direct systems I mean all two, three, or other multiple wire systems, with or without storage, in which the energy is supplied direct from the dynamos to the mains, and from the mains to the users, without change of pressure. I include amongst converted systems all those in which the energy is either generated at a high pressure, or converted up to a high pressure for transmission through the mains, and afterwards converted to the lower pressure at which it is supplied to the users.

In this Paper I do not deal with works using water power, but solely with those in which the electrical energy is obtained from fuel.

The total cost to the user may be grouped under four heads—Works Cost ; Maintenance ; Management ; Profit.

These may be conveniently sub-divided into 12 sub-heads or divisions, as follows :—

TABLE I.



Of these 12 heads I propose to deal at length with 1 to 8 only. The remaining heads of management and profit are outside the province of us enigneers, except in one important particular, which is that the interest or profit to be paid on the capital employed is affected by the choice of system used, and by the skill of the designer of the works, so that it is necessary for us to deal with it.

Let us assume that our ideal works are designed for the most economical production of 5,000,000 units of energy per annum, distributed to users in a large town and under average conditions. We are now in a position to estimate with considerable accuracy that the capital required for the preliminary expenses, for obtaining the requisite Parliamentary powers, and for the complete equipment of such works will not exceed £500,000, or at the rate of 2s. per unit sold per annum. I have arrived at this figure after considerable study of the capital account of existing companies, and of works carried out by local authorities, and I find that it is nearly certain that several existing works will reach this figure as soon as their plant is completed to the scale intended, and worked to the full output ; so that, if we consider that entirely new works could now be certainly carried out at a lower cost than that of any existing works, it will be seen that my estimate is on the safe side.

Now I think that such works ought to be able to include in the total cost to the consumer such a sum as profit as will yield 7 per cent. per annum on the whole of the loan as well as subscribed capital. In the case of a local authority, a portion of this 7 per cent. would be applied to paying the interest and sinking fund on the original loan, and the remainder would be applied as a profit in the reduction of local burdens or in introducing local improvements ; but in the case of a joint-stock company this capital of £500,000 might advantageously consist of £200,000 in ordinary shares, £100,000 in 6 per cent. preference stock, and £200,000 in 4 per cent. debenture stock, so that the average of 7 per cent. on the whole £500,000 might be divided up as follows :—

4 per cent. on debenture stock	£8,000
6 per cent. on preference stock	6,000
10½ per cent. on ordinary stock...	21,000
Total	£35,000

This sum of £35,000 is equal to a profit of 1·68d. per unit sold. The cost of managing such a company can also be dismissed in a few words. Under this heading it is convenient to group directors' fees, salaries of managing staff and office, meter readers, collectors, all stationery, law and audit charges, rates, taxes, and insurance. If we take the practice of the best managed works as a guide, we find that about £8,200 per annum is sufficient to cover all these charges for the largest output that has been yet obtained. It is evident that a sum of £9,000 a year would be an ample one for the management charge on the output of 5,000,000 units. This management charge, therefore, works out at 0·42 a unit.

You will see, then, that at the scale of working that we are now considering, which is at a scale of output certain to be reached

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within a year or two by a large number of works, the management and profit items, taken together, should amount to 2·1d. per unit. As I have said above, we engineers have nothing to say in controlling these figures. They are certain to be reached in course of a few years, as it is a mere question of output. The question which I now propose for your consideration is this: What chance have we of reducing the present works cost and maintenance cost included in the sub-heads 1 to 8 to such an extent that the energy may be sold to the public at, possibly, the low figure of 3d. per unit? I believe that Mr. Swinburne has stated that electrical energy, whenever the demand is continuous, such as for certain electrolytic or electro-metallurgical processes, can be generated and distributed to short distances at a works and maintenance cost of ¼d. a unit. I believe Mr. Swinburne has good grounds for this estimate, if cheap fuel is available. But for our present purpose, which chiefly concerns the supply of electrical energy used largely for electric lighting, and to a minor degree for power, we cannot fix such a low figure for our ideal works and maintenance cost for the future. Mr. Swinburne's case and those which we are now considering differ so widely. We can hardly hope for many years to come to improve the load-factors of works for general supply much above 20. The average of the London stations is still a long way off this figure, and I fear that the extensions of the use of energy for power and purposes other than lighting are likely to go on for some years to come at a slow rate. At a load-factor of 20 you must remember that all maintenance charges work out nearly five times as great as they would be if the output was continuous. It is useless to put before you ideal figures which we cannot hope to approach. I propose, instead, to adopt figures which we may hope to reach at no distant period, and have therefore prepared those given on Table II., and I give reasons for fixing on them as I deal with each sub-head in turn.

TABLE II.—*Ideal Standard Works Cost.*

		d.	d.
Works Cost—			
	Cost per Unit Sold.		
1.	Fuel—2·5lb. Welsh coal at 20s.	0·27	
2.	Water	0·01	
3.	Petty stores..	0·02	
4.	Wages	0·10	
5.	Superintendence..................................	0·10	
	Total works cost..................	——	0·5
Maintenance—			
6.	Material on repairs..............................	0·20	
7.	Wages on repairs.................................	0·15	
8.	Superintendence..................................	0·05	
		——	0·4
9. 10. 11.	Management		0·42
12.	Profit		1·68
			3·00

Working expenses, 44% of receipts.

FUEL AND WATER.—DIVS. 1 & 2.—FUEL.

I agree with Professor Kennedy in the remarks that he made on my Paper read before the Institution of Civil Engineers* that the importance of the cost of the fuel used on electrical energy supply works is not to be measured merely by the money spent on the fuel itself, but that it is, to a certain extent, a measure of the quantity of plant that must be employed, and so affects the cost of upkeep of the plant, and to some extent every cost item, except, perhaps, management and profit items.

At a very early stage in the history of electrical supply works it was found that in practice the amount and cost of the fuel used differed very widely from the amount estimated from the known efficiency of the plant.

In 1883 modern engine builders were making engines and boilers using less than 2½lb. of good coal per indicated horse-power, and the mechanical efficiency of these engines was certainly not less than 85 per cent. At that time dynamos could be made of 85 per cent. efficiency. We all thought that our distribution losses should not exceed 15 per cent.; so that, putting these figures together we were justified in hoping that our fuel bill would not exceed 5½lb. of coal per unit sold. We soon, however, found that in practice we could not approach such a degree of economy; so that the opinions of practical engineers in charge of supply works rapidly veered round to the opposite extreme, and among these gentlemen, even in 1888, when I estimated that the figure which was then prevalent of about 24lb. of good Welsh coal used per unit sold might in the future be reduced to 5¾lb., I met with much incredulity. At so late a date as that of my Paper before the Institution of Civil Engineers in 1891,* Mr. Raworth, in the course of discussion, stated that to his knowledge from 19 to 22lb. of coal was commonly being used, and that he considered the figures I then gave—namely, 7·9lb. for the Kensington and 6·5lb. for St. James's stations, for the best months of the year—were so satisfactory that they opened up a prospect of a new era for shareholders in those companies. I am glad to say that since that date improvement has been very regular; during the past year we have several times seen recorded during the winter months—in which, of course, the economy of fuel is at its best—a fuel consumption under 5lb. of Welsh coal per unit sold; so that my forecast, made six years ago, has already been more than justified.

I have arrived at my new possible or ideal figure of 2½lb. of Welsh coal per unit sold in the following manner:—I find that we can in London count on obtaining this coal having an average calorific value of 14,500 B.T.U. per lb. With proper arrangements for heating the feed water to nearly boiling point boilers can be obtained which will evaporate 12lb. of water at our working pressure of 150lb. I think that the losses due to irregular working and banking fires can be so minimised that 2½lbs. may evaporate 25lb. of water into dry steam—not on tests only, but as shown on the monthly bills. Condensing steam-engines can and will be made for us using not more than 12lb. of steam, at from three-quarters to full load, or 13lb. of steam at from half to three-quarters load per indicated horse-power hour. To these engines dynamos can be coupled direct of such efficiency that the combination will not use more than 18½lb. to 20½lb. of steam per unit per hour, measured at the dynamo terminals at the corresponding loads, so that an average of 20lb. per unit generated may be counted on during the time that these engines are actually at work. This allows for 10 per cent. of the steam evaporated being condensed in the pipes, or used in feed pumps or other obscure sources of loss, and a further 10 per cent. for our distribution loss, in order to account for the 25lb. of water I require to be evaporated by the boilers.

It appears to me that the most convenient method of discussing the problem of reaching these ideal figures is to consider in turn the fuel that we use and the boilers and other steam-producing apparatus, the engines for using the steam, the dynamos for generating the energy, and, finally, the means for distributing the energy to the users—in each case with a view of locating the losses that now take place, and considering the best means of minimising these losses as far as may be possible.

In London the favourite fuel hitherto used in electric supply works has been Welsh coal of the best quality, as it has been found that the cost of the carriage of fuel form such a large part of its total cost when delivered on to the works, that in most cases it pays best to use nothing but fuel of the highest calorific value. This value in the case of the best Welsh coals may be taken at 14,500 British thermal units; for, although values as high as 16,700 have been noted in the case of Nixon's and a few other Welsh coals, yet is probable that these exceptional values are not attained on the average, even from coals from the very same seam.

As our ideal figure of 2½lb., therefore, contains 36,250 B.T.U., it will be convenient, for purposes of comparison, or for considering the use of other fuels, to point out that 2½lb. of Welsh coal is equal to 36¼ B.T.U. per watt-hour of the energy sold.

Table V. gives the calorific values of various fuels, determined by Bryan Donkin and Co. (Limited), arranged in the order of their efficiency when used in a Lancashire boiler fitted with Perret's furnace.

TABLE V.—*Calorific Values of various Fuels, determined by Messrs. B. Donkin and Co. (Limited).*

Fuel.	Description.	Where from.	Value of B. Ther. U.	Evaporation in Boiler per lb. of Fuel, lbs. of Water from 80° F. at 50lb. press.	Clinkers and Ash, &c.	Efficiency of Boiler
Coal.........	Large......	Welsh, best............	15.500	10·0	2·4	66·5
„	Small......	Cheshire, Orrel Col. Co.	14,500	8·7	2·4	64·0
„	Large......	Welsh, Ocean	13,950	7·9	8·5	58·7
Anthracite.	Pea.........	„ Llanelly	13.840	7·7	5·2	57·0
„	Nuts	„ „	13.560	7·7	6·6	58·5
Coal.........	Large	„ Ffaldau	13,560	7·7	9·5	58·5
„	„	Yorkshire, Ravensworth	14,820	7·5	10·5	51·0
Coke	„	London	...	6·85	...	...
Coal.........	Dust	Welsh	...	6·78	7·1	...
„	Small	Nottingham	11,630	6·5	12·9	58·0
Anthracite.	Dust	Welsh	13,700	6·35	6·2	47·0
Coke (ord.)	Breeze ...	London	10.610	5·4	19·6	52·5
Coke	„ ...	Welsh (Ebbw).........	12,000	5·4	5·5	46·0
„	DustBreeze	Nottingham	11,200	3·7	20·0	33·8
„ (pan).	Breeze ...	London	8,840	3·32	28·6	...
Refuse...	House (unsorted)...	„	...	2·13	...	...

I have been enabled, through the kindness of Messrs. Bryan Donkin and Co., to avail myself of these figures, which show at a

* *Proceedings* Institute of Civil Engineers, Vol. CVI., p. 2.

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glance the (comparative) value of Welsh coal as compared with other steam coals, of large Welsh as compared with small Welsh, of small anthracite, large and small coke, and coke dust; and, for the information of those who hope for great things from the use of town refuse for steam-raising purposes, I give at the foot of this table Mr. Bryan Donkin's determination ot its value. The Perret furnaces used for these determinations is well suited for making such a comparison, as it burns efficiently all classes of fuel, even the smaller and finely divided coals, coal dust, coke breeze, and coke dust, and in these cases minimises the loss of small combustible, which is liable to fall through the grate bars. The results shown on this Table emphasise the fact that in practice we can utilise a large percentage of the thermal unit in such fuels as anthracite, Welsh coal, and coke, the heating power of which lies chiefly in the solid carbon which they contain; and that the small and dust fuels of the same class are only less valuable because a part of them is liable to fall through the bars, and because, being so finely divided, they usually contain more earthy matter to form clinker and ash in the furnace than the larger coals or cokes, which can be more easily hand-picked, sorted, or washed free from such impurities.

The very large class of steam coals used in the Midlands and North is only represented in the Table by the one test of the Yorkshire Ravensworth coal, but the majority of these coals, whether station, which my firm put down for the London, Chatham, and Dover Railway at Victoria Station in 1883. These boilers had copper fire-boxes, and, on test trials, gave an evaporative efficiency of 8½lb. to 9lb. of water per lb. of Welsh coal. This type is in most respects satisfactory; but, on account of the level of the grate bars being so much below the level of the fire doors, it is difficult to propely clinker the fires—so much so that when a batch of coal is used that contains much clinker it is very difficult to clean the fires in a reasonable time, so that the evaporative efficiency is thereby much reduced. From this cause the average efficiency of locomotive boilers does not much exceed 7lb. of water per lb. of coal when taken from the monthly bills, and under the conditions usually met with in supply works. It is also not an easy matter to bank the fires of a locomotive boiler in an economical manner.

The St. James and Pall Mall Company have used large boilers of this type made by Davey, Paxman and Co.; and the Metropolitan Company have used others made by Hornsbys—all, I believe, with good results. I, however, have been unable to obtain the correct evaporative duty. This type of boiler is rather more costly to maintain than the other types; the fire-door ring is liable to give trouble from leakage, and a great deal of space must be wasted in order to give access to the smoke-box end of the boilers for tube-sweeping purposes.

V. (*a*).—Table showing Number of British Thermal Units in One Pennyworth of Fuel of various Qualities and Prices.

Price of Fuel in Shillings per Ton of 2,240 lbs.

British Thermal Units per lb. of Fuel.	5/-	6/-	7/-	8/-	9/-	10/-	11/-	12/-	13/-	14/-	15/-	16/-	17/-	18/-	19/-	20/-	21/-	22/-
10000	373300	311000	266666	233333	207407	186566	169600	155555	143589	133333	...	...	...	...	...	...	...	...
10200	380800	317200	272000	238000	211600	190400	173100	158600	146500	136000	126900	...	...	...	...	...	...	...
10400	388300	323400	277300	242700	215700	194100	176500	161700	149300	138600	129400	121300	...	...	...	...	...	...
10600	395800	329700	282700	247300	219850	197900	179900	164900	152200	141300	131900	123700	116500		...	...	...	...
10800	403300	335900	288000	252000	224000	201700	183300	167900	155100	144000	134400	126000	118600	112000	...	...	...	...
11000	410800	342100	293300	256700	228100	205400	186700	171100	157900	146600	136900	128300	120500	114100	108000	...	...	...
11200	418200	348300	298700	261300	232300	209100	190100	174200	160800	149300	139400	130700	123000	116200	110000	104500	...	...
11400	425700	354600	304000	266000	236400	212900	193500	177300	163700	142000	141900	133000	125200	118200	112000	106400	101300	...
11600	433200	360800	309300	270700	240600	216600	196800	180400	166600	154600	144400	135900	127300	120300	114000	108300	103100	98400
11800	440600	367000	314700	275300	244600	220300	200200	183500	169400	157300	146900	137700	129600	122300	116000	110200	104900	100100
12000	448100	373200	320000	280000	248800	224000	203600	186600	172300	160000	149400	140000	131800	124400	118000	112000	106700	101800
12200	455600	379400	325300	284700	252900	227800	207000	189700	175200	162600	151900	142300	133900	126500	120000	113900	108400	103500
12400	463000	385700	330700	289300	257100	231500	210400	192800	178100	165309	154300	144700	136200	128500	121700	115800	110200	105200
12600	470500	391900	336000	294000	261200	235200	213800	195900	180900	168000	156800	147000	138100	130600	123600	117600	112000	106900
12800	478000	398100	341300	298700	265400	239000	217200	199000	183800	170600	159300	149300	140500	132700	125700	119500	113800	108500
13000	485400	404300	346700	303600	269500	242700	220600	202100	186700	173300	161800	151700	142800	134700	127500	121400	115600	110300
13200	492900	410600	352000	308000	273700	246400	224000	205300	189500	176000	164300	154000	145000	136800	129560	123200	117300	112000
13400	500400	416800	357300	312700	277800	250200	227400	208400	192400	178600	166800	156300	147100	138900	131750	125100	119100	113700
13600	507800	423000	362700	317300	282000	253900	230800	211500	195300	181300	169300	158700	149400	141000	133500	127000	120900	115700
13800	5[illegible]5300	429[illegible]00	368000	32[illegible]000	2[illegible]6100	257600	234200	214600	198200	184000	171800	161000	151500	143100	135750	128800	122700	117100
14000	522800	435400	373300	326700	29[illegible]00	261400	237600	217700	201000	186600	174300	163300	153700	145200	137500	130700	124400	118800
14200	...	441700	378700	331300	294400	265100	241000	220800	203900	189300	176800	165700	156000	147200	139500	132500	126200	120500
14400	...	...	384000	336000	298600	268800	244400	223900	206800	192000	179200	168000	158100	149300	141500	134400	128000	122200
14600	...	...	...	340700	302700	272500	247800	227000	209600	194600	181700	170300	160300	151400	143500	136300	129700	123900
14800	.	...	...	...	306900	276200	251200	230100	212500	197300	184200	172700	162500	153400	145500	128100	131500	125600
15000	...	...	...	...	...	280000	254500	233200	215400	200000	186700	175000	164700	155500	147200	140000	133300	127300
15200	...	...	...	...	...	...	257900	236300	218200	202600	189200	177300	166900	157600	149100	141900	135100	129000
15400	...	...	...	...	...	...	...	239400	221100	205300	191700	179700	169100	159600	151000	143700	136900	130700
15600	...	...	...	...	...	...	...	...	224000	208000	194200	182000	171300	161700	153000	145600	138600	132400
15800	...	...	...	...	...	...	...	...	...	210600	196700	184300	173500	.63800	155000	147500	140400	134100
16000	...	..	...	...	...	...	...	...	...	...	199200	186700	175700	165800	157000	149300	142200	135800

large engine coal, nuts, or engine slack, only contain from 50 to 70 per cent. of carbon in the solid form; so that, although on account of the thermal unit contained in the combined carbon and in the hydrogen, these fuels, when tested in the calorimeter, may give a calorific efficiency approaching that of the anthracite and Welsh coals, yet we find very rarely that any form of furnace now in use is able to utilise any considerable percentage of these hydrogen units, even when the best of the modern automatic stoking apparatus is used. So that. when judging the comparative value of these fuels, we should always remember that it is far more difficult to obtain a high boiler efficiency from these latter fuels than from those which contain the larger percentage of carbon in the form of coke. In order that you may conveniently calculate the T.U. contained in a pennyworth of coal of various qualities and prices, I have prepared Table V. (*a*), which shows this at a glance for all fuels from 10,000 up to 16,000 B.T.U. per lb., and for all prices from 5s. up to 22s. per ton.

Fuel and Water.—Divs. 1 and 2.—Boilers, Economisers, &c.

The boilers which have hitherto been chiefly used in electric supply works have been of the locomotive, marine, or semi-marine tubulous, or Babcock and Wilcox type, and the Lancashire type.

Locomotive Type.—Several large locomotive boilers were put in by Mr. W. H. Maw for driving the *Daily Telegraph* printing works, and the success of these was so great that I asked him to design for me boilers of the same type for the first London central

The Marine and Semi-Marine Type.—The marine type has been used in a few instances, notably in the Whitehall Court station of the Metropolitan Company, and is highly economical; but it is a rather costly boiler to construct. Equally good results may be obtained from the semi-marine type, which is a modification of it, made by Messrs. Davey, Paxman and others, which they call the "Economic" boiler; in this boiler the flues are carried right through from front to back, and the products of combustion are deflected back through the tubes by a firebrick back. In Scotland this boiler is called a "dry-back" boiler. It has many merits: it is very simple, and easily repaired; the intensely heated "dry-back" acts as a very good smoke preventer, so that Midland steam coals can be used without producing smoke, which is not the case with either the locomotive or Babcock's type. Prof. Kennedy has used a large number of these boilers for the Westminster Supply Company, and, he tells me, with uniformly good results from every point of view. The test of this boiler given in Table IV. shows it to be of the highest efficiency. I have not personally had much experience in its use until quite recently at the new central station in Shoreditch for the Great Eastern Railway. The sole fault in this boiler (and it is not a great one) is the rather awkward position of the smoke-box over the fire door.

Babcock and Wilcox Boilers.—These boilers, as you well know, consist of a large group of inclined tubes, having the water inside the tubes, the highest end of the tubes being at the firing end of

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the boiler. The tubes are connected at both ends by special headers to steam drums placed overhead. The firing is carried on on large grates, and the products of combustion are deflected by fire-tile bridges so that they are obliged to follow a serpentine course through the tubes, the hot gases passing several times transversely to the tubes. My experience in the use of Babcock boilers has been altogether satisfactory, and I believe that the best evaporative efficiency yet obtained in supply works has been with these boilers. I make this statement all the more readily as in my 1891 Paper* I said that this class of boiler, presenting as it does such considerable radiating surface of brickwork, would not give such economical results during the long hours of standing with banked fires as other boilers which are internally fired; but since that date the skill of the designers, and the great skill and attention of the users, has resulted in so minimising these losses that I believe these boilers stand quite at the head of the list, not only as regards economical working on full-load tests, but also in the small use of fuel when standing banked. These are my own observations, but I understand that the experience of others has been equally satisfactory, at least wherever Welsh, anthracite, coke, or other smokeless fuels are used. I am told that when used with smoke-producing fuel there is a tendency for the lower row of tubes to cool down the products of combustion, that these tubes become coated with soot, and the evaporative result is unsatisfactory. I believe, however, that the makers have now introduced special means to get over this difficulty. The chief refinements that those who use these boilers have been able to introduce, and which have led to reduction in the waste of fuel during long hours of light firing and banking, are principally in the alteration of ash-pit, flue doors, and dampers, so as to regulate the air admission with great nicety, or to completely shut it off. We also find that the maintenance of the fire-tile bridges between the tubes which cause the gases to follow the undulating path above described is a matter of extreme importance; and last, but not least, this boiler should be kept perfectly clean. Up to a few years ago we were content with periodical cleanings and scalings; but now, by the use of suitable boiler fluids and frequent blowing off at the surface as well as at the lower cocks, we find that we can keep the interior of these boilers as free from scale, and in all respects as clean, as when they left the makers' hands. Test results with these boilers have shown that 9¾lb. of water can be evaporated with Welsh coal at 170lb. boiler pressure: if the calorific value of this coal is taken at 15,000, this is equal to 76½ per cent. efficiency; and, as my table of costs will show you, in practice we have reached to within a narrow percentage of this figure, even when all banking coal and other sources of waste are taken into consideration.

Lancashire Boilers.—We are told from time to time that the evaporative efficiency of this boiler ought to be the highest, and its maintenance cost the lowest, of any boiler. I believe the latter claim to be better founded than the former. The boiler is easy to clean, and the repairs should be few at low pressures and far between; but it must be remembered that we have no extended experience of the cost of maintenance of these boilers when used at the higher pressures of 140 to 170lb. per square inch, now so common in electric works—as, for instance, the maintenance of the usual fusible plug is not an easy matter, and it is, therefore, necessary to depend on some form of low-water alarm, which is always a troublesome piece of apparatus; again, although the accidental lowering of the water level of a locomotive or a Babcock boiler, or an "Economic" boiler may have serious consequences, yet these are nothing to what occurs when the flues of a Lancashire boiler come down from this cause.

As regards the evaporative efficiency of the Lancashire boiler, I think it has been somewhat overrated. Owing to the fact that the great majority of Lancashire boilers are in use in the Midland and Northern counties, where the fuel used is cheaper than that we use in London, and where little or nothing is said if smoke is produced, and where low cost of maintenance is of higher importance than high evaporative efficiency, mill engineers have been led to regard this as the one and only boiler; but that this type is not efficient when taken by itself is amply proved by the fact that no first-class mill is ever fitted up without the addition of economisers—in fact, we may say that the Lancashire boiler without its economiser is only half a boiler. In most cases the gases would leave the Lancashire boiler at 700deg., leaving 300deg. to be taken out of the gases by the economiser; whereas in tests of the locomotive, marine, semi-marine, or Babcock boilers the gases leave the boiler itself at a temperature very slightly in excess of that of the steam; so that in this latter case an economiser would be a refinement and not a necessity. I do not think this fact has been sufficiently brought home to us engineers when the merits of the Lancashire type of boiler have been so persistently put before us by outside engineers, so that many of us—myself included—have made the mistake of putting down Lancashire boilers for supply stations in country towns without economisers, thinking that if we made these boilers large for their work we should get the required economy, whereas with this type the only way to get high economy is to use a rather small boiler and a large economiser. At any rate, the electric works using Lancashire boilers have hitherto not shown at all well in comparison with other types. In towns where the fuel is obtained so near to the works that the cost of carriage is small compared with the actual cost of the fuel itself, it pays to put down boilers fitted with special stoking plant to deal with these inferior fuels. In most of these cases Lancashire boilers have been used, but, as I shall show hereafter, the results hitherto obtained from the use of such cheap fuel have not been very satisfactory; in fact, the very cheapness of the fuel itself has been a snare to the works engineers, causing them to neglect refinements in fuel economy to such an extent that in many cases the greater part of the saving which they ought to have shown from the low price of their fuel has been lost. In some cases the price of their fuel has been actually higher that in the best London works, where economical working has been studied.

It is now time to put before you in a tabular form the data which I have been able to prepare to show the working efficiency of the boiler plant used in 10 of the works which I propose to compare. In all cases the quantity and calorific value of the fuel used is given with sufficient accuracy; but I have not in all cases been able to ascertain the water used per unit with the same accuracy, although this would have been a very desirable check on my other figures.

Table III. shows the actual boiler efficiency observed in these 10 works; I have designated them by letters, which enable you to identify them, in the following tables:—

TABLE III.—*Boiler Efficiency.*

Works.	System.	Type of boiler.	Fuel.		Lbs. of fuel per unit sold.		Lbs. of water evaporated per lb. of fuel.	Efficiency of boiler per cent.
			Class.	Value in B.T.U.	1892	1893		
E	"Converted" Alternating	Lancashire	Small	11,300	21·0	23·0	4·12	38·0
N	"Direct"	„	„	12,000	17·7	17·1	5·0 ?	43·5
O	„	„	„	12,000	16·6	17·0	6·0 ?	52·0
J	½ "Converted" Alternating ½ "Direct"	„	„	12,000	16·0	14·8	5·2	45·2
I	½ "Converted" Alternating ½ "Direct"	Babcock and Wilcox	Welsh	14,500	14·7	12·0	7·8	56·5
Q	"Direct"	Locomotive	⅔ Welsh ⅓ Coke	...	...	10·2	7·5	54·5
U	„	Babcock and Wilcox	Welsh	14,500	8·9	8·0	7·85	57·0
V	„	Economic	„	14,500	9·9	7·5	8·0	58·0
W	„	Babcock and Wilcox	„	14,500	6·9	5·83	8·5	61·5

TABLE IV.—*Recording Maximum Efficiency of Sundry Types of Boilers at Test Trials.*

By whom carried on.	Boiler.	Fuel used.		Lbs. water evaporated.		Efficiency per cent.
		Description.	Cal. value.	From and at 212°.	From 170° to 150°.	
J. F. Crossland.	Lancashire	Lofthouse unscreen'd nuts	12,875	7·74	...	56·5
„	With McPhail & Simpson's superheater	„ „	12,723	10·05	9·3	76·3
J. Holliday, at Messrs. Bryan Donkin's Wrks	Perret's grate with Lancashire	Welsh small	16,734	9·96	9·2	65·9
„ „	„ „	Coke dust	8,400	6·02	5·5	69·3
Prof. Robinson, at St. Pancras	Babcock and Wilcox	Welsh	15,000	11·9	11·0	76·5
Prof. Kennedy, at Glasgow	Marine type......	Coke	12,120	7·91	7·3	63·0
Prof. Kennedy, at Eccleston-place	Semi-marine type	Welsh	14,866	12·2	11·25	78·0
Prof. Kennedy, Nov. 26, 1888	Thornycroft water-tube boiler	,	14,900	13·4	12·4	86·8

* *Proceedings* Inst.C.E., Vol. CVI., p. 2.

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In all the tables they are arranged in the actual order of fuel economy, F showing the largest consumption of fuel per unit sold, and W the smallest.

Table IV. gives the evaporative duty and efficiency of several types of boiler determined at special tests.

I would draw attention to the remarkably high results obtained by Prof. Kennedy, shown on Table IV., in his Glasgow trials, and beg that this result, which was obtained with marine-type boilers using small gas works coke, may be compared with that shown by Bryan Donkin, in Table V., with a Lancashire boiler using similar coke.

Referring to Table III., works J are using Lancashire boilers fitted with automatic stokers of the Vicars type. In this case, which is under my own control, every means has been studied to increase the evaporative efficiency of the boilers; but this is a typical case of the difficulties attending the use of small coal, even if it be of a fairly high calorific value. In this case a considerable part of the loss is due to the small coal falling through the bars. The coal supplied is of variable caking quality: sometimes it cakes together sufficiently to reduce this loss; in other cases it hardly cakes at all, and from 15 to 20 per cent. of the combustible is lost. The point I have above referred to of the extreme difficulty of utilising the heat units in the hydrogen is here met with. If the air admission is not managed with the utmost nicety, the losses due to over-dilution of the products of combustion by air become so great that the evaporation is largely diminished, and this without any apparent neglect on the part of the stoker.

Before leaving the subject of boilers, I ought to say a few words on the use of forced draught. A good many of us have formed the opinion that one of the best methods of meeting the short period of heavy load is by the use of forced draught applied to a closed ash-pit, as has been done by Meldrum and others. It is evident that existing boiler plant might in case of emergency, or for short periods, be forced to evaporate 50 per cent. more steam than at present; and this would be particularly convenient to meet the times of maximum load, so that in this way the waste of fuel due to lighting up extra boilers for these short periods might be reduced or altogether avoided. We should also be able to burn small or finely-divided, and hence cheaper, fuel during the times of light load in an efficient manner. Another method of reducing the cost due to the necessity of lighting up additional boilers for the period of maximum load would be by using liquid fuel, to be used only on emergency, or during these periods of maximum load.

As is well known, Mr. Holden, on the Great Eastern Railway, has been very successful in the use of astatki, or crude petroleum, with his works boilers, and on some of the locomotives of the Great Eastern Railway. The principal objection to his system appears to be the noise of the blower, and the same applies to nearly all the systems of forced draught where an injector blower is used; but there seems little doubt that this noise may be minimised by properly arranging the air inlet—that is to say, by drawing the air fom a point outside the building, placed so that the noise at the entrance cannot be a nuisance to the neighbours. As it is evident that it is very easy and convenient to safely store such liquid fuel in deep underground tanks, and as is evident, in face of the troubles we have lately gone through from the coal strike, that it is necessary to have such a considerable storage, this question of the employment of liquid fuel deserves careful attention by all interested in supply works.

There is another point to which I wish to call attention. A long and interesting series of articles has recently appeared on water-tube boilers in the *Engineer*, in the course of which the writer more than once states that it is impossible to force any of the existing types of water-tube boilers, as any such forcing invariably results in the production of wet steam, and consequent loss of economy. It is difficult to know how the writer could have formed such an erroneous impression. My own experience is that the works where the best results have been obtained are those where the Babcock and Wilcox boilers have been forced the hardest. At works W, the boilers, which are nominally supposed to evaporate 11,000lb. of water per hour, have frequently been forced to 16,000, or about 50 per cent. in excess of the duty guaranteed by the makers, and at such times of heavy forcing there has never been any trace of priming or wet steam.

On the whole, I think that there is a fair prospect of improving and supplementing our boiler plant and our methods of working it so that we may obtain in the future an average boiler efficiency of 70 per cent.—equivalent to an evaporation of 10lb. of water at a pressure of 150lb. when using Welsh coal, and an equivalent smaller evaporation from inferior and lower-priced coal.

(To be continued.)

Electric Tramways in Russia.—The municipal council of Nijni-Novgorod has just decided upon the construction of three electric tramways.

THE GLASGOW CORPORATION ELECTRIC SUPPLY.*

BY WILLIAM ARNOT.

The Provisional Order was obtained on August 14, 1890. Lord Kelvin was consulted in October, 1891, and advised supply with a direct current at not more than 200 volts. In November, 1891, Prof. A. B. W. Kennedy was requested to prepare a scheme. A site was obtained in Waterloo-street, at the corner of Mains-street. On Saturday, February 25, 1893, the arc lamps on the principal streets were first lighted, and the current was switched on to the incandescent mains on Saturday, April 22, 1893. The site at Waterloo-street station measures about 31 yards by 31, and contains 972 square yards. The building stands on a layer of concrete 2ft. thick laid throughout the entire block. It consists of the engine room, first floor with offices and workshop, and second floor with laboratory, drawing office, meter room, and cable floor. Behind the main building is the boiler house, with the battery room above it.

Boilers.—These consist of six marine type steel boilers, measuring 12ft. long and 10ft. in diameter, working at a pressure of 160lb. They have each two furnaces of the corrugated type, with an internal diameter of 3ft. The fire grates are 5ft. long. There are 194 wrought-iron lap welded tubes in each, 2¾in. external diameter and 8ft. 6in. long. A smoke box is on the front of each boiler connecting the tubes to an uptake which communicates with the main flue. This is led into the chimney at a height of 15ft. There are no underground flues. Each boiler is covered with 2½-in. composition, and stands on two cast-iron brackets. There are two "Tangye" (steam 7in., water 4½in.) pumps, each capable of delivering 4,800 gallons per hour, either through a Wright's feed-heater or direct. There is an injector connected to the cold feed capable of delivering 5,000 gallons per hour. The water tank has a capacity of 3,500 gallons.

The steam pipes are 7in. and 8in. diameter, steel, lap welded, with wrought-iron flanges screwed and brazed. In the engine room the steam main forms a complete ring, slung by means of rods from cast-iron brackets. Four of the boilers have a duplicate connection to this ring, the remaining two have one connection.

Engines.—These are Willans' central valve compound engines.

Dynamos.—The nine dynamos are two-pole shunt-wound with drum armatures. They are coupled direct to the engines, with a heavy disc to ensure steadiness in the running. The combined plant stands on one sole plate. The total maximum output of the several dynamos is 1,190 units.

The absolute necessity of working without making any smoke has led to the use of gas coke, obtained from the Corporation Gas Works. At a preliminary trial on one boiler, in April, 1893, when working with a very light load, the water evaporated was 27,458lb. in eight hours, 3,770lbs. of coke being used.

Mean boiler pressure, 149lb.
Mean feed temperature, 145°.
Evaporation per hour, 3,432lb.
Actual evaporation per lb. of coke, 7·28.
Reduced to standard ....8·15.

The value of this per unit generated was ·24.

The analysis of the coke showed :—

Moisture	10·68
Ash	10·16
Loss on ignition	79·16

Assuming this to be carbon, it gives 11,416 thermal units per lb. The result of measurement in a calorimeter gave 11,286. It may therefore be taken that the evaporative value of this coke is 11·75 pounds of water under standard conditions.

These figures do not take account of the coke used at night when no work is being done. The trial only lasted for eight hours. An extended test was made by Prof. Kennedy on the 2nd and 3rd of November, when the following results were obtained :—

Total duration of experiments	hours	48
„ Coke put on fires	lbs.	61,900
„ Coke used in boilers of which the stop valves were closed	„	9,260
„ Net coke used for steam	„	52,640
„ Water through meter, allowing for all differences of level	„	378,970
„ Water used while station was shut down	„	16,296
„ Net water used during running hours	„	361,674
„ Electrical work at dynamo terminals	E.H.P. hours	8,991
Electrical work in Board of Trade units, or kilowatt hours		6,708
Pounds of water evaporated per lb. of coke put in fire, actual,		6·12
„ „ „ „ „ „ reduced to standard,		7·38
„ „ „ „ of net coke, actual,		6·87
„ „ „ „ „ reduced to stand.		7·91
Ratio of stand-by fuel to total fuel on fires		14·96 per cent.

* Abstract of a Paper read before the Institution of Engineers and Shipbuilders in Scotland, March 20th.

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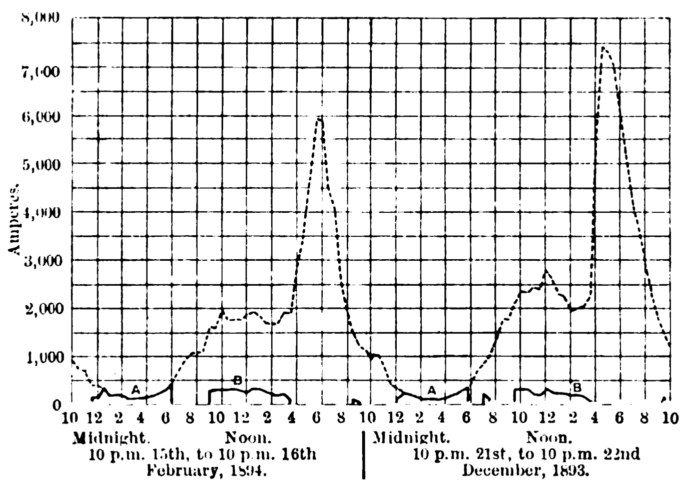
Pounds of water used per unit generated		56.5
" " " net water only		53·93
" " per E.H.P. hour		42·14
" " " net water only		40·2
Pounds of coke put on fires per unit generated		9·23
" net coke used "		7·85
" coke put on fires per E.H.P. hour		6·88
" net coke used "		5·85
Total running hours during the two days		33·75
Mean load during running time	kilowatts	198·7
Maximum load	"	669·4
Ratio of mean to maximum load	29·7	per cent.
Load factor per actual hours and engines	68·4	"
Mean steam pressure, lbs. per sq. inch above atmosphere		151·5

The total coke put on the fires was 61,900, but of this 9,260 was required to supply damped fires and condensation in the steam pipes through the night. The main steam pipe is always under steam for the sake of the joints. The ratio of 14·96 per cent. between these figures is rather high ; the water consumption is much too high. These figures will be improved, faulty traps and drain cocks being responsible for much of the loss.

The engines and dynamos combined show an excellent efficiency. Curves given by the author show that with an engine load factor throughout the station of 50 per cent., or half load, an efficiency of 80 per cent. can be maintained in the generating plant.

Accumulators.—A set of accumulators is placed over the boiler house. This position keeps them in a suitable temperature ; otherwise during the winter they would be affected by frost. The set consists of 114 cells. Each cell has 61 lead plates, with a capacity of 1,000 ampere hours, with a discharge rate of 200. There are six cells as



Load Curves.—Full line curves A. A., Battery Discharge ; B. B., Battery Charge.

repair cells, or, as they are sometimes called "milkers." From these plates are taken to replace faulty ones in the working set, and should a cell show any weakness it is not allowed to discharge for a day, but is short-circuited by two "milkers" in series. It has thus four volts across it.

Distribution.—The distribution begins practically at the switchboard. The current is generated at from 210 to 230 volts, and is kept constant at the feeding points at 205, or 102 on each side of the system. The balance is maintained in the station by means of two 100-volt machines. The difference in current between the two sides does not generally exceed 200 amperes at any load. Exceptional nights have been known, such as 650 amperes, when both machines had to be run on the one side.

I have put before you (see Figure) curves showing one of the heaviest days, and one of last month, which shows a falling-off. I have noted the ratio between the amperes of current applied for and the maximum output. In December it was 54·3, and in February 37·1. The real efficiency of running is shown in the plant load factor, which in February was 68·5 per cent. It has been as high as 71 per cent. This factor is the ratio between the output and the possible output if the machines were run full load from the time each one is started till stopped. This is the percentage that tells on the costs of running, fuel, water, oil, &c.

The lamp connections have progressed in a fairly steady way. October has the largest number of applications. The maximum output has not reached more than 54 per cent. of the total lamps wired.

The underground work in the streets is, I presume, pretty well known to you. The copper strip is laid on porcelain insulators in iron culverts, which are water-tight. I do not mean that under a pressure they would keep out water, but owing to their construction, the lids overlapping the culverts, the ground in which they lie must be flooded before the water could rise high enough to enter through the seam. I have never known an instance of water in the culverts. Water does collect in the brick junction boxes, especially in Bath-street, and districts where we have heavy clay soil. Provision is made in all such for their thorough drainage. Where it is not possible to lay copper strip, indiarubber covered cables have been laid in cast-iron pipes.

There are, generally speaking, three wires on each side of the street ; in some cases there are only two wires, positive and middle on one side, negative and middle on the other. Where strip is laid, the positive is always next the building, and the negative always outside. Where cable, the positive is painted blue, middle white, and negative red. The entire network is connected together throughout the city, positive to positive, middle to middle, and negative to negative. There are only two conductors to each feeder, one positive and one negative. The middle wire is brought back to the station from several points, and has a sectional area of 1in. at the station.

Faults in the underground mains are easily found by means of a compass needle. The needle is placed on the faulty conductor and brought to be parallel with it by means of a strong directing magnet. The other conductor is flashed to earth, and the direction of the excess current due to the fault is noted. In this way it is easily traced. Nearly all the faults are caused by careless workmen.

There are now 382 consumers, who have applied for a current of 15,487 amperes, which represents roughly 46,460 8-c.p. 33-watt lamps, distributed somewhat as follows :—

—	Shops.	Warehouses.	Offices.	Churches	Private houses.	Clubs, hotels & theatres.
No.	242	21	91	3	12	13
Amperes	7,776	2,680	3,629	229	275	1,256

CORRESPONDENCE.

A UNIVERSAL SHUNT-BOX.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The writer of the "Editorial Notes" in your issue of the 20th inst. is apparently compelled to admit that this form of shunt-box has some important advantages, a conclusion somewhat different from that to which an ordinary reader would be led by your article of the 6th inst. But he endeavours to explain away the errors observed when using ordinary shunts, and in so doing makes several mistakes.

In the first place, he assumes that the galvanometer with which the tests given on page 695 of your last issue were made (and which showed errors of 4 per cent. and 11 per cent. when used for condenser tests with the ordinary shunts) had "a serious amount of damping," and was "therefore badly suited for ballistic purposes." Secondly, he states that the error made in measuring the ratio of two steady currents can quite easily be attributed to slight want of proportionality between the deflections of the galvanometer and the currents producing them." Both these statements are incorrect.

As a matter of fact, the galvanometer in question was an excellent ballistic one, specially constructed for condenser work, and in the first condenser experiments quoted, had a logarithmic decrement of only 0 053. This, as anyone knows, is far from being "a serious amount of damping," especially for comparative tests such as tho·e under discussion ; and yet the apparent ratio of the capacities obtained by using the ordinary $\frac{1}{99}$th shunt was wrong by 4 per cent. What *is* "serious," however, is that with the ordinary form of shunt, *the act of shunting the galvanometer alters the damping*, and (unless this alteration is determined and allowed for) leads to incorrect conclusions. With the "universal shunt" the damping is independent of the shunt used, and, as shown in the figures above referred to (*see* p. 695), gives results practically right without the necessity of determining and making any correction whatever.

Coming now to the second statement, that the error in comparing the two steady currents can be attributed to want of proportionality, it is easy to see that this cannot possibly be the true explanation. For since the second current was 100 times the first, it follows that if the resistance of the $\frac{1}{99}$th shunt had been exactly $\frac{1}{99}$th that of the galvanometer, then

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the two deflections would have been exactly the same whatever the law connecting deflection and current. The fact of the two deflections not being identical, absolutely proves that the resistance of the shunt and galvanometer were not in the ratio 1 to 99, although the conditions for promoting equality of temperature between the copper-wound shunt and the copper-wound galvanometer were (as pointed out by Prof. Ayrton at the meeting of the Institution of Electrical Engineers on the 12th inst.) exceptionally favourable.

Thirdly, I am quite at a loss to understand why "The selection of a shunt which happens to give a ratio of 99·63 for purposes of comparison was unfortunate, and greatly reduces the value of the experiments." Surely, the two first letters in "unfortunate" should be deleted, and the word "reduces" replaced by "enhances." As a matter of fact, the two currents in the ratio of 100 to 1 were chosen as being two widely different currents whose relative strengths we could conveniently measure with great accuracy, and the $\frac{1}{99}$th shunt was purposely used in the comparison by the ordinary method of shunting, *so as to eliminate all possible error that might otherwise result from want of proportionality of the galvanometer.* Had we not made this so-called "unfortunate" selection (or something equivalent) the tests would merely have amounted to a relative calibration of the galvanometer, whereas our sole object was to test the relative merits of the two methods of shunting. It was therefore essential to arrange the experiments so that *the shunts*, and *not the galvanometer*, were placed under test, and this was done in a very satisfactory manner by the method adopted.

Referring to the question of alteration of the resistance in the circuit produced by shunting, your criticism is correct. But with the usual shunting ratios $\frac{1}{10}$th, $\frac{1}{100}$th, and $\frac{1}{1000}$th, it is to be noted that for all values of r (the resistance permanently shunting the galvanometer) not exceeding 20·4 times the resistance of the galvanometer, our original statement holds good, viz., that altering the plug of our shunt-box produces *less* change in the resistance of the circuit from its original value, than if an ordinary shunt-box be employed.—Yours, &c.,

T. MATHER.

ELECTROSTATIC ERROR IN ELECTROMAGNETIC INSTRUMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In referring to this subject in your Editorial No es last week, you say that you "incredulously stroked the glasses of both instruments with a finger," but found no deflection in either case. May I suggest that perhaps your "incredulity" might have something to do with the failure of the unvarnished instrument to respond to the touch. But, joking apart, there is not the slightest doubt that merely stroking the glass with the finger will produce the effect stated in the Paper, and it is not at all necessary that the glass should be "rubbed briskly, if not violently, with a handkerchief," to deflect the pointer, for many times I have produced a deflection of 80 volts or more on the unvarnished 100-volt instrument, by a *single* stroke of my *finger* across the glass, without either the glass or my finger having been dried or specially prepared in any way whatever. In some cases the instrument had been standing on a bench in the laboratory of the Central Technical College unused and untouched for several days previous to the test, and the glass had become quite dusty. Not only have I obtained this result, but Prof. Ayrton and several of our students and staff have done likewise. Further, it is a well-known fact that certain voltmeters in central stations can be deflected by a stroke of the finger on the glass. For example, little more than a week ago the engineer in charge of an important low-pressure central station begged me not to stroke the glass front of one of the voltmeters on the switchboard, for he said that he could not be sure of its readings for five or ten minutes after it had been touched.

To give another instance, an electrical engineer of considerable experience informed me that he had returned a voltmeter, which had been fixed with an isolated plant, to the makers several times, with the complaint that it was vague and inaccurate. Each time the makers, after testing it, said the instrument was quite correct. Eventually the vagueness and inaccuracy were found to arise from the attendant taking a pride in his engine-room, and keeping his instruments clean, thereby electrifying the glass and producing the errors complained of.

Sticking gold leaf on the glass, as suggested by the "engineer of unusually large experience," whose letter you quote, will, of course, prevent the error; but this remedy has the serious disadvantage that gold leaf, not being transparent, the pointer is mostly hidden behind an opaque sheet. Now, the conducting varnish (not "hygroscopic varnish," as you term it) is not only as effective as gold leaf in preventing electrostatic action, but, being quite transparent, allows the whole length of the pointer to be seen.—Yours, &c.

T. MATHER.

ROLLASON'S WIND MOTOR.

TO THE EDITOR OF THE ELECTRCIAN.

SIR: We thank you for your notice in last week's issue. Your paper being an influential one, we hope you will allow us to correct some statements relating to the cost per horse-power. I take the figure 3-H.P. for 10 hours per day, this gives us a total of 30-H.P. per day. Assuming the light is required for three hours per day, a gas engine to accomplish this (direct lighting) would have to be of 10-H.P., working for three hours, thereby bringing the cost up to more than our motor (in addition to the cost of gas). I am taking summer breezes and lighting, as in the winter the winds are stronger, and consequently the motor developing more power.

We are completing our price lists, which compare favourably with other motors in the market, and are at present in a position to make them up to 20-H.P.

Thanking you, in anticipation of insertion.—Yours, &c.,

GEO. R. ROLLASON.

13, Berners-street, Oxford-street, W., April 25, 1894.

AMERICAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

NEW YORK, *April* 13, 1894.

General Electric Company.—This concern has issued its annual report, which shows a sad state of affairs, a shrinkage of assets of no less than \$12,450,000 being confessed, as against a surplus of over \$1,000,000 a year ago, and a surplus (that of the separate companies) of \$9,278,000 two years ago. Among the assets, patents and franchises are valued at \$8,159,264, though but few have any real value and these but a short life remaining, while the expenses which they have entailed in litigation have made them a burden rather than a source of profit. Of the other assets, amounting in all to \$25,300,000, \$4,200,000 are represented by manufacturing plant and real estate, \$5,500,000 by stock and bonds of manufacturing and local companies, \$4,800,000 by manufacturers' stock and material, \$8,900,000 by notes and accounts receivable, and the remainder by cash (\$591,000) and the value of work in progress. The liabilities consist of stock, \$34,711,000, debenture bonds and interest on same, \$10,083,000, notes and accounts payable, \$1,067,400, and sundries \$65,000.

The Niagara Plant.—No action has yet been taken for the transmission of power from Niagara though a half-dozen subsidiary companies have been formed for that purpose. One of these, on the plea of propelling canal boats by electricity, obtained a franchise, by corrupt political methods it is charged, permitting it to use the tow path and lands of the Erie Canal, which are owned by the State of New York, for the purpose of laying conduits and erecting buildings for the distribution of electricity. It now seems that the terms of the franchise are such that the grantee can erect generating stations anywhere on these lands, and thus compete in this manner with the scores of central stations now established in towns along the line of the canal. This is an example of the dangers to which legitimate business enterprises in the States are subjected through the power of corrupt politicians.

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LEGAL INTELLIGENCE.

Wise v. Metropolitan Electric Supply Company (Limited).

The hearing of this case was resumed before Mr. Justice Stirling, on Wednesday. Counsel engaged in the case were:—Mr. Graham Hastings, Q.C., and Mr. Beaumont for the plaintiff; and Sir Richard Webster, Q.C., Mr. Phipson Beale, Q.C., and Mr. Vernon Smith for the defendants.

Sir RICHARD WEBSTER referred to the decision of Mr. Justice Kekewich in the case of Shelfer and Meux's Brewery Company against the City of London Electric Lighting Company, and said that that learned judge held that the liability of the Company with regard to nuisance still existed, but he would not grant an injunction under the circumstances of the case. He (Sir Richard) would show his lordship that they had an even stronger case against an injunction than had the defendants in the other action.

Mr. JUSTICE STIRLING said, unless there was something to distinguish the legal aspect of this case from the case referred to, he should feel bound to accept Mr. Justice Kekewich's construction of the law as to the liability.

Sir RICHARD WEBSTER said the question of law was the same, but his clients had an even stronger case as against an injunction. He then called

Mr. STEPHEN BABINGTON BARLOW, solicitor, member of the firm of Messrs. Barlow and James, solicitors to the defendants, who said he had a conversation with Mr. Hunt on June 1, 1892, and he made notes at the time of the substance of the conversation. Mr. Hunt said, in his opinion, the site at South Mews was the most suitable of any place between Oxford-street and Marylebone-road. He himself and the Vestry Clerk desired to have the Company in the parish. He further said the site had been occupied by a filthy mews behind small and old property. Mr. Hunt did not make the slightest suggestion that he did not approve of the site, or that it was not a proper site; nor did he say that he objected to White assigning his lease to the Company.

Mr. FRANK BAILEY, engineer to the defendant Company, said he was appointed to that position on October 1, 1889. Mr. Gordon had prepared the plans for the erection of the station, and he (witness) superintended the construction of the works. The question of possible vibration was most carefully considered, and no suggestion made with the view of preventing it was rejected without consideration. It was decided at first that the foundations should be a brick bed set in cement and resting upon a layer of felt, which, in turn, was placed upon sheet lead, whilst underneath that again were two or three feet of concrete. The foundations were perfectly isolated from the surrounding walls. The whole cost of the station, excluding the laying of the mains, was probably over £80,000. The first complaint, so far as he knew, was from the houses on the east side, and those houses were acquired by the Company, who put in the wiring for electric lighting, and let them to new tenants. So far as he knew, no complaint had been since received. Witness took two bedrooms and a sitting-room at No. 9, Manchester-street, and occupied them conjointly with Mr. Hick, from the beginning of January until about the middle of February. At that time four engines were running at the station. He made numerous experiments, but could never detect anything in the shape of vibration. Mr. Gillam, of whom these rooms were held, said he had not noticed any vibration, and the works had been no nuisance to him. He (Gillam) said he believed Mangan, the tenant of the houses purchased, had only complained in order to compel the Company to purchase. The houses were well kept up; but it was quite clear that they were not well-built. After receiving complaints from the immediately-adjoining houses, they carefully examined all the steam-pipe connections in the station, and made every provision they could think of to isolate all portions of the moving plant from the surrounding walls. It was suggested that the connection with the exhaust pipe might tend to increase the vibration, and that connection was cut off at the point where it left the engine, the joint being made good again with a copper sleeve. It was further suggested that the exhaust of the vapour from the top of the shaft set up pulsations in the surrounding atmosphere, and in order to counteract that a fan was applied, which blew air under pressure into the base of the exhaust pipe, but no difference was found in the working, and that led him to the conclusion that there was nothing in the suggestion; the fan itself caused far more disturbance outside the station than anything else. As the speed of the exciting-engines was rather high, it was decided to reduce it to the extent of 20 per cent. In 1892 complaints were received from the houses on the west side of Manchester-street; he could not at first believe that there could by any possibility be any vibration there, but after visiting the houses several times he did detect a slight tremor in No. 43. He reported the matter to his Board, and was instructed to do everything possible to remedy the trouble. He came to the conclusion that the only cause of the vibration was the presence of some sensitive communicating medium in the subsoil. He therefore sunk a bore-hole to learn something of the nature of the strata. Down to a depth of 25ft. he found a spongy clay which was more like mud than clay; at a depth of 25ft. he found what at first was supposed to be a layer of gravel, but which was afterwards discovered to be claystone. Below that claystone they came to very hard dry blue clay. This at once revealed the cause of the trouble, that they were resting upon a compressible bed. Witness submitted a plan showing a method of sinking pillars or columns down to the hard clay, and to brace the tops of the columns by a system of girders, which would form a platform upon which the engines would work. This plan was adopted, and the columns were sunk. They tested at the base of the column to ascertain whether the clay upon which they rested was really incompressible, and incapable of transmitting vibration downwards. When the columns were constructed, and after a complaint had been received from Mr. Wise, he made experiments with a beam and pencil, and found that there was a lateral movement. He then prepared plans for sinking and tieing together two diagonal struts or raking piles. It was clear from their observations that the vertical columns were not sustained by the material through which they were sunk; the clay was too soft to afford sufficient support to keep them rigid, and the function of the struts was to afford that rigidity which they could not otherwise obtain. One pair of struts had been sunk, and it was proposed to sink another pair at the north end of the engine-house. The cost of these remedial works was, up to the present, about £2,000. They were also sinking a trench on one side of the premises to the depth of 12ft., the effect of which would be to cut off any tremor on the surface, but would not cut off the lateral movement for the prevention of which the diagonal struts were put in. They thought it advisable to increase the rigidity of their engines by tieing together the top of the cylinders of the engines with the side of the alternators. From observations he had made, he should say the vibration observable was less in times of frost, if, indeed, there was any at all then. They used at the station the best Welsh steam coal. At the time of the coal strike the coal merchant could only obtain bituminous coal, which caused smoke. He had made observations to see what amount of smoke and dirt came from surrounding property, and the result was appalling. Within five minutes a piece of varnished cardboard 2ft. square was completely covered with smuts. He was at present making experiments with the view of reducing the noise from the machinery, but had not yet found the best remedy to apply. When the other works were completed they would, if the experiments were not successful, make such structural alterations as would lessen the effect of the noise outside by constructing double roofs, and other changes of a similar kind. They supplied 236 shops, 702 private houses, 6 churches, 4 public halls, and 21 hotels and public-houses, and they had further applications coming in every day.

Cross-examined by Mr. Graham Hastings: He did not say the nuisance was now entirely got rid of, but he believed it would be when the struts now being constructed were completed, which would probably be in about two months' time. He had in his first affidavit stated it as his opinion that the putting in of the vertical columns would prevent any vibration. He was prepared, if necessary, to clear out the intervening soft, spongy clay, but that was not contemplated in the works now proceeding. The trench had been completed for more than a month.

THURSDAY, APRIL 26.

On Thursday morning the cross-examination of Mr. Frank Bailey was resumed by Mr. Beaumont. Witness thought the lateral vibration at the top of the vertical columns was not more than two millimetres, or one thirty-second of an inch. If only one strut were used for the purpose of stopping lateral vibration the horizontal position would be the best, but with two struts tied together at the apex of the triangle, the bases being firmly embedded in the hard clay, the angle of 30deg. from the vertical or 60deg. from the horizontal was quite as useful. He accounted for the variation in length of the vibrations, as shown by diagrams put in of observations at plaintiff's house, by the variation in the speeds of the seven engines. The incidence of the vibration was of an extraordinarily erratic character; at the same time that it was very apparent in Wise's house it might be scarcely observable in the house next door, and sometimes it was greater on one floor, and at other times greater on another. He would not say that the evidence of Prof. S. P. Thompson and other witnesses as to the vibration was inaccurate or exaggerated, but slightly coloured. There was "artistic colouration" perhaps on the part of Prof. Thompson. In the latter part of the summer of 1891 cracks developed themselves in the chimney at the works, and the shaft was hooped and rebonded, but he did not come to any conclusion as to the cause of the cracks. It would be a very difficult matter to clear out the whole of the spongy clay under the engine foundations, and either fill it up with concrete: it was merely a question of time and expense, but it would not be a ruinous expense. Some part of the district now lighted from the Manchester-street station might be supplied from the Paddington station, but the whole district could not be transferred without their going to a great deal of expense in putting in new machinery of a special type. It had been intended to replace the present engines by engines of slower speed, but he had found it impossible to get alternators to suit the proposed new conditions

Prof. A. B. W. KENNEDY said he had been consulted by the defendant Company with regard to complaints as to the works at Manchester-street. He visited Mr. Wise's house at a quarter past six one evening in November last year. Seven engines were running at the time at a speed of 350 revolutions per minute; two exciters were running on the load and one was running light. On the second floor front he distinctly felt a vibration with a slow and irregular period, from four to eight per minute. In other rooms he also noticed slight tremors. The vibration was greater in the back room of the third floor in Wise's house than in any other room in that or any other house he visited. The houses were old ones, and he had no doubt if they were rebuilt and put up properly there would be no vibration. He did not hear any noise in houses on that side of the street. He visited other houses than that of Wise, but found the vibration much less, and in some cases not at all. The hum of the alternators was perceptible in some of the nearer houses. He went again on a later occasion, and had similar experiences. Prof. Thompson was present upon each occasion. With regard to the means adopted to nullify the effects of vibration, he quite approved of them. He was not prepared to suggest that the removal of the spongy clay and the substitution of concrete would be an improvement upon the triangular struts; in fact, he preferred the stiffening by means of the struts.

Cross-examined by Mr. Graham Hastings: As an addition to the struts a block of concrete might be of some use in minimising the tendency to vibration; but the combination of these two means would present a very

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great engineering difficulty, and would also involve a difficulty in the running of the station.

Dr. JOHN HOPKINSON stated that he had made a personal examination *in situ* of the clay formation in which the vertical columns were embedded, and found it as hard and firm a base for a foundation as could be had anywhere. He thought it was most probable that the diagonal columns, when completed, would completely remove the vibration. He did not approve of the suggestion of filling up the void, if the soft clay were removed, with concrete, for the height would be so great in comparison with the width of the block as to make it of little use. Slower engines would probably diminish the vibration, but, on the other hand, would cause more noise.

Cross-examined by Mr. Hastings: Even if it had been known at the outset that this layer of soft clay was present, he did not know that he could say the site was a bad one. With that knowledge to begin with, they might have taken steps of a similar character, though at a lesser expense, to those which had now been taken.

Mr. ROBERT WALKER, F.R.I.B.A., District Surveyor for St. Martin-in-the-Fields, stated that he was employed by the defendant Company to prepare the plans for the buildings for their central station at South-mews, Manchester-street. He submitted the plans to Mr. Hunt, Lord Portman's agent, and explained them to him. A question was raised as to whether there might not be a nuisance caused by the smoke, but witness showed the means which would be taken to prevent any nuisance from that cause, and he raised no further objection. Mr. Hunt never suggested that the site was an inappropriate one for the works.

Cross-examined by Mr. Hastings: Mr. White (the original lessee under Lord Portman) and himself had a trial hole made to ascertain the nature of the soil. They sunk down to about 14ft. near the chimney shaft, getting on to the spongy clay. They built upon that, putting in a bed of concrete. It was quite enough foundation for any building. There was very little water in the clay at the time the trial hole was sunk.

Re-examined by Mr. Phipson Beale: It was summer time when his trial hole was made, and the clay was fairly hard, but it was of a saponaceous character, which would become soft and spongy with the addition of water.

This concluded the evidence. A brief discussion took place as to whether it was necessary to address his Lordship upon the Electric Lighting Act 1882, and the Provisional Order, or whether his Lordship would follow the decision of Mr. Justice Kekewich in the Meux and City of London Electric Lighting Company case. Mr. Beale read the decision of Mr. Justice Kekewich upon the point of law, that learned judge having held, as reported in *The Electrician* last week, that there was nothing in the Act or in the Order which would exempt the undertakers of electric lighting works from the liability to an action for nuisance. Subsequently Mr. Beale addressed the Court upon the evidence, and contended that it did not reveal a sufficient interference with the ordinary enjoyment of the premises to entitle the plaintiffs to maintain an action for an injunction. If there was any annoyance at all it was of the slightest character, and such as might reasonably be caused having regard to the general requirements of the neighbourhood in modern times as compared with the period at which the leases were granted to the complaining tenants.

The Court adjourned for the day upon the conclusion of counsel's argument.

Alabaster and Another v. Harness.

This case came before Mr. Justice Hawkins and a Special Jury on Monday and Tuesday last. The defendant was the Managing Director of the Medical Battery Company (Limited). The plaintiffs alleged that in 1892 a certain Dr. Tibbits brought an action for libel against them; and that the defendant unlawfully and maliciously, and without reasonable or probable cause, and without having any interest in the action, advised, procured, and instigated the said Herbert Tibbits to commence and prosecute the action; and that the said Herbert Tibbits, acting on such advice and instigation, did in fact, without any reasonable or probable cause, commence and prosecute the action. Alternatively, that the defendant unlawfully and maliciously upheld and maintained the said action. That the plaintiffs were thereby involved in trouble and expense, and expended £596 in costs, which sum they now claimed. The defendant pleaded that he had a common interest in the said action.

Mr. T. E. GATEHOUSE said that during the year 1892 his attention was called to certain electric belts sold by the defendant, and an article on the subject appeared in the plaintiffs' journal. On September 16th they learnt that a circular had been sent by the defendant to the various newsagents in London threatening proceedings if they continued to sell copies of the paper. They at once consulted Messrs. Lewis and Lewis, and on September 22nd a writ was issued against the defendant claiming an injunction to restrain the publication of this circular and damages. On September 23rd, there appeared in the journal an article headed "The Medical Profession and Electrical Belts," and commenting severely on a pamphlet written by Dr. Tibbits about Harness's belts, and on that day Harness issued a writ for libel against the plaintiffs in respect of their earlier articles. On October 6th Tibbits issued his writ in the action complained of. Tibbits stated at the trial that he was bringing the action for his own benefit, and that Harness was finding the money; and that he had not been solvent since 1885 or 1886. This action resulted in a verdict for the defendants, and the costs as between solicitor and client amounted to £596. The taxed costs as between party and party amounted to £435, of which not a penny had been received from Dr. Tibbits.

The witness was cross-examined about a defence fund which had been started, but he stated that his paper refused to accept any sum from the public for their costs, and he believed the subscribers to this fund had had their money returned.

OLIVER STOCKMAN said he had been a clerk to Mr. Fleet, who acted as solicitor to Harness and the Medical Battery Company. Asked as to what took place before Dr. Tibbits brought his action, witness said that there were interviews at Mr. Fleet's office while the action was pending and before the issue of the writ, at which Harness was present. When he was asked to give evidence he informed Harness of the fact, and the latter instructed him to tell all he knew. Harness wanted everything to come out.

J. F. S. CRIDLAND, Solicitor, said he was the solicitor to Tibbits on the record. His costs were paid by the Medical Battery Company. The cheques were signed by Harness and A. Smith, an accountant to the Company.

Mr JELF, Q.C., for the defendant, submitted there was no case, because Harness obviously had a "common interest."

The learned JUDGE said there could be no doubt a common interest would prevent any cause of action arising. The question of what was a common interest had never been decided, and should be fully discussed.

Mr. JELF intimated that he should call no evidence, and it was agreed that the jury should be discharged, and that the case should be adjourned for further consideration, and decided by the learned Judge alone on the facts already in evidence.

Moritz v. Lord Ardilaun and Others.

In this case, heard last week in the Queen's Bench Division, Dublin, before Justices Harrison, Johnson, and Gibson, Mr. W. M. JELLETT applied on behalf of the defendants, who are sued as the committee of the Kildare-street Club for an order for security for costs. The action was brought by Mrs. Rose Moritz to recover a sum of £170 on account of a contract for putting in electric light in the club premises, Kildare-street. It appeared that in July, 1892, the defendants advertised for tenders for the lighting of the club by electricity, with the result that the tender of the Manchester and Liverpool Electric Engineering Company was accepted. The contract was signed by George Moritz as manager. It was subsequently discovered that the Company was not a registered Company, and a long correspondence ensued, the outcome of which was an agreement to take the personal undertaking of the proprietor of the Company, it transpiring that it was really owned by one person. The contract was then signed by "R. Moritz," as proprietor. On February 13th a writ of summons was issued in the name of the Manchester and Liverpool Electric Engineering Company, and that was discontinued. The present action was then commenced, and for the first time they heard of the plaintiff, "Rose Moritz." The Company had since been wound up. The amount sued for was made up of £70, which had been deducted by the defendants for alleged delay, and the balance was for extras, the amount of the contract having been paid. The plaintiff resisted the application, and referred to a joint affidavit made by Rose Moritz and George Moritz, her husband, stating that since the Company, of which she had been the sole proprietor, had been wound up all its liabilities had been cleared off.

The Court made the order applied for.

TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

The 1894 Edition of "THE ELECTRICIAN" Electrical Trades' Directory and Handbook is NOW READY. This valuable book contains 1,000 closely-printed pages, and several new and useful features have been added. The price of the Directory and Handbook is 7s. 6d. Postage in the United Kingdom, 9d.; abroad, 1s. 4d.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket-book by W. Geipel and H. M. Kilgour, is now ready; price 7s. 6d., by post 7s. 9d. (abroad 8s.). A large paper edition with wide margins can be supplied, price 12s. 6d., post free 13s. (abroad 13s. 6d.). Prospectus on application to the Publisher.

"DRUM ARMATURES AND COMMUTATORS."—This book, written by Mr. F. Marten Weymouth, is also ready; price 7s. 6d. (abroad 8s.). Prospectus on application.

TENDERS INVITED.—The Royal Free City of Arad (Hungary) invite tenders for the construction and carrying on of electric works to furnish electric light and power for the district with all the necessary plant and apparatus. Further particulars are given in our advertisement columns, and all other information, including conditions, &c., can be obtained on application to M. Salacz Gyula, Mayor of Arad, Hungary. Tenders have to be in by noon of July 1st.

——— The Directors of the Great Indian Peninsula Railway require tenders for the supply of telegraph and miscellaneous wire, &c., which must be in by Thursday next.

TENDERS ACCEPTED.—The Dublin Town Council have accepted the tender of John Fowler and Co. (Limited), Leeds, for the entire work for the extension of the city electric lighting plant for £8,050, on the condition that the buildings be executed by Dublin tradesmen, and that the boilers and copper steam and exhaust pipes be manufactured in Dublin.

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Plant Wanted.—University College, Bristol, require prices of dynamos and motors. Particulars will be found in our advertisement columns.

Plant for Sale.—We would again call our readers' attention to the advertisement in another column of the electric plant offered for sale by Mr. H. Cuthbert Hall, 46, Queen Victoria-street, E.C., offers for which will be received up till Monday next, the 30th instant.

Sale.—An advertisement appears elsewhere, offering for sale by private contract the valuable and well-known electrical and telegraph plant and apparatus business carried on by Messrs. Latimer Clark, Muirhead and Co. at Westminster. All particulars can be obtained of Mr. J. Worley, 27, Leadenhall-street; Messrs. Trinder and Capron, 47, Cornhill; or of Messrs. Bircham and Co., 50, Old Broad-street, E.C.

Appointment Vacant.—The Corporation of Sunderland require an engineer to superintend the laying of mains and the construction of their electric lighting station, and after to act as resident engineer at the station. Further particulars will be found elsewhere, and applications must be sent in to the Chairman of the Highways Committee by May 12th next. Mr. F. M. Bowey, Town Hall, Sunderland, is Town Clerk.

Sale by Auction.—The whole of the electrical fittings of the Industrial Section of the recent Bristol Industrial and Fine Arts Exhibition are to be sold by auction in the buildings on May 10th.

Liquidations.—A meeting of the Caledonian Telephone Company, Limited (in voluntary liquidation), is to be held at Mr. Barton's, 109, St. Vincent-street, Glasgow, on May 23rd, at 3 p.m., to receive an account of the winding up.

Bankruptcy.—A receiving order has been issued in the estate of William Glover and William Henry Hobson, trading at 272, St. James-road, Old Kent-road, S.E., as Glover and Hobson, engineers.

Dissolution of Partnership.—Messrs. Vaughton and Titley, electrical engineers, of 26, Great Charles-street, Birmingham, have dissolved partnership. Debts will be paid by Mr. E. E. Vaughton, who continues the business.

Personal.—Mr. F. H. Nalder, of Messrs. Nalder Brothers and Co., was married on March 27th last, at Beckenham, to Miss H. M. Merry.

——— We understand that Mr. T. H. Parker, son of Mr. T. Parker, of Wolverhampton, has set up in business as a consulting electrical engineer in Stourbridge.

——— The National Telephone Company having acquired the business of the Home Telephone Company, Mr. John L. Newland, who was Manager of the latter Company, has now assumed the management of the Private Wire and Telephone Installation Company.

Underground Mains.—The underground work for the Edinburgh Corporation electric light scheme is now in progress. "Doulton" casing is being used, and about fifty miles of 2½in. ways on this system will be laid. The Sunderland conduits will, we understand, shortly be commenced, for which work about ten miles of 2½in. ways of "Doulton" casing is to be provided. Some bare copper mains in culverts will be laid both at Edinburgh and Sunderland, and Messrs. Doulton and Co., of Lambeth, are supplying special insulators for both contracts.

"Parish Councillors' Guide."—Messrs. Jordan and Sons, of 120, Chancery-lane, have just issued a handy guide to the Local Government Act by Messrs. H. C. Richards, W. H. C. Payne, and J. P. H. Soper. The object of the book is to give explanations and notes for the benefit of those who have dealings with the newly-formed local authorities. The authors promise a larger work dealing with the subject in greater detail, to be shortly published.

Messrs. Marryat, Lillywhite and Co.—In addition to a contract just completed for lighting Mr. W. Hazell's house at Russell-square, London, and contracts in hand for installation work at Manchester, Liverpool, Cardiff, Richmond, and London, this firm have just received instructions to put down a complete plant for about 200 16-c.p. lights for Mr. J. W. Kennedy, at the Horse-Shoe, Chatham.

Messrs. John Davis and Son.—This firm have sent us a catalogue relating to coaling and mining, surveying, engineers', and mathematical instruments. A large number of dials and compasses, &c., are illustrated, together with drawing materials, and general optician's goods.

Messrs. Gent and Co.—This firm have secured the contract for lighting the offices into which the centre of the Agricultural Hall, London, N., will be divided (over 100 in number), and also the stands and exhibits at the forthcoming shoe and leather fair.

Gas v. Electricity.—At the half-yearly meeting of the South-West of England District Association of Gas Managers, held at Salisbury last week, a general notion was expressed that so far from the electric light having been a detriment to the consumption of gas, its introduction had really acted as a stimulus to managers and companies to increase the business and to perfect the utility of gas in every possible way.

Electric Lighting of Trains, &c.—The flooring and sides of the brake vans carrying the accumulators on the electrically-lighted trains of the London, Brighton, and South Coast Railway are being coated with "anti-sulphuric enamel" to prevent damage by the fumes and spray given off from the batteries. This material is also being employed by the Birmingham Central Tramways to prevent possible damage to the cars from the storage batteries.

Electric Fire Risks.—An interesting and instructive lecture upon fire risks was delivered on Tuesday last by Mr. A. Barrett, of Cambridge, to the members and friends of the Norwich Insurance Institute.

National Telephone Company.—This Company announces under date April 20, 1894 (original date of circular March 13, 1894), that, "in order that the telephonic service in London may be brought to a state of the highest efficiency, the Company have decided to introduce the Twin Wire or Metallic Circuit System." The alarming announcement is also made that this will render necessary a rearrangement of the Company's exchanges, requiring that the present exchange numbers of subscribers to the National Company's system will have to be altered. There have been for some time past unmistakable indications of discontent amongst subscribers to the Company's metropolitan service, and the rearrangement of the telephone numbers will undoubtedly prove the last straw. The change will be most serious to those firms who, at certain periods of the year, prepare large quantities of stationery for their various offices, warehouses, &c., and so serious will be the dislocation of business arrangements entailed in the change of the telephone numbers that we shall be much surprised if an agitation is not started to prevent the rearrangement suggested by the Company's circular, in which subscribers are naively told that they will be informed at the earliest possible moment as to what their new exchange number is likely to be. As the alteration in the exchange numbers must have been under consideration long before the new contracts for 1894 and 1894-1898, were entered into by the present subscribers, the liability of subscribers to abide by the terms of their contract in the light of the serious change contemplated, is surely open to question. There must be many old subscribers to the system who would prefer to be without the telephone in preference to adopting other numbers than those by which they have become well known to their clients and friends.

Hooper's Telegraph and India-Rubber Works (Limited).—A circular has been issued by the Managing Directors of this Company, notifying that the estate of the late Mr. William Hooper having been taken out of Chancery, a limited liability company has been formed to continue the business.

Indestructible Gas and Ignition Tube Company (Limited).—This Company have just issued new circulars and price lists of gas engine tubes, and incandescent lamps and electric lighting plant and apparatus, of which they are either manufacturers or for which they act as London agents. The Company are sole agents in London for the "Duplex" high-speed gas engine, the "Crown" gas engine, and for the dynamos, arc lamps, carbons, &c., manufactured by Messrs. Conrady and Co., of Keighley.

Straker's Filtering Oiler and Oil Bath Bearing.—In this system of bearing lubrication, which has recently been brought out by Messrs. Straker, Whitworth and Co., the oil is supplied to the shaft from an oil bath enclosed within the pedestal. Attached to the shaft is a small milled wheel, the lower edge of which is immersed in the oil, and the rapid rotation of this oil-flyer carries the oil in a fine spray upwards to the top of the pedestal, from which it passes through a strainer to the bearing. The action can be maintained at any speed above 150 revolutions per minute. It is claimed that this system introduces a saving of 75 per cent. in the oil used.

Patent Office Library.—Number of readers during the week ended April 21st, 2,440.

Antwerp Exhibition.—A meeting was held on Wednesday last at the Mansion House, London, to settle certain matters of detail connected with the Antwerp Exhibition, which opens on the [illegible] prox. It was stated that everything pointed to the British section of the Exhibition being a great success.

Alleged Theft of Copper Wire.—At the Woolwich Police Court, Thomas Haynes and John Wenbourne were charged with stealing and receiving 280lb. of copper wire, &c., value £13. 10s., the property of Mr. W. C. Johnson, of Charlton, and, after some evidence had been offered, were remanded.

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BLACKPOOL.—Efforts are being made to get the trams running again by Whitsuntide, and it is anticipated that by that time the line will again be worked by electricity from Foxhall to the north end of the line.

BRADFORD.—The Gas and Electricity Supply Company of the Corporation on Wednesday instructed their electrical engineer to draw up plans for an electric lighting station at Frizinghall.

BRECHIN.—At a meeting of the Town Council, held on Thursday, it was moved that a deputation from the Council be appointed to accompany the Montrose Town Council on their visit to inspect the electric light station at Coatbridge; but it was resolved to delay sending a deputation until the result of the visit of the Montrose Council was known, and what action was taken in that burgh.

CHELMSFORD.—At the meeting of the Town Council on Wednesday the Town Clerk intimated that the Board of Trade would not agree to a portion of the Council's draft Provisional Order, and after some discussion it was decided that the matter be left to the authorities in London.

CHURCH LIGHTING.—The Marylebone Presbyterian Church is to be renovated and improved, and the opportunity is to be taken of installing the electric light therein.

CLAIM FOR WAGES.—James Gifford Black, electrician, manager for Messrs. Spagnoletti and Crookes, on the electric lighting works at Hanley (Staffs.), was summoned by Thomas Shuling, a wireman, for a week's wages, at the rate of 35s. a week, in lieu of notice, and 7s. 10d. railway fare. The evidence showed that plaintiff came from Banbury, and in March was engaged by the plaintiff as a wireman on the electric lighting works at Hanley. He began work on March 31st, and on the following day the defendant complained of some of the work. Plaintiff stated that he was not responsible for the bad work, which was the fault of the carpenter who made the joints. The result was that the plaintiff said he would give notice on the Saturday. Defendant replied that he must either go at once or that evening. Plaintiff came back to work next morning, and when defendant saw him he wished him to take 12s. 6d. for the twenty hours' work he had done. Plaintiff asked for his railway fare, but defendant refused to give it, and Shuling took out a summons.—The defence was that it was the custom of the trade to give only an hour's notice.—Several workmen were called, and stated that with most firms it was the custom to give only two hours' notice to the men, but in some cases a week's notice was given.—The Stipendiary ultimately found for the plaintiff for £2. 15s. 4d. and £1. 4s. 6d. costs.

COUNTRY HOUSE LIGHTING.—Messrs. Drake and Gorham have secured the contract for the lighting of "The Rookery" for Baron W. Von Schroder. The plant will include a dynamo suitable for charging a D.P. battery of about 100 16-c.p. incandescents for nine hours.

DARTFORD.—The Electric Construction Company having written to the Local Board that they had seen that a member of the Board was preparing a scheme for lighting the town by electricity, and inviting a deputation to visit their works at Wolverhampton, it was announced at the last meeting of the Board that they were not prepared to consider the question of electric lighting, having just entered into a three years' contract with the Gas Company.

ELECTRICAL TRAMWAYS IN IRELAND.—The Dublin Grand Jury on Friday considered an application for permission to construct tramways from Dollymount to the Hill of Howth, and, having heard the evidence and arguments of counsel on behalf of the promoters of the Company, and on behalf of the Great Northern Railway Company in opposition, decided to approve of the proposed tramways; tramways Nos. 1 to 4 to be worked by electricity, and tramway No. 5 to be worked by electricity or steam.

EXHIBITION.—It is under consideration to celebrate the Jubilee of the Emperor of Austria by a great exhibition for the whole Empire, to be held at Vienna in 1898. The chief object of the exhibition is to illustrate the progress achieved during the 50 years' reign of the Emperor Francis Joseph.

FAREHAM.—The Chairman of the Local Board of Health has called a public meeting of ratepayers, to be held at the Foresters' Hall last (Thursday) evening, to take into consideratian the offer of the Fareham Electric Light Company (Limited) to sell their business and undertaking to the Local Authority.

FOLKESTONE.—A public meeting convened at the request of a number of the largest ratepayers to protest against spending £35,000 on the electric Light was held at Folkestone on Monday, the Mayor presiding. The speakers were all in favour of the electric light being introduced either by a private company or at a lower cost. A resolution proposed by Councillor Hall and seconded by Councillor Baker:—"That the spending of £35,000 to light such a small area as stated in the scheme passed by the Corporation on the 6th inst. would be extravagant and unnecessary," was carried unanimously; also "That a copy of the resolution be forwarded to the Corporation, and should they continue to proceed with the scheme, that copies be sent to the Local Government Board and the Board of Trade."

GREAT MISSENDEN.—The contract for the village street lighting by electricity has expired, and there will be no more public lighting until the autumn. The electric light will, however, be continued to be supplied to private consumers.

HULL.—Some complaint having been made as to the alleged excessive charges for electric light supplied to the Town Hall in comparison with the corresponding quarter of last year, Dr. Holder, the Chairman of the Electric Lighting Committee, has elicited from the Borough Engineer that the electric current had been used to drive a 1½-H.P. engine in the Town Hall, as well as for lighting several rooms, marquees, &c., for which no allowance had been made. Dr. Holden said that if the current for the engine had been taken from a separate meter a great saving would have been shown in the charge for lighting the Town Hall, and it was manifestly unfair to work the engine as had been done, and to allow it to be supposed that the increased consumption of current was due to the lighting of the hall. After some discussion it was resolved to lay down a separate meter for motor purposes.

IPSWICH.—At the meeting of the Town Council on Wednesday it was decided to at once take the necessary steps to obtain a Provisional Order.

KINGSTON.—The Town Council have resolved to apply to the Local Government Board for permission to borrow £6,000 additional capital for electric lighting purposes, in order to meet the increasing demand for the current.

LLANDUDNO.—Messrs. Bellis and Kingsland have forwarded the Improvement Commissioners a draft of the Provisional Order, which they propose respecting the electric lighting of Llandudno. The Commissioners have referred the Order to a Committee for consideration and report.

LITTLEHAMPTON.—To those gentlemen who had written to the Local Board on the matter of electric lighting for the town, the clerk was instructed at the last meeting of the Board to reply to the effect that, although the Board did not at present contemplate supplying the electric light in their district, they would not oppose the formation of a company for that purpose, subject to the conditions of ultimate purchase, &c., being satisfactory.

LONDON COUNTY COUNCIL.—At the meeting on Tuesday the Highways Committee reported that the Council on April 10th instructed them to consider the advisability of widening the footways of the Victoria Embankment by taking in a few feet of the carriage-way on each side, in order to allow the electric light standards to be placed on the sides of the carriage-way without interfering with the trees. With reference to this suggestion they pointed out that the footways are of great width, 20ft. on the river side and 16ft. on the other, and in order that the lamp standards might be clear of the trees the width of each of the footways would have to be increased by 8ft., and that of the carriage-way correspondingly reduced from 64ft. to 48ft. Having regard to all the circumstances, they were of opinion that it was not advisable that the course indicated in the reference should be adopted. They understood that the Parks Committee had now under consideration a suggestion that some of the trees should be removed to facilitate of the proper growth of the remainder; and they thought it advisable that, until some decision should have been come to upon this suggestion, the further consideration of the question of the position to be occupied by the lamp standards should be deferred. The Council adopted the Committee's report.

NEWARK.—At the quarterly meeting of the Newark Tradesmen's Association last week a discussion arose on the question of introducing the electric light into the town. Mr. Norledge said that several gentlemen had obtained the best expert advice, and had ascertained that the electric light could be supplied to Newark at practically the same price as the gas, and they were prepared to enter into an arrangement with the Corporation to establish a plant, and they proposed to light the principal parts of the town as an experiment. An installation in the north of England had been inspected, which had proved a great success from the start, and a similar plant could be laid down in Newark for £5,000 or £6,000. After some discussion it was resolved to ask the Corporation to take up the matter, Mr. Norledge saying that all the information that had been collected would be placed at their disposal.

POPLAR.—The report prepared by Mr. W. H. Preece has been presented to the district Board of Works, and will be considered at their next meeting. Mr. Preece states that, having obtained a Provisional Order, the Board is under an obligation to proceed with it, the principal question being whether the Board shall itself undertake the supply or whether the powers shall be transferred to a private company. He recommends the former course being adopted. The report points out that the price of gas is constantly rising, whereas the price of electric current is assuredly becoming less,

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largely on account of labour troubles in connection with the former, and the expiry of patents in connection with the latter. Practically there now little difference between the cost of the two illuminants. The population of the Bow, Bromley, and Poplar district is estimated at 166,000, and the area covered by the Provisional Order represents about 6 per cent. of the whole. It is necessary to consider the probable needs of the entire district, and Mr. Preece recommends that full provision should be made for supplying not only the area covered by the Order, but the more extensive area not yet included. He estimates the probable ultimate demand at an equivalent of 50,000 8-c.p. lamps, and the installation of this number would cost about £150,000, and realise an annual income, at 6d. per unit, of £22,000, with a profit of about 6 per cent. on the capital outlay. Thirty-five arc lamps would be required to light the two principal thoroughfares in the district, at an estimated cost of £18 per lamp per annum. He also recommends that buildings should be erected capable of containing plant for the whole ultimate supply, but that to commence with only sufficient plant should be put in for a 10,000-lamp installation, at an estimated expenditure of £28,500, plus working capital, bringing up the amount to £30,000.

PORTSMOUTH.—We understand that the ceremony of switching on the electric light is to take place on the 9th prox., when a large and representative gathering will witness the inauguration at the works, and in the evening a banquet is to be given by the Mayor at the Town Hall.

SHIRLEY AND FREEMANTLE (HANTS.).—At the last meeting of the Local Board the Clerk read the minutes of an extraordinary meeting of Board whereat he was instructed to make application to the Board of Trade for a licence under the Electric Lighting Act. He had since received a communication from the Board of Trade, pointing out that it was unusual for Local Authorities to apply for a licence before they took up a Provisional Order. It was resolved to refer the matter to committee, as was also a communication from the Brush Company.

SOUTHAMPTON.—The Town Council on Wednesday referred to a committee the consideration of the advisability of acquiring the undertaking of the Southampton Electric Lighting and Power Company.

STAFFORD.—At the last meeting of the Town Council the tenders recommended for acceptance by the Electric Lighting Committee (as set out in last week's *Electrician*) were adopted. An attempt was made to substitute the tender of a local builder for that of Mr. Lovatt, but it was defeated by 17 to 13 votes.

SUFFOLK.—The Visiting Committee of the Suffolk Joint Committee have had under consideration the question of lighting the new infirmaries by electricity, the Medical Superintendent having submitted a report setting forth the relative merits and cost of lighting by gas and electricity, and an application was made to the Joint Committee at the last meeting for power to expend a sum not exceeding £1,720 for such purpose. After some discussion, however, it was decided to light the new infirmaries with gas while the present contract with the Woodbridge Gas Company continued.

SUNDERLAND.—A special meeting of the Highways Committee of the Corporation was held on Friday for the purpose of considering the progress of the preparations for lighting the principal streets of the town by electricity, and the question of the contract to be made with the gas company in view of those preparations. The Borough Engineer was of opinion that the works would be ready for supplying electricity next December. The present contract with the gas company expires in June, and the Committee decided to negotiate with the company for the purpose of entering into another contract for one, two, or three years, with power to withdraw all or any of the lamps (92) in the electrically-lighted area, and that in the meantime Prof. Kennedy be requested to prepare an estimate of the number of lamps required, their cost, and the cost of supplying them with electric current.

WOLVERHAMPTON.—The foundation stone of the new Corporation electric light works in Commercial-road is to be laid on the 21st prox.

WREXHAM.—The Town Council on Tuesday accepted the offer of the Wrexham Electric Lighting Company (Limited) to sell their Provisional Order for the installation of electric lighting in Wrexham and district for the sum of £350.

YORK.—At a meeting of the Streets and Buildings Committee of the Corporation, held on Tuesday, to consider the question of electric lighting for the city, it was resolved that the high tension system should be adopted, and the City Surveyor was instructed to prepare a report upon the tenders of four firms to be presented to an early meeting.

SMOKING CONCERT.—The second annual Bohemian concert in connection with the City Electric Athletic Club was held at the Café Monico, Piccadilly-circus, on Wednesday evening last. Mr. J. Cecil Bull acted as chairman of a most successful gathering.

PATENT RECORD.

A record of Applications for Patents and Patent Specifications Published is compiled for this journal by MR. J. C. CHAPMAN, *Fel. Chartered Inst. Patent Agents, of 70, Chancery-lane, W.C., from whom any information on the subject may be obtained.*

APPLICATIONS FOR PATENTS.

NOTE.—*The Specifications of Applications for Patents are not open to public inspection until after the acceptance of the complete specification. The names within parentheses are those of communicators of inventions, or where complete specification accompanies application an asterisk is suffixed.*

March 22, 1894.

6,046. L. A. P. LIÉNARD and H. E. A. LIÉNARD. London. Improvements in the methods of effecting the electrolysis of saline solutions. (Date applied for under Patents, &c., Act, 1883, Sec. 103, September 22, 1893, being date of application in France.)*

6,057. H. EDMUNDS. London. Improvements in electrical conductors and in the method of making connections between electrical conductors.

March 24, 1894.

6,039 J. A. KINGDON. London. Improvements in the means of protecting electrical conductors.

March 27, 1894.

6,212. M. A. CATTORI. London. Improvements in and relating to conduits for electric railways.*

6,218. W. P. THOMPSON. Liverpool. Improvements in or relating to electric keyboards for type-writing and type-setting machines and the like, also applicable for circuit-closing devices. (C. E. Allen, United States.)*

March 28, 1894.

6,241. F. A. R. READ and H. G. COLEMAN. Stoke-on-Trent. A method of depositing and affixing metals by electricity upon a medium which is fastened upon ceramic objects by burning in a kiln.

March 29, 1894.

6,315. A. L. SHEPARD. London. An improved rotary electrical differential controlling device.

6,323. W. M. MORDEY. London. Improvements in or relating to alternating current apparatus or circuits.

6,323. J. A. ARCHER. London. Improvements in electric battery apparatus.

March 30, 1894.

6,366. E. V. COOKE. Patricroft. Improvements in electric arc lamps.

6,368. E. A. HOOD and P. SIMON. London. An improved apparatus for tightening telegraph wires and the like.

6,389. R. HUTCHINSON. Glasgow. Improvements in making elastic or semi-elastic compositions for insulating and other purposes.

6,402. G. E. B. PRITCHETT, T. W. PRITCHETT, and A. G. GOLD. London. Improvements in electric accumulators.

6,417. A. ESSINGER and T. HARDEN. London. Improvements in connection with switches for electric current transformers.

SPECIFICATIONS PUBLISHED.

All Specifications price 8d. each.

1893.

6,000. THWAITE. Electrofusion of steel.
6,233. DU BOIS. Electric clocks.
6,306. NIELSEN. Electric current meter.
6,780. DOUBLEDAY and SUSSMANN. Secondary batteries.
8,958. RIGOLA. Applying electricity to the body.
9,380. HADDAN (Reisinger). Breaking electric circuit.
9,557. PRENTICE. Dynamo-electric machines.
9,627. FARADAY. Electric light fittings.
9,641. HALL and PICKERNELL. Signal for telephone circuits.
9,864. EVERED and WATSON. Electric switches.
10,015. CROMPTON and DOWSING. Utilising electrical energy for culinary purposes.

COMPANIES' MEETINGS AND REPORTS.

Indo-European Telegraph Company (Limited).

The twenty-seventh ordinary general meeting of this Company was held on Thursday at Winchester House, Major-Gen. G. B. Tremenheere, R.E., presiding.

The MANAGING DIRECTOR (Mr. W. Andrews) read the notice convening the meeting.

The CHAIRMAN said: I am very sorry to tell you that since we last met we have lost from our midst Mr. Henry Weaver, who died last autumn. Mr. Weaver was one of the oldest and most prominent figures in the telegraph world, and a gentleman of great ability and ripe experience. I need hardly add that his services were valuable to you and to us all. Our Chairman, Mr. Herbert Tritton, having had a long illness,

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I regret to say he has been obliged to go away for a charge, which we hope will restore him to health, and that we shall soon see him in his place again. From the figures set out in the printed report you will see that we have had a very prosperous year. We have realised £5,380 more than in 1892, but the expenses are rather in excess of the previous year. We are, nevertheless, enabled to place £15,000 to the reserve, to declare, with your sanction, a dividend, including the bonus at the rate of 10 per cent. for the year, and to carry forward £6,452 to the next account. The working of our telegraph has been carried on with great regularity. It is, as you are aware, 4,000 miles in length—from London to Teheran. After crossing the North Sea by our wires in two of the Government cables, the line passes from the German coast to the Russian frontier, 585 miles; through Russia, 2,382 miles; and Persia, 471 miles. It is extremely creditable to our staff and employés that the messages have been as a rule transmitted with great accuracy, punctuality, and speed, day and night, all along the line. The actual average time between London and Teheran has been eminently satisfactory throughout the year. The result has fortunately been equally satisfactory on the lines of the Government of India and on the Government lines in Persia and in the Persian Gulf. The through service from origin to destination, covering an average of some 8,000 to 9,000 miles, through almost every variety of climate, has left nothing to be desired. Of course, while giving the manipulating staff every credit, the engineering staff must not be forgotten, nor the excellent management which has to organise, control, and regulate the whole, producing the result which is seen in the prosperity of the Company. The Directors, looking at all the facts, at the large augmentation of the Company's business and work, have thought some recognition should be given of the valuable services rendered, and with this object we have set aside the sum of £4,000 from the receipts of the year for that purpose. We think that the occurrence in June, 1893, of the completion of the first 25 years of the incorporation of the Company would be a peculiarly fitting occasion to let the officers and staff see that the Company is not unmindful of services rendered, and I am glad to think from the applause just accorded to my statement that the shareholders cordially approve of this policy. The Directors are glad to say that the measure has given the staff great satisfaction and encouragement. Gentlemen, there is little more for me to say. As on previous occasions, and in continuation of a cautious policy, we have written down certain items this year which are included in our expenses account, and I think I may congratulate you upon the very sound position of your company. If any shareholders desire to ask any questions or make any remark, the Board will be happy to hear them. I will now move—

"*That the report and accounts now submitted be received and adopted, and that a dividend be, and is hereby declared for the half-year ended December 31, 1893, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax, making in all 10 per cent. for the past year.*"

Mr. C. W. EARLE seconded the resolution.

Mr. STOCK hoped that of the £4,000 to be given to the officers a portion would be set aside for the executors or representatives of the late Mr. Weaver, who, he believed, did a great deal for the benefit of the Company.

Mr. MACANDREW asked if he was to understand that the £4,000 had been already deducted from the income of 1893, or was to be charged to the amount carried forward?

The CHAIRMAN: It has been deducted already. I may just say that we understand Mr. Weaver's family are left in very good circumstances, and we could not well distribute any money to his executors.

The resolution was then carried unanimously.

The CHAIRMAN: I now beg to move the re-election of Mr. John Von Berenberg Gossler and Mr. H. H. Meier, who retire by rotation in pursuance of the provisions of the Articles of Association.

Mr. C. HOLLAND seconded the resolution and it was carried.

Mr. STEVENS moved a vote of thanks to the auditors and their re-election.

Mr. STOCK seconded, and the motion was agreed to.

Mr. GARDINER (of Messrs. C. F. Kemp, Ford and Co.) said that as one who had occupied the honourable position of auditor of the Company for 26 years he desired not only to thank the meeting for re-electing his firm as their auditors, but he had also to thank them for what was a very unusual thing, namely, that the auditors should be thanked for their services. It was very nice to get their remuneration, but it was better still to get it with a vote of thanks.

Mr. STOCK then moved—

"*That the very best thanks of this meeting be given to the Chairman and Directors for their ability in conducting the business of the Company.*"

He said the Board had managed the Company for a long time with great skill, as was shown by the dividend declared on that and on previous occasions.

Mr. ST. LAWRENCE SMITH seconded the motion, which was adopted unanimously.

The CHAIRMAN briefly acknowledged the vote of thanks, and hoped that the attention of the Board to the shareholders' interests would be as successful in the future as it had been in the past.

The proceedings then terminated.

Great Northern Telegraph Company.

The following abridged report of the general meeting held at Copenhagen on the 21st inst. has been forwarded by the Company for publication:—

Mr. F. Zahle presided at the meeting, and the CHAIRMAN of the Company (Mr. C. F. Tietgen), in rendering an account of the working of the Company during the past year, stated that the twenty-fifth year of their existence had been a stormy one in several respects, and especially to the Company's cables. In Europe 11 of their cables had been subject to 22 interruptions, while 18 interruptions had to be recorded of six cables in the Far East. The cable steamer "H. C. Oersted" had been on active service for 177 days; the "Store Nordiske" for 218 days, of which only seven days have been on account of other parties. This explains the fact that the item of "sundry receipts" appears in the working account as a much smaller amount, and the expenses of the cable steamers as a much larger amount than usual. The interruptions have been not only more frequent than in former years, but also of longer duration. This was due to the stormy and unsettled weather that prevailed in European as well as in Eastern waters. In Europe some of the repairs have been effected under circumstances of special difficulty, as at the beginning of 1893 the movements of the cable steamer were hampered by ice. Both in Europe and the Far East it has been necessary to renew considerable lengths of the cables where they have been found corroded by rust. This is especially the case where the cable has been covered with seaweed and other vegetation on the bed of the sea. The expenses on account of spare cable charged to the reserve and renewal fund have therefore been rather heavy, and shareholders must be prepared for similar expenses in the future. The old cable picked up is, however, not entirely without value, as a large portion of the core is perfectly sound, and fit to be re-sheathed with new iron wires, and by taking advantage of this the cost of spare cable is sensibly reduced.

There has been a very brisk traffic over the Company's lines, in Europe especially, and also in the Far East. The receipts have in consequence shown an increase, but one by no means proportionate to the increase in work. This is due to several causes, which are entirely beyond the Company's control, but which, nevertheless, call for special attention. The first is the great and constant depreciation of silver. Three years ago the Company could effect their remittances from the Far East to Europe at a rate of exchange of 5s. 3½d. per tael, or 3s. 11d. per dollar; a year ago the value of the tael had declined to 3s. 10d., the dollar to 2s. 9½d., and at this moment a tael is worth only 2s. 8d., and a dollar only 2s. At the beginning of 1893 the Company endeavoured to meet the losses thus incurred by a moderate increase in the rate of exchange at which the charges were collected at their stations in China and Japan. Both the Japanese Telegraph Administration and the Eastern Extension Telegraph Company concurred in the expediency of this measure, but, unfortunately, the Chinese Administration refused to agree, and, consequently, it had not been possible to apply the increased collection to the whole of the traffic. The Chinese have not been satisfied with preventing the general application of this arrangement, but have started a direct competition of rates with the Company's cables. It was mentioned at the last general meeting that the Chinese had opened their first competing line across the Siberian frontier in March, 1893, but so confident were the Company of the superiority of their service, that although the new route might have the effect of decreasing the Company's revenue, they contemplated the result with perfect equanimity, provided the Chinese loyally carried out their obligations and did not underbid the Company. The correctness of this statement has been amply borne out by subsequent events, seeing that within six weeks after the opening of the so-called "Helampo Route" to the public, that route had to be closed and remained totally interrupted for three months. The Company, however, have been sadly disappointed in their hopes as to the loyalty of the Chinese in carrying out their obligations. Instead of competing with the Company at equal rates, as stipulated by the Russo-Chinese Convention, they at once commenced underbidding the Company by fixing lower charges to Europe. At their stations in the interior, they have even gone to the extremity of refusing to accept telegrams directed by the senders to go *viâ* the Company's cables, and have also refused to collect the charges officially notified by the Company. In addition to this, the Chinese Administration in October last began a severe competition with the Company for the local traffic between the ports where the cables are landed, viz.:—Shanghai, Foochow, Amoy, and Hongkong, by reducing their rates between those places to one half of those which, according to arrangement, had been in force since 1886, and this in face of the fact that the depreciation of silver had already virtually reduced the charges in the same proportion. The Company have met these and other provocations in a most considerate and conciliatory spirit. At first they tried by friendly remonstrances, followed by more formal protests, to induce the Chinese Administration to fulfil their obligations—unfortunately, however, without success. After that the Company applied to the Danish and Russian Governments, both of whom promised their support, and the Russian Minister at Peking, Count Cassini, who is also the representative of the Danish Government at that place, has actually succeeded in persuading the Chinese to take up a more correct attitude in several respects. There is, therefore, reason to hope that the Minister will also ultimately succeed in inducing the Chinese Administration to desist from contravening the Russo-Chinese Convention by underbidding the Company. In the meantime the war of tariffs continues, but fortunately the Company's case is so just, and their position so strong, both financially and legally, that they are perfectly able to stand a prolonged campaign if required.

Whilst the injurious influences hitherto mentioned relate only to the Far East, the third cause of the Company's revenue not having been in proportion to the increased work has chiefly affected the European traffic. This is the considerable reduction of rates inaugurated at the International Telegraph Conference, at Berlin, in 1885, and completed at the Conference at Paris in 1890. As this cause has been operating for a long period, it is possible to speak with authority as to its constant and detrimental effect on the Company's revenue as proved by statistics. The following Table shows the total number of telegrams exchanged every year over all the Company's cables since 1881, the year succeeding the application of the word rate to the European traffic, and also the exact traffic receipts, includ-

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ing Government subsidies, which the Company have earned by their work, due allowance being made for losses on exchange.

	Number of telegrams.	Traffic receipts.	
1881	797,670	£225,192 10 4	
1882	884,410	230,382 16 8	
1883	910,532	243,826 14 2	Duplication of Far East cables
1884	921,259	266,080 6 0	
1885	937,561	262,259 12 5	Telegraph Confrnce. at Berlin
1886	961,259	241,408 14 1	
1887	1,065,538	250,783 0 3	
1888	1,227,420	260,150 15 9	
1889	1,265,996	267,828 15 0	
1890	1,319,912	*280,911 13 0	Telegraph Cnfrnce. at Paris; Laying of Swedish-English cable.
1891	1,405,315	*284,696 1 8	Duplication of Danish-French cable.
1892	1,417,912	263,045 19 8	
1893	1,531,271	275,593 0 6	

* The rise in 1890-91 is partly due to a temporary appreciation of silver.

It will be seen from this summary that the increase in traffic during the said period of 12 years leaves nothing to be desired. Although in some years—as, for instance, 1884-86 and 1892—the increase has been comparatively trifling, the period taken as a whole shows an increase in the number of telegrams transmitted of no less than 733,601, or about 92 per cent. This is ample proof not only of great commercial progress, but also of the activity displayed by the Company, who have spent during the same period some half a million of pounds on new cables in order to insure a satisfactory transmission of the growing traffic. The traffic receipts, on the other hand, present quite a different aspect. They, too, show a fairly satisfactory increase before the Telegraph Conference at Berlin (1885), considering that from 1881 to 1884 they increased about 17 per cent., or in about the same proportion as the number of telegrams. The reduced tariff adopted at Berlin, however, resulted in a sudden and marked decline in the receipts in 1886. It is quite true that the latter rose again by degrees during the next few years, but only to fall off once more in 1892 in consequence of the reductions adopted at Paris. And although a fresh rise made itself felt in 1893, the whole of the receipts in that year were only 3½ per cent. higher than in 1884, while the number of telegrams had increased by 610,000 or 66 per cent. during the same period. From a practical point of view, the receipts during the last 10 years must be considered as stationary, seeing that the average yearly receipts are actually lower than the receipts in 1884. When, at the same time, it is borne in mind that both the ordinary and the extraordinary expenses of the Company are necessarily increasing, and that considerable outlays are constantly required, in order to keep their cable system in a state of efficiency, even the most sanguine shareholder will no doubt agree that the circumstances referred to above give rise to serious reflections. It is not with the object of discouraging the shareholders that this subject is brought to their notice, but only in order to prove to those shareholders—especially in France—who now and again advocate a higher dividend at the cost of the additions to the reserve fund, that such a policy would be fatal to the Company. The present additions to that fund are absolutely necessary—firstly, because the expenses of maintaining and renewing the Company's lines are becoming heavier in proportion as the cables are getting older; and, secondly, because it is only by means of the accumulating interest on the investments of the reserve fund that the Company will be able to meet such further tariff reductions as cannot fail to be in store for them, and also to compensate for the cessation of the Government subsidies, when in course of time their concessions expire.

Although the results of the last ten years' working, when thus closely examined, are not absolutely gratifying, and although they clearly prove the necessity of the financial policy adhered to up to the present, it is still gratifying to study the financial recapitulation, comprising the first 24½ years of the Company's existence, which has been prepared by the Directors, and a copy of which can be obtained by any shareholder. This recapitulation shows total receipts of £5,474,533, against ordinary and extraordinary expenses of £1,664,573 on total net receipts of £3,809,997. These receipts have permitted a distribution of £368,250 in interest and amortisation of debentures, £2,474,527 in interest and final dividends on shares, £862,968 in reserve and renewal fund (less amounts written off), £35,443 in pension fund for the staff, £30,653 in remuneration to Directors, and a balance of £38,154 carried to 1894.

At December 31, 1893, the liabilities of the Company were £1,700,000, against assets estimated at £2,824,536, or an excess of assets of £1,124,536.

The yearly dividend has averaged nearly 7½ per cent., and the shares have attained more than double their nominal value, and it must therefore be admitted that the shareholders have every reason to congratulate themselves on the results of the past. With regard to the future, the Company can face coming events with equanimity, provided the shareholders are prepared to place the same confidence in the Board as hitherto, and to support their financial policy.

For the year 1893 the Board recommend that the extra dividend, the addition to the reserve fund, &c., be fixed at the same figures as last year.

The Directors have sustained a sad loss through the demise of their able and conscientious colleague, Mr. A. Garde, who has been on the Board since 1887. To fill the vacancy the Directors have invited His Excellency Vice-Admiral J. S. Meldal to join the Board.

Metropolitan Electric Supply Company (Limited).

The seventh ordinary general meeting of the Metropolitan Electric Supply Company (Limited) was held last Monday, under the presidency of Sir John Pender, G.C.M.G. M.P.

The SECRETARY (Mr. E. Cunliffe Owen, C.M.G.) having read the notice calling the meeting, and the report of the Directors having been taken as read,

The CHAIRMAN said: The accounts which are in your hands, and which have been prepared in the form prescribed by the Board of Trade, give such full details as to the Company's financial working that it will not be necessary for me to trouble you with more than a few remarks upon them. You will have seen from the capital account that the second £50,000 of the debentures authorised in 1892 have all been issued, making a total of £100,000, nearly the whole of which are held by our shareholders, showing the real interest which is taken by them in the progress and welfare of the Company. This issue of debentures brings our capital up to £600,000, which has practically been all expended, while the continual increase of new customers and the extension of mains will render it necessary for us to make still further provision for coming capital outlay. Referring to the other side of the capital account, you will find that the expenditure during the year has amounted to £35,072, the greater part of which has gone in mains and in the necessary apparatus and connections for supplying our new customers. There has also been some expenditure, which, though not large in amount, is of considerable importance to the Company's welfare. I refer to the expenditure at our Manchester-square station and at our Sardinia-street station. In the first of these cases we have found it necessary to alter and supplement the foundations of the engines and machinery in order to do away with any possible cause of complaint as to vibration, and I may add that these works are also having the effect of materially improving the working of our plant. You have doubtless seen that an action in reference to this question of vibration is in course of being heard. I am, of course, unable to refer to it in detail, but I can assure you that the Board are fully alive to its importance, and have left no stone unturned to provide for the interests of the Company being properly and adequately guarded. With reference to the expenditure at Sardinia-street, we have sunk a well at the station, and have put down a pumping engine for the supply of water, and from the experience we have gained, we have no doubt that we shall be practically independent of the water company and water rates, and that a very considerable economy will thus be effected in one of our prime necessities. One other point to which I must refer is the item of management charges, which now disappears for the first time from the capital expenditure of the year. In dealing with this matter the Board have considered it right to allocate a small portion (about £700) of the salaries of the engineer's department direct to the more important items of construction, by way of percentage, as representing the work done by that department in the way of supervision and actual expenses; but no appointment of general management expenses has been made to capital this year, the time having now arrived when, in the opinion of the Board, the whole of such charges should be borne by revenue. This leads me to the consideration of the revenue account itself, which in one sense has been somewhat disappointing. When in November last we issued a circular to you referring to the prospects of the Company, the Board were guided by the fact that in each of the three quarters which had then been completed, the income from current had shown an increase of nearly 50 per cent. over the corresponding periods of 1892. We had, therefore, reason to hope that the Christmas quarter, under normal conditions of weather and demand for light, would show a similar increase. Owing, however, to the remarkable absence of fogs, which, except from our point of view, has been so pleasant a feature of the past winter, and to the exceptional brightness of the general weather, the increase of revenue over the Christmas quarter of 1892 was only 8 per cent.; and this was in spite of the fact that our customers were increasing in numbers in about the same proportion as usual. But I would remind you that all lighting companies have been seriously affected by the past winter, and I am simply repeating what has already been dwelt upon by the chairman of all other kindred companies, whether gas or electric. In our case we estimate the falling off at about £10,000, which, after allowing for extra cost of production would have given an extra 1½ per cent. dividend on our capital. The total income for current has been £64,312, being an increase of £13,500 over 1892, which has been earned at an additional works cost of £6,600, which would have been only slightly increased to earn the larger income to which I have just referred. Looking at the details of this expenditure, it will be seen that, speaking generally, coals have increased by only £2,200, general stores by £800, station wages and salaries by £1,600, and repairs and maintenance by £2,000. With regard to the item of fuel, the Board took full advantage of the reduced price of coal at the time the contracts were made last year, but the small increase of cost under this head as compared with earnings is not so much due to economy in purchasing as to the fact which the Board have always desired to impress upon shareholders—that increase of output does not involve anything like a proportionate increase of cost. The more light we can sell the less per unit does it cost us to produce, and therefore the more profitable is our working. This observation also applies to the second item of oil, water, and stores, which need no further remark. Wages and maintenance make, however, an important item of increase, which is owing to the fact that our Rathbone-place and Amberley-road stations have been working during the year—not, as yet, to a sufficient extent to earn a large income, but still involving the expense of staff and maintenance as though they were. With all these considerations, the total works cost has been kept down to a figure which is most hopeful for the future. The items remaining for special notice are the general management expenses, which now appear for the first time as a full charge against revenue and the depreciation fund. With regard to management, very considerable economies have been in operation since last year, reducing the total by

nearly £4,000 from the cost in 1892; and as to depreciation, to which question the Board have given specially careful attention, without laying down any hard-and-fast principle for the future, we are of opinion, at present, that the amount we have advised should be written off (namely, £7,000), with the further £1,000 off preliminary expenses, fairly meets the case, more especially having regard to the fact that our business compels us to maintain our buildings and plant in the greatest condition of excellence and efficiency, the whole cost of which up-keep is charged direct to revenue, as is apparent from the figures before you. We now come to the final result as shown in the net revenue account No. 5—namely, a net balance (after providing for debenture interest) of £13,548. With this we recommend payment of a dividend of 5s. a share, carrying forward £1,073 to next year. We should have liked to recommend a larger dividend, but under all the circumstances we consider that the progress is very encouraging, and that our business, which I want you to realise, is still in process of development, is being established on a firm and satisfactory basis. Our lamp connection is still continuing to increase in very much the same proportion as heretofore, as will be clear to you from the diagram on the wall. You will also notice the plan which shows the houses we supply, and which gives a most encouraging idea of the gradual filling up of our areas, especially those in which we have worked longest. Paddington still lags behind, but that is our newest district. I ought to mention here that we are of opinion that the time has now arrived for the institution of transformer sub-stations in some of our more crowded districts. By the adoption of this system, which we have always kept in view, we hope to effect a considerable saving in the cost of supply. Before saying anything further, I think it is right to allude to a letter which I have received this morning from one of our shareholders. He intimates that he may probably not be able to attend the meeting, but that he feels greatly disappointed that in the speech which I made last year I alluded to a dividend of 5 per cent. You will remember, gentlemen, that that was not in my speech. It was a question that was put to me, and which I answered with the same confidence then that I would answer it to-day. My belief then was strong that, looking to the growth which we had before us of our system, we should, in all probability, pay a dividend of 5 per cent.; but I have shown you to-day that one of the quarters of the year was short by £10,000, and that made all the difference in our power to pay this 5 per cent. I mention that as showing the uncertainties and the changes that may take place from time to time; but I am pleased, to tell you to-day that in this quarter of March we have received £24,000, whereas in 1893, for the same quarter, the amount was only £19,000 while in 1892 we received only £13,000, and in 1891 only £10,000. I therefore think you will see that I am justified in speaking hopefully, though at the same time I want you to understand that we are engaged on a new business altogether. Science has not yet developed it to the extent that I believe science will develop it, but when I tell you that at the present time our machinery would, if continuously worked, produce in about 40 days the power which we need in the course of a year, you can see that we have a large amount of electricity at our command, and I hope that by-and-by we shall have customers to use it. There are other things connected with this system which require to be dealt with, and they are the use of this electric power for other purposes than lighting. We have not even touched any of these matters yet, but there is no doubt that these days of active competition will find some means of employing that enormous waste which exists now in the system. We have not the power which the gas companies have of storing our electricity in great reservoirs. If by scientific progress and development we can establish some cheap system of accumulating the electric power on an enormous scale it would add greatly to the advantage and dividend-paying power of these companies. Let me say another thing, because I know that a great many who go into these undertakings think that the wisdom of the Directors is such that they can do anything they please; but we have to learn as well as you. I may tell you that after a very careful investigation at the time this Company was formed, we made our calculations that we should receive at least £1 a light, and I was rather criticised for mentioning such a low price. Other experts thought that we ought to receive 25s. or 30s. To-day, however, the average amount that we receive is only 8s. 9d. per light You, therefore, see what Directors have to contend with, and with all the knowledge we possess it is very difficult for us to extract gold out of stone if there is no gold in it. I speak, however, with perfect confidence and belief in the future of electric lighting. It has so many advantages that I cannot conceive it being otherwise than prosperous. It remains, however, for your Directors to use all their knowledge and experience in conducting the affairs of the Company. Knowledge can only be gained by experience, but you may depend upon it that that experience will not be thrown away, and we shall do all we can to increase the dividend-paying powers of the Company. I may say that we have also to contend against a great many difficulties which have been set up by the Board of Trade, and I think the time will come—and will come very soon—when the different electric light companies will require to meet and consider the question of approaching the Board of Trade with a view to obtaining an alteration in the relations subsisting between that Board and these Companies. We are too much restricted, and we do not, I consider, get quite fair play, and until we get fair play from the Board of Trade, you may rest assured that we shall not be satisfied. There is competition, as you know, between companies. One company wants to try and do a little better than their neighbours; and there is a little of what is called "cutting," which will, I hope, be eventually stopped. I trust that we shall establish our system upon a broad and honourable basis, and that those who do the work the best will get the work to do, and that they will not be dependent upon making a small reduction here to-day and another small reduction there to-morrow, because all that will end in the necessity of an understanding with one another in order to protect our mutual interests. I think I have pretty well given you the whole of the details that it is in my power to give you. We have a suit pending about vibration. People take advantage of such undertakings as ours to try and get a little money out of us if they can do so. Until all these questions are settled, we shall have trouble; but still I hold that we have got the nucleus of an important business, and if we watch it carefully I think its development will be such that it ought to satisfy both the Directors and the shareholders. I now beg to move:—

"*That the report and accounts for the year ending December 31, 1893 presented to this meeting, be and are hereby approved and adopted, and that a dividend of 5s. per share on the whole of the Ordinary shares of the Company be and the same is hereby declared, such dividend of 5s. per share to be payable on May 1, 1894, to all holders on the Company's register on April 17, 1894.*"

Admiral of the Fleet LORD JOHN HAY, K.C.B.: I will second that.

Mr. H. E. YOUNG complained that the Chairman's anticipations regarding the dividend had not been fulfilled. He was a shareholder in the City of London Electric Lighting Company, the Westminster Electric Lighting Company, the St. James and Pall Mall Company, and the Liverpool Electric Light Company, and he was also a shareholder in other electric lighting companies in the country. He had had reports from all these companies this year, and they have all had to contend with the same weather which this Company has had to contend with. This was certainly a point in their favour, but from all the other companies he had received what he called better reports. From some of them he got a steady dividend of 5 per cent., and they all showed good hopes for the future. He also complained of the amount of the Directors' fees, and asked whether the Company had had any dealings with the Telegraph Construction and Maintenance Company, and whether it had had any dealings with Messrs. Verity and Sons. He concluded by moving a resolution, in effect fixing the Directors' remuneration at 800 guineas, instead of £2,100.

Mr. MUNRO seconded the motion.

Mr. ADAMS said that the question of the remuneration of the Directors was, if he remembered aright, dragged up last year or the year before, and he thought that the shareholders came to the conclusion that "the labourer is worthy of his hire."

The CHAIRMAN: In answer to the gentleman who moved the resolution, the solicitor informs me that that resolution is out of order. At the same time, while it is ruled out of order now, he can have it in perfect order for the next meeting. However, I want to take up the question which he has raised, and to deal with it irrespective of the question of order altogether. He has not been quite as straight as he might have been in mentioning other companies, which, I may say, are suffering quite as badly as we are. I think that when comparisons are made it will be found that we are building on a foundation which is likely to result in a permanent structure in the future. He has not told you with respect to the St. James Company that, while they paid their shareholders 7½ per cent. in 1892, they paid only 4½ per cent. in 1893.

Mr. YOUNG said that he took as an example not the St. James Company, but the Westminster Company.

The CHAIRMAN: You named the St. James Company.

Mr. YOUNG: But not, I think, in contrast with this Company, with which I compared the Westminster Company.

The CHAIRMAN: I like a little opposition myself and for attention to be drawn to any sore that may exist, because it is the duty and the business of Directors to heal sores if possible. In building up a concern like this we have a much larger area than any of the other companies. We have laid down about 70 miles of mains, and we are likely to run that up to 100 miles. That is a very large area of main work, and without the mains, you cannot, of course, exist. When we get our system completed, we shall then be in a position to deal with a much larger amount of income than we can at present in giving dividends, but you cannot expect in a new company of this kind that that should be the result at once. As this gentleman has said, I am connected with nearly all the Electric Telegraph Companies, but do not suppose that the connection with those companies does not give one knowledge and experience. My whole time is devoted to the work. I rarely leave this building from the time I come into it in the morning until I go home. I am attending carefully and closely to all these matters, and I think that my time and experience ought to be considered. It is not an ordinary concern you are dealing with, but a concern which is developing every day. It requires men of judgment to do this work, and I think we have such men at this Board. It is a very old story, after all, and I have had to deal with it in all these companies. The first thing which someone tries to do is to cut down the Directors' remuneration. We are not, however, what are called "guinea-pigs," but practical working Directors, doing our work well and faithfully to the shareholders, and if you think that we are not doing it faithfully, the sooner you get rid of us the better. At the same time, I have laid before you truthful statements—statements that can be investigated by any men you choose to appoint, and I hold that the shareholders, getting all the information that we can give them, should not ignore the fact that when we first approached them with the prospectus we based our estimates on £1 a-light, whereas we are now only receiving 8s. 9d. That will show you how we have had to adapt ourselves in order to meet that great difference. Had we been getting £1 a-light, we should have paid you a dividend which would have astonished you. However, the future is there, whether you leave us to conduct the Company or appoint others. Depend upon it, however, that it is not a good thing to make changes when a concern such as this is growing, although my co-Directors and myself are ready to do what the shareholders wish. My experience in electricity entitles me to say that I have never yet misled the shareholders or put before them anything that was not actually true and accurate. The question was put to me whether we have any connection with the Telegraph Construction and Maintenance Company. We have no connection with them, excepting, I believe, that we have a small sample of their mains to lay down and to test alongside

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of the Company. It is two miles out of 245 miles. That is all the connection we have with the Telegraph Construction Company. So far as regards Messrs. Veritys doing work for us, we do something for them in supplying them with current, but they do nothing for us. If, therefore, you thought there was any jobbery—because it is as well to come to the point at once—you were in error. Our connection with the Telegraph Construction Company, so far as regards the telegraphs, is very important, but, as I have already said, our relations with them so far as this Company is concerned are very small, while at the same time they are as pure as crystal glass. If there is any other question to be put to me I shall be glad to answer it.

Mr. ADAMS asked what number of lights could be got with their present capital and mains?

The CHAIRMAN: Your first question is rather difficulty to answer, but, so far as I can see, we can get at least 50,000 more lights, and probably double that number. There is one thing, however, that I find about this question of electric lighting, and I find it in my own case. I use the electric light from the Westminster Company. I have a good many lights in my house at Arlington-street, but it is marvellous how I have learned to be economical in its use. When gas is lighted it continues alight generally until the household retires, but with the electric light it is turned off when its use is no longer required. In my own case, when I go down to dinner I turn the light off, and I turn it on again when I come back. The greatest economy is practised in connection with the use of the light. As far as I can see, the margin of light we have still at command ought to give us a very considerable dividend when we get it fully employed.

Mr. POLLOCK said he thought that a circular was sent out in the autumn telling the shareholders that the dividend declarations would be not once a year, but twice a year. Was there any alteration in regard to that question?

The CHAIRMAN: That is a matter that has been very carefully considered. I think I said when we talked about this matter of half-yearly dividends that we would declare them the moment we had such a number of lights taken up as would enable us to pay such a dividend. That is still the intention of the Board, but it is a very considerable expense to hold half-yearly meetings. What I have thought was that sending out a sort of letter would answer the purpose. I think it is quite right that shareholders should be informed about their affairs twice a year. I have no objection to sending you a letter every half-year, or to meet you every six months, but we desire to keep down the expenses in every way. When we get into an easy position it will give me the greatest possible pleasure to meet you and tell you how we are going on, and encourage you as you would encourage us in the work we have to do. What I propose to do at the end of the six months is to send you a statement showing the position of the Company. It is, however, difficult to fix upon the proper time to do so, because, as I have said, we expected to receive £10,000 more, and the absence of fog deprived us of that amount and made all the difference in addressing you to-day as rather discontented shareholders. I am a large shareholder, and am discontented, too, but next year I look forward with great hope to being able to declare a better dividend than that which we recommend on the present occasion.

Mr. MUNRO asked whether it was intended to fill the two vacancies on the Board?

The CHAIRMAN: No; that is one of the economies we are practising.

Mr. MUNRO thought that the auditors' fees were very large.

The CHAIRMAN pointed out that the amount included the Board of Trade's fee.

Mr. MUNRO inquired what the recognised fee of the auditors was?

Mr. JOHN GRIFFITHS replied that no fee had been fixed. He should like the shareholders to understand that what the Directors required of them was a great deal more than usually devolved on auditors. They were quite prepared to act as auditors for the usual fee, and for such work they would accept a very reasonable fee; but if they were called upon to perform, as they were, a continuous audit of the accounts, they would require the remuneration they had hitherto been paid. A very large proportion of the expenses this year for auditing had been absorbed by the Board of Trade on account of their official audit.

Mr. HILL thought that as comparison had been made between this Company and the Westminster Company, he would like to know how the question of capital bore.

The CHAIRMAN: I think that the less we say about our neighbours the better. You ought to be satisfied, I think, with what we tell you in our report, and you can yourselves look into the reports of other companies. I only ask you to look carefully into the affairs of this Company, and if you are shareholders in them, to look carefully into the affairs of other companies, and then make up your mind and form your own judgment whether we are acting wisely and properly, and in the interests of the general body of the shareholders. I believe that at the present time all the companies are more or less disappointed because they are not paying larger dividends. I have already told you that I am disappointed in the case of this Company on that account, but I see that there is a great future for us, and I am disposed to be patient. It is a new source of business. When gas was first established, those connected with that industry went through a great deal more trouble than we; and I say that looking to the advance of the electric light already and its youth in every sense, I anticipate its becoming one of the best investments in the City of London.

Mr. JOHN NEWTON said that about three years ago he took the same line as Mr. Young did, and referred to the number of companies that Sir John Pender was connected with. He pointed out that that gentleman was trying to control a capital of £20,000,000, that he was a Director of so many companies, and this, that, and the other. He then felt a little sore because his friends had been induced to put their money into it. Since then their capital had doubled, because they were then laying the foundation of a vast business, and they had got the benefit of it. It was that that caused him to rise and say that Mr. Young had made a mistake in one of his remarks. The Companies which the Chairman was connected with as regarded telegraphy had been enormously successful.

Mr. YOUNG: I did not say that they had not been.

Mr. NEWTON said he thought that Mr. Young had stated that where gentlemen were Directors of a great many companies it would be found that those companies had large amounts of debenture capital, and paid small dividends. The telegraph companies were burdened with a large amount of debenture capital, to which he objected, but they were, nevertheless, getting good dividends. Theirs was a company in which he thought they could very wisely wait patiently, and they might be sure that if they paid those who looked after the property well, it would be well managed.

The CHAIRMAN: You have heard the remarks which have been made by the different speakers, and you have heard my reply; and I will now ask you to approve of the resolution which I have moved, and which had been seconded by Lord John Hay.

The resolution was unanimously adopted.

Sir EYRE M. SHAW, K.C.B., then proposed the re-election of the retiring Directors, Lord John Hay, Mr. Joseph Charles Parkinson, and Mr. John Denison Pender. Those gentlemen had, he remarked, brought to bear on the business of the Company all the experience and knowledge which could be obtained in a lifetime of business habits. They had rendered very great service to the Company.

Admiral Sir GEORGE H. RICHARDS seconded the motion, which was unanimously adopted.

The auditors, Messrs. Deloitte, Dever, Griffiths and Co., were also re-elected.

A cordial vote of thanks was then passed to the Chairman and Directors for their services in the past year.

The CHAIRMAN: On behalf of my colleagues and myself I beg to thank you. I assure you that I always prefer that any feeling or grievance of any kind should be fought out at these meetings. We come by degrees to get a thorough knowledge of our shareholders, who on their part come to get a thorough knowledge of the Directors. You may depend that "unity is strength," and I have not the slightest doubt in telling you that I am quite sure that we shall become better friends every time we meet.

The proceedings then terminated.

Brazilian Submarine Telegraph Company (Limited).

The following is the report of the Directors to be submitted to the forty-first ordinary general meeting, to be held at Winchester House, Old Broad-street, E.C., on Wednesday next, May 2nd, at noon:—

The revenue for the half-year ended December 31, 1893, amounted to £96,261. 16s. 6d., and the working expenses to £24,284, 12s. 4d. After providing £12,880 for Debenture interest and sinking funds, and £1,423. 1s. 9d. for income-tax, there remains a balance of £57,674. 2s. 5d., to this is added the sum of £3,533. 6s. 9d. brought forward from June 30th last, making a total of £61,207. 9s. 2d. First and second interim dividends, amounting to £39,000, have been paid, and £20,000 transferred to the reserve fund, leaving the sum of £2,207. 9s. 2d. to be carried to the next account.

The receipts for the half-year include the sum of £1,500 dividend to June 30, 1893, on the Company's shares in the African Direct Telegraph Company (Limited).

In accordance with the provisions for repayment of the first issue of debentures, dated July 31, 1884, 187 bonds, representing £18,700, were drawn on the 20th inst. for payment at par on July 31st next. By this payment the first issue of debentures will be extinguished, and a reduction will be effected in the expenses of £19,360, the annual amount of the sinking fund and interest now payable in respect of this issue.

The new land lines between Buenos Ayres and Valparaiso constructed by the Pacific and European Telegraph Company (Limited), in which your Company has acquired a considerable interest, were opened for public service on March 19th last, with satisfactory and promising results. We are thereby again enabled to carry traffic to and from the West Coast of South America, and the public are thus afforded further facilities for telegraphic communication.

The various sections of the Company's line are in good working order.

Submarine Cables Trust.

The following is the report of the trustees to be presented to the twenty-third ordinary annual meeting of the certificate holders, to be held at the offices of the Trust, 50, Old Broad-street, London, on Thursday next, the 3rd prox., at 1 p.m.:—

The revenue for the financial year to April 15, 1894, including the balance of £80. 3s. 3d. brought from the previous accounts, amounted to £22,672. 19s. 5d.

During the past year the following coupons have been met:—

Due.	Paid.
April 15, 1893	£1. 10s. balance July 14, 1893.
October 15, 1893	£1. 15s. on account October 16, 1893.
	£1. 5s. balance February 1, 1894.
April 15, 1894	£1. 15s. payable April 16, 1894.

The expenses of the Trust amounted to £1,301. 7s. 4d., and the payments on accounts of the coupons to £21,131. 5s., together £22,432. 12s. 4d., leaving a balance of £240. 7s. 1d. to be carried forward.

The trustees regret to report the death, on May 7, 1893, of their colleague, Sir James Anderson, who was one of the original founders of the Trust. The meeting will have to elect two auditors for the current year; Mr. John G. Griffiths and Mr. John Gane offer themselves for re-election.

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NEW COMPANIES. STATUTORY RETURNS, &c.

[*In addition to the information given under this heading, detailed particulars of many of the Companies whose returns appear below will be found in* "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK, 1893, pages 320-348, *&c., &c.*]

THOMAS PARKER (LIMITED).—This Company was registered on April 19th, with a capital of £75,000 in £10 shares, to carry on business as electrical and mechanical engineers, electricians, and manufacturers of and dealers in machinery, materials, stores, appliances, and apparatus of every description applicable for or in connection with the supply, or use, of electricity or magnetism for any purpose, and to generate, accumulate, distribute, and supply electric, magnetic, or other force, for the purposes of light, heat, sound, motion, &c. The subscribers (with one share each) are:—John H. Woodward, Edmund S. G. Rees, William Armistead, Charles H. Iles, Lawley T. Smith, Mein Wilkie, and Robert Willcock, all of Wolverhampton.

JOHN SIMPSON (LIMITED).—This Company was registered on April 18th with a capital of £15,000, in £10 shares, to acquire the weaving shed, gas works, electric lighting works, &c., at Hapton, Lancs., the property of John Simpson, and to carry on the business (*inter alia*) suppliers of gas and electricity for the purposes of light, heat, and motive or other power.

WILLIAM SMITH AND BROTHERS (LIMITED).—Capital, £100,000, in £10 shares, machinists, iron and brass founders, metal workers, boiler makers, millwrights, tool makers, implement makers, mechanical engineers, &c.

TRAMWAY MOTOR COMPANY (LIMITED).—This Company was registered on April 18th with a capital of £200,000, in £10 shares (of which 5,000 are Preference), to enter into and carry into effect certain agreements to be made with the Connelly Motor Company (Limited), George. F. Mellen, and William N. P. Reid, for the acquisition of certain inventions, and in relation to the employment of motive or other agencies in tramways, railways, carriages, ships, &c.

VALENCIA AND ALBERIQUE TRAMWAYS COMPANY (LIMITED).—This Company was registered on April 17th with a capital of £1,000, in £1 shares, to acquire from Joaquin Latorre a concession granted by the Spanish Government for the making of a system of tramways between the towns of Valencia and Alberique; to enter into and carry into effect two agreements with the vendor for the acquisition of the concession, and for the construction of the tramways; and to carry on the business of tramway and omnibus proprietors, electrical engineers, and contractors for electric lighting in the Kingdom of Spain.

VULCAN GAS ENGINE COMPANY (LIMITED).—This Company was registered on April 14th with a capital of £1,000, in £1 shares, to enter into and carry into effect an agreement between Henry M. Dimsdale and the Company for the acquisition by the latter of certain patents relating to improvements in the construction of gas engines, and to carry on the business of engineers, tool makers, iron and brass founders, boiler makers, &c.

"WILLIAMS" VALVELESS ENGINE COMPANY (LIMITED).—This Company was registered on April 19th, with a capital of £25,000 in £1 shares, to carry on the business of engine and boiler makers and builders, metal founders, mechanical, electrical, and general engineers, &c.

ANDERS' TELEPHONE COMPANY (LIMITED).—The statutory return of this Company, made up to March 26th, has been filed; 3,607 £1 shares have been taken up, of which 3,000 were issued as fully paid to the vendors, George L. Anders and Walter Kottgen. Upon the remaining 607 shares the full amounts have been called and paid.

ANGLO-PORTUGUESE TELEPHONE COMPANY (LIMITED).—The annual return of this Company, made up to April 12th, has been filed. The nominal capital is £75,000, in £1 shares, and of these 50,000 were issued as fully paid to the Edison-Gower-Bell Telephone Company (Limited), of 53, New Broad-street, London, E.C., who now hold 37,400 shares. Share warrants, comprising 10 shares each, are outstanding to the extent of £4,020.

BIRMINGHAM ELECTRIC SUPPLY COMPANY (LIMITED).—The annual return of this Company, made up to March 20th, was recently filed, when the whole nominal capital of £100,000, in £5 shares, was subscribed for and allotted. Upon 20,000 shares a call of £2 per share has been made, while the full amount has been called on the remainder, resulting in the receipt of the full amount of £70,000.

BRITISH ELECTRIC LIGHT COMPANY (LIMITED).—At the time of filing the annual return of this concern for 1894, 8,641 shares of £10 each were taken up, of which 1,145 were issued as fully paid. Upon the remaining 7,496 shares the full amounts have been called and £74,960 paid.

BRITISH ELECTRIC PROPULSION AND TRACTION COMPANY (LIMITED). In consequence of neglect to file annual returns, steps are to be taken to strike the name of the Company from the Register or to enforce the penalty for such neglect.

BRITISH VOLTA ELECTRIC GLOW LAMP COMPANY (LIMITED).—The statutory return of this undertaking shows that out of a nominal capital of £2,000, in shares of £1 each, 542 have been taken up, of which 300 were issued as fully paid to William Habgood, and 100 to Edwin C. Lacey, for their interest in Provisional Patent No. 16,514 of 1893, for "Improvements in electric incandescent lamps." Upon the remaining 142 shares a call of 6s. per share has been made, resulting in the payment of £36. 13s., and leaving £5. 19s. in arrears.

GALLOWAYS (LIMITED).—The annual return of this Company, made up to March 12th, has been filed. 2,108 shares of £100 each had been taken up out of its nominal capital of a quarter of a million. Upon each of these shares the full amount has been called, and £210,800 has been paid in respect thereof.

GORSEINON ELECTRIC LIGHTING COMPANY (LIMITED).—The statutory return of this Company, made up to and filed on March 22nd, shows that 786 shares have been subscribed for out of a nominal capital of £1,000, in £1 shares. Upon each of these shares a call of 7s. 6d. has been made, resulting in the payment of £273, and leaving £21. 15s. in arrears.

CITY NOTES.

AFRICAN DIRECT TELEGRAPH COMPANY (LIMITED).—Notice is given in our advertisement columns that a drawing of 111 Four per Cent. Mortgage Debentures and of 14 of the Four per Cent. Registered Debentures (Series B) of this Company will take place at the offices, Winchester House, E.C., on Tuesday next, at noon.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY (LIMITED).—Our advertisement columns set out the numbers of the 187 Five per Cent. Debentures (1884 issue) which were drawn at the eighth and final drawing at the offices, Winchester House, E.C., on Friday last. These Debentures will be paid off at par on July 31st, at Parr's Banking Company and the Alliance Banking Company (Limited), Bartholomew-lane, E.C., after which date the interest thereon will cease.

CHARING CROSS, EUSTON AND HAMPSTEAD RAILWAY COMPANY.—We announced last week that the amount received in response to the application for capital had been returned to the subscribers. It is now stated that the prospectus is to be revised with the view of placing the scheme again before the public later in the year.

CITY AND SOUTH LONDON RAILWAY COMPANY (LIMITED).—The traffic returns of this Company for the week ended April 22nd were £886, as against £851 in the corresponding period of 1893, being an increase of £35. The total receipts for the half-year amounted to £14,612, as against £14,568 for the corresponding period of 1893, an increase of £44.

CITY OF LONDON ELECTRIC LIGHTING COMPANY (LIMITED).—The Directors forward the following returns relating to this Company for the quarter ended March 31st last, and state that it is their intention for the future to publish similar returns at the expiration of every quarter:—

	Quarter ended March 31st.	Corresponding quarter last year.
Revenue from sale of current for public lighting	£3,100	£2,778
Revenue from sale of current for private lighting, &c.	12,460	5,061
Total	£15,560	£7,839

No. of 8-c.p. lamps connected March 31, 1894, 84,634; increase during quarter, 19,293. No. of 8-c.p. lamps connected March 31, 1893, 85,275; increase during corresponding quarter last year, 15,034.

LONDON PLATINO-BRAZILIAN TELEGRAPH COMPANY (LIMITED).—The 16th ordinary general meeting of the shareholders of this Company will be held at the offices, 19, Great Winchester-street, E.C., on Tuesday, at 1 p.m. The Register of Transfers was closed on Tuesday last, and will remain closed until Wednesday next.

PANULCILLO COPPER COMPANY (LIMITED).—An extraordinary general meeting of this Company was held on Wednesday, at Winchester House, London, E.C., when resolutions were passed authorising the Directors to transfer the undertaking to a new company, to be called the Central Chili Copper Company (Limited), to be formed with a capital of £280,000.

SAN PAULO GAS COMPANY (LIMITED).—At the meeting of this Company, Mr. Frederick Delmar, who presided, said that, "with regard to the question of electric light competition which was alluded to on former occasions, he did not think there was much to fear, for several reasons. In the first place, with electric light a large expenditure had to be incurred in the first place for the cost of wiring, &c.; and with regard to the incandescent lamps, which were a great feature in electric lighting, the current was charged for at the rate of 7d. per Board of Trade unit, which, worked out volume for volume, gave a result in cost of about one-third more than gas. It was his opinion that under those circumstances they need have no fear, as the electric light would only be adopted by the richer portion of the community, while the poorer would continue to use gas. Added to that there was always a field for the utilisation of gas into which electricity could not enter; such as for cooking purposes and for heating and ventilating apparatus. They need, therefore, have no anxiety for the future." The speaker is evidently uninformed of the steady progress which is being made in the application of electricity to cooking and heating apparatus.

STOCK EXCHANGE NOTICES.—Application has been made to the Stock Exchange Committee by the Telegraph Construction and Maintenance Company (Limited) to grant a quotation to their £150,000 Five per Cent. Debentures in lieu of £150,000 Five per Cent. Bonds expired January 1, 1894. The Committee have appointed this day (Friday) a special settling day in the partly-paid scrip of £100,000 Five per Cent. Debenture Stock of the City of London Electric Lighting Company (Limited), and have ordered these securities, as well as the undermentioned, to be quoted in the Official List:—National Telephone Company (Limited), further issue of £74,983 Four and a-Half per Cent. Debenture Stock; Oriental Telephone

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and Electric Company (Limited), 171,504 shares, Nos. 1 to 171,504, in lieu of those of the old Company of the same name; W. T. Henley's Telegraph Works Company (Limited), 6,837 Ordinary shares, Nos. 602 to 1,091, and 1,182 to 7,528.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY (LIMITED).—This Company's traffic receipts for the week ended April 20th (after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited) were £2,940.

COMPANIES' SHARE LIST.

Present Amount	Amount of Share	Last Dividend	Name	Previous Week's Price, April 18.		Price Wednesday, April 25.		Rate per Cent. Yielded.	Dividend Due	Business Done During Week Ending April 25. Highest	Lowest
			TELEGRAPHS.					£ s. d.		Highest	Lowest
£1,134,640	Stock	9 0	Anglo-American	42	44	42	44	5 15 11	Jan., Apr., July, Oct.	–	–
£2,932,680	Stock	18 0	Do. Preferred	80	81	80	81	5 17 3	" "	81½	80½
£2,932,680	Stock	5/0	Do. Deferred	7¾	8¼	7¾	8¼	..	.. ..	7¾	..
£184,500	100	4%	African Direct Telegraph 4% Deb.(Reg.&Bearer)	100	103	101	104	3 16 11	January and July	–	..
130,000	£10	3/0	Brazilian Submarine	11¾	12¼	11¾	12¼	5 4 0	Mar., June, Oct., Dec.	12¼	11¾
£18,700	£100	5%	Do. 5 per Cent. Bonds	100	103	100	103	4 17 1	January and July	..	–
£75,000	£100	5%	Do. 5 per Cent. Bonds (2nd Series, 1906)	108	112	108	112	4 4 10	June and December	110	–
10,000,000	$100	$1¾	Commercial Cable Capital Stock	146	150	146	150	4 13 4	Jan., Apr., July, Oct.	..	..
16,000	10	8/0	Cuba Submarine	12	13	12	13	6 3 1	February and August	12⅝	..
6,000	10	10%	Do. Preference 10 per Cent.	18	19	18	19	5 5 3	" "	..	..
12,931	5	1/7½	Direct Spanish (£4 paid)	2½	3	2½	3	5 6 8	April and October	3	2½
6,000	5	10%	Do. Preference 10 per Cent.	8½	9	8½	9	5 11 1	" "	..	..
60,710	20	2 0	Direct United States Cable, 1877	9	9½	9	9½	7 8 11	Jan., Apr., July, Oct.	9½	9⅟₁₆
400,000	10	2/6	Eastern	14⅞	15½	14⅞	15½	4 5 11	" "	15⅟₁₆	14¾
70,000	10	6%	Do. 6 per Cent. Preference	16	16½	16	16½	3 12 9	" "	16¼	.
£1,294,100	Stock	4%	Do. 4 per Cent. Mort. Debenture Stock	114	117	114	117	3 8 5	May and November	116½	115½
£105,900	100	5%	Do. 5 per Cent. Debentures, 1899	107	110	107	110	4 10 11	February & August	..	..
250,000	10	2/6	Eastern Extension	15½	15⅞	15⅝	15⅞	4 8 2	Jan., Apr., July, Oct.	15¹³⁄₁₆	15⅟₁₆
£320,000	Stock	4%	Do. 4 per Cent. Debenture Stock	113	116	113	116	3 9 0	February & August	115½	114½
£62,700	100	5%	Do. 5 p. c. (Austln. Gov. Sub.) Debs 1900	103	106	103	106	4 14 4	January and July	104¾	..
£108,700	100	5%	Eastern & S. African 5 per Cent. Mor. Deb., 1900	103	106	103	106	4 14 4	" "	..	..
£300,000	100	4%	Do. 4% Mortgage Debentures 1909 (regd.)	104	107	104	107	3 14 9	February & August	..	..
£200,000	£25	4%	Do. 4% Mauritius Sub. Debs.	107%	110%	107%	110%	3 12 9	May and November	108½	..
180,227	10	2/6	Globe Telegraph and Trust	8⅝	8⅞	8¾	9	5 0 0	Jan., Apr., July, Oct.	9⅟₁₆	8⅞
180,012	10	6%	Do. 6 per Cent. Preference	15½	15⅞	15½	15⅞	3 18 1	" "	15¾	15½
160,000	10	5/0	Great Northern	21½	22½	21½	22½	3 16 7	Jan., April, and July	22½	
£200,000	100	6%	Do. 5 per Cent. Debentures, 1883 issue	104	107	104	107	4 13 6	March & September	106	105½
17,000	25	12/6	Indo-European	45	47	45	47	5 6 5	May and November	47	46½
37,548	10	4/0	London Platino-Brazilian	4	6	4	6	..	" "	–	–
£100,000	100	6%	Do. 6 per Cent. Debentures	106	109	106	109	5 10 1	March & September	..	–
£100,000	£100	4%	Pacific European Tel. 4% Guar. Debs. "Red 1942	102	105	102	105	3 16 2	..	..	–
11,839	8	4/0	Reuter's	5½	6½	5½	6½	..	April and October	.	.
8,381	£100 Cert.	35/0	Submarine Cables Trust 6 per Cent.	112	117	111	116	5 3 5	" "	115	111
15,693	10	5/0	West African Telegraph	3	5	3	5	..	January and July	..	–
£249,900	100	5%	Do. 5 per Cent. Debentures	100	103	100	103	4 17 1	March & September	102½	..
80,000	10	2/0	West Coast of America	2½	3	2½	3	..	January and July	..	..
£150,000	100	8%	Do. 8 per Cent. Debentures, 1902	102	106	103	107	7 9 7	June and December	106	105
83,821	10	1/0	West India and Panama	1½	1¾	1½	1¾	..	..	1½	..
34,563	10	6%	Do. 6 per Cent. 1st Preference	10½	10¾	10½	10¾	5 11 7	May and November	10⅝	10½
4,669	10	6%	Do. 6 per Cent. 2nd Pref.	9	10	9	10	6 0 0	" "	..	..
£80,000	100	5%	Do. 5 per Cent. Debentures, 1917	107	110	108	111	4 10 1	June and December	110	–
64,242	15	4/6	Western and Brazilian	7½	8	7½	7¾	..	May and November	7⅝	7⅟₁₆
88,129	7½	4/6	Do 5 per Cent. Cumulative Preferred	6	6½	6	6½	..	..	6½	..
88,129	7½	4/6	Do. 5 per Cent. Deferred	2	2½	2	2½	..	..	2⅟₁₆	..
£178,200	100	6%	Do. 6 per Cent. Debs., Series "A" 1910	105	108	106	109	5 10 1	February & August	..	–
£222,700	100	6%	Do. 6 per Cent. Mort. Debs. Series "B" 1910	105	108	106	109	5 10 1	" "	–	–
$1,214,000	$1,000	7%	Western Union 7% 1st Mtge (Building) Bonds	113	118	113	118	5 18 8	May and November	..	–
£169,000	£100	6%	Do 6 per Cent. Sterling Bonds	100	104	100	104	5 15 5	March & September	–	–
			TELEPHONES.								
44,000	5	10/0	Chili Telephone (fully paid)	1½	2½	1½	2½	..	–	..	–
224,350	10/0	3½d.	Consolidated Telephone Const. & Maintenance	⅟₁₆	⅟₁₆	⅟₁₆	⅟₁₆	..	May and November	..	–
230,000	£1	6d.	Oriental Telephone and Electric	..		¼	½	..	Yearly	..	–
484,597	5	2/6	National	4⅝	4⅞	4⅝	4⅞	5 2 7	June and December	4⅞	4⅞
15,000	10	6%	Do. 6 per Cent. Cumulative 1st Pref.	15	16	15	16	3 15 0	" "	15	–
15,000	10	6%	Do 6% Cumulative 2nd Pref. (fully paid)	14½	15½	14½	15½	3 17 5	" "	14⁹⁄₁₆	–
119,234	5	2/6	Do. 5% Non-Cumulative 3rd Pref.	5⅝	5⅝	5⅝	5⅝	4 8 11	–	5⁹⁄₁₆	5½
925,017	£100	4½%	Do. Deb. Stk. 4½%	116	118	116	118	3 16 3	January and July	117	116
58,000	5	1/0	United River Plate	1½	2	1½	2	–	" "	1⅝	..
£146,870	Stock	5%	Do. 5 per Cent. Debenture Stock	90	100	90	100	5 0 0	" "	–	–
			ELECTRICITY SUPPLY COMPANIES.								
40,000	£10	..	City of London Electric Lighting (fully paid)	11½	12½	12	13	–	–	12½	11⅟₁₆
20,000	10	6/0	Do. 6 per Cent. Cumulative Pref. (fully paid)	13½	13¾	13½	13¾	..	–	13½	–
19,900	£5	..	Electricity Supply Co. for Spain	..		..		..	–	–	–
£150,000	£5	..	Electricity Supply Company Ordinary	..		..		..	–	–	–
£59,900	£100	5%	Do. 5 per Cent. Debentures, 1900	..		..		–	–	–	–
8,322	£5	..	House to House Electric	..		..		–	–	–	–
15,000	£5	..	Kensington & Knightsbridge El. Light (fully paid).	..		..		–	–	–	–
10,000	£5	6%	Do. 1st Pref. Cumulative (fully paid)	..		..		..	January and July	–	–
80,000	£5	1/9	Liverpool Electric Supply (£4 10s. paid)	5¾	6½	5¾	6½	..	–	–	–
15,000	£5	2/6	Do. (fully paid)	6½	6⅞	6½	6⅞	..	–	..	–
111,000	5	..	London Electric Supply	½	¾	½	¾	.	–	..	–
49,900	£10	4/0	Metropolitan Electric Supply (fully paid)	7½	7¾	7½	7¾	2 11 7	..	7⅟₁₆	7½
£100,000	Stock	5%	Do. 5% Debs. (Bonds of £10, £20, & £40)	106	109	106	109	4 11 9	June and December	..	–
6,452	£10	..	Notting Hill Electric	4½	5½	4½	5½		–	–	–
19,930	£5	4/6	St. James' and Pall Mall	6½	6¾	6¾	7½	.	–	7	6⁹⁄₁₆
20,000	£5	7%	Do. 7 per Cent. Preference	8	8½	8	8½	4 2 4	–	8⅜	8⅟₁₆
59,900	5	2/6	Westminster Electric Supply (fully paid)	5¾	6½	5¾	6½	3 4 0	–	6⅟₁₆	6
			ELECTRIC MANUFACTURING, &c., COMPANIES.								
90,000	3	1/6	Brush Electrical Engineering	2⅞	3½	2⅞	3	6 0 0	–	3	2¹⁵⁄₁₆
90,000	2	6%	Do. 6 per Cent. Pref. Non-Cumulative	2⅛	2⅝	2⅛	2⅝	5 1 1	–	2⅟₁₆	2½
£125,000	Stock	4½%	Do. 4½ per Cent. Debentures	103	111	103	111	4 1 1	March & September	–	..
20,000	5	2/6	Crompton and Co., 7 per Cent. Cumulative Pref.	3½	3¾	3½	3¾	..	January and July	3⅝	..
12,139	5	..	Edison and Swan United	–		–		.	–	–	–
£20,000	£5	..	Electric and General Invest. Ordinary (£1 paid)	..		..		..	–	–	–
120,000	2	..	Electric Construction	½	1	..		.	–	–	
12,845	2	..	Do. 7% Cumulative Pref.	1½	1¾	1½	1¾	..	..	..	
91,195	2	10/0	Elmore's Patent Copper Depositing	½	¾	½	¾	–	–	..	–
20,000	5	..	Fowler-Waring Cables (fully paid)	½	1½	½	1½	..	–	–	..
59,000	10	15/0	India Rubber, Gutta Percha &c., Works	23	24	23	24	6 4 2	February & August	23⅝	23½
£300,000	100	4½%	Do. 4½ per Cent. Debentures, 1896	101	105	101	103	4 7 5	March & September	–	..
11,334	£10	6/4	International Okonite Ordinary	1	2	1	2	–	–	–	–
16,000	£10	..	Do. 8 per Cent. Preference	–		–		–	December and June	–	–
20,900	9	..	Manchester Edison-Swan "A" (£1 paid)	—	½	—	½	–	..	–	..
78,919	5	3/6	Swan United (£3. 10s. paid)	2	2½	2	2½	7 0 4	May and November	..	
37,350	12	36/0	Telegraph Construction and Maintenance	38	40	39	41	5 17 1	March and July	39¾	39
£150,000	100	5%	Do. 5 per Cent. Bonds, red. 1894	–		–		..	January and July	–	–
37,514	£5	–	Woodhouse and Rawson Ordinary (£3. 15s. paid)	–		–		–	–	–	–
41,095	£5	–	Do. Preference (fully paid)	–		–		–	–	–	
			RAILWAYS AND TRAMWAYS.								
£680,000	Stock	3%	City and South London Railway	27	32	27	32	1 19 0	May and November	–	..
87,590	£10	1%	Liverpool Overhead Railway	7⅜	7⅝	7	7½	–	–	–	–

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